Accounting

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Accounting

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M O D U L E

Strategy and Management Accounting

Version 1.1

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Strategy and Management Accounting

Strategy and Management Accounting

REQUIEM FOR REEL TAPE

Reel Tape was a great company to work for in the 1960s. We were one of the premiere companies in the reel-to-reel tape business. There was little competition on the West Coast, and we had the region pretty much to ourselves. When cassettes came in, we switched our product line but not our attitudes. We still did business the old way. But the market had changed. There was competition from the Europeans, the Japanese, and from other Far East producers. These competitors were pricing products below our costs. They had also improved their quality, were delivering products on time, and were introducing new products such as high bias chromium oxide tapes before we did. When we woke up, it was too late. We discovered that we had lost touch with our customers. Many had left or were leaving us. Why did we not wake up earlier?

I guess there are many reasons, but an important one was the lack of a good management accounting system. We thought of accounting systems as necessary evils for external financial and tax reporting. As long as we were making money, no one cared. The words from the song in the musical Evita captured our mood:

When the money keeps rolling in you don't keep books
You can tell by the happy grateful looks
Accountants only slow things down, figures get in the way…

When we began to address our problems seriously, we found out that our accounting system had no information on many of the questions our management needed to know. For example, we did not collect information on:

What were our defect rates and sales return rates?
What caused our quality problems?
What was our on-time delivery record? What was the competition's record?
Which market segments and customers were more profitable?
Which types of cassettes had higher profit margins?
What was it costing us to introduce new products late?

I can go on with this list. The point is we mistook the profits we were showing on our external financial statements for profits we could sustain!

This story comes from an interview the authors did a few years ago with a senior executive of Reel Tape Inc. It is a real company whose name is disguised for privacy reasons. The story, however, is true and very familiar. Insert Xerox, Eastman-Kodak, Ford, Chrysler, GM, Harley-Davidson, Caterpillar, and many other U.S. and European companies, and the story probably captures the experiences of these companies in the 1970s and early 1980s. Fortunately, unlike Reel Tape Inc., these companies woke up and turned things around. What is noteworthy is that a good management accounting system played an instrumental role in supporting the comeback of these companies.

▲ PURPOSE OF THIS MODULE

The story of Reel Tape Inc. illustrates the importance of a good management accounting system for accomplishing key organizational objectives. These include providing the information the firm needs to help it produce low cost products, maintain quality, deliver on time, and keep up with the pace of innovation. Reel Tape's story raises two important questions that are addressed in this module.

▲ What is management accounting and what role does it play in an organization?

▲ What are the attributes of a good management accounting system?

In developing answers to these questions two conceptual triangles are introduced. Learning to use these two triangles will help understand, evaluate, and even design a good management accounting system.

Key Point

The first triangle focuses on quality, cost, and time (QCT). This is the strategic triangle. It highlights the three strategic variables that are the central objectives of most organizations today.

Key Point

The second triangle focuses on the technical, behavioral, and cultural (TBC) attributes of management accounting information. This is the attribute triangle. It focuses on the properties needed in a good management accounting system.

▲ WHAT IS MANAGEMENT ACCOUNTING?

Management accounting is a system of measuring and providing operational and financial information that guides managerial action, motivates behaviors, and supports and creates the cultural values necessary to achieve an organization's strategic objectives.

There are four key ideas contained in this definition of management accounting. These ideas capture the nature, scope, purpose, and attributes of management accounting.

1. By ***nature*** management accounting is a measurement process.
2. The ***scope*** of management accounting includes financial information, such as cost, and operational information, such as percentage of defective units produced.
3. The ***purpose*** of management accounting is to help an organization reach its key strategic objectives. It is not meant for mandated financial and tax reporting purposes.
4. Good management accounting information has three ***attributes:***

   ▲**Technical—**it enhances the understanding of the phenomena measured and provides relevant information for strategic decisions.

   ▲**Behavioral—**it encourages actions that are consistent with an organization's strategic objectives.

   ▲**Cultural—**it supports and/or creates a set of shared cultural values, beliefs, and mindsets in an organization and society.

This definition of management accounting contains some ideas that are different from other definitions of the field. For example, the Institute of Management Accountants (IMA), the professional association of practicing and academic management accountants, defines management accounting as:

> The process of identification, measurement, accumulation, analysis, preparation, interpretation, and communication of financial information used by management to plan, evaluate, and control within an organization and to assure appropriate use of and accountability for its resources. Management accounting also comprises the preparation of financial reports for nonmanagement groups such as shareholders, creditors, regulatory agencies, and tax authorities.[1]

A comparison of IMA's definition with the one used in this module reveals several key differences:

- ▲ The IMA definition focuses heavily on what management accountants do. The definition in this module includes their list but emphasizes the purpose of these activities—attaining strategic objectives.
- ▲ The IMA definition includes only financial information. This module includes operational information as well. Both financial and operational data are critical if a firm is going to be able to compete.
- ▲ The IMA definition includes nonmanagement reporting for tax and regulatory purposes as part of management accounting. We agree that it is management's function to prepare these statements. However, these reports have to conform to mandated rules and do not provide the type of strategic information management needs. The focus in this module is on strategic management reporting.
- ▲ Finally, the IMA definition is silent on the attributes of management accounting information. The definition in this module gives prominent recognition to the three attributes of management accounting.

The next section explains more fully the key ideas in our definition.

▲ NATURE AND SCOPE OF MANAGEMENT ACCOUNTING

Management accounting systems report the results of operations using financial and nonfinancial measures. These systems also help project and plan future operations. The Reel Tape Inc. story contains several examples of information that managers need. These include better product cost data and metrics of on-time delivery of products. These items exemplify two of the many measures dealt with in management accounting. Cost is an example of a measure expressed in financial terms, while on-time delivery is an example of an operational measure.

Learning the procedures for measuring, collecting, reporting, interpreting, and presenting these data to managers is the subject matter of managerial accounting. There are formal procedures that govern the measurement process. However, applying these procedures poses problems since there are many alternative methods of measuring the same phenomenon. For example, product cost or customer profitability can be computed in several ways. Similarly, quality can be measured using a variety of methods. Each alternative is a valid measure, and each may be useful under certain conditions. Understanding these multiple methods of measurement, and knowing when and how to use them, is a major part of studying management accounting.

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[1] National Association of Accountants (former name of the Institute of Management Accountants), Statement on Objectives of Management Accounting, New York, 1981.

▲ PURPOSE OF MANAGEMENT ACCOUNTING—THE STRATEGIC TRIANGLE

The fundamental purpose of management accounting is to help an organization achieve its strategic objectives. Meeting these objectives satisfies the needs of its customers and other stakeholders. Typical stakeholders include shareholders, creditors, suppliers, employees, and labor unions.

Strategy is the way that a firm *positions* and *distinguishes* itself from its competitors. Positioning refers to the selection of target *customers* or *markets*. Distinctions are made on the three dimensions of *quality, cost,* and *time*. Different customers have different expectations about the features and performance reliability (quality) they want in a product, the price (cost) they are willing to pay, and when and how quickly they want the product or services delivered (time). An ice cream company, such as Häagen Dazs, specializes in premium high butterfat content and high priced ice creams. Häagen Dazs is quite different from Lady Lee which makes an everyday variety of low butterfat and lower priced ice creams. The two companies compete for different types of ice cream consumers. Häagen Dazs also competes more directly with Ben & Jerry's on providing a high quality premium ice cream, at the best price (cost), with timely introduction of new flavors.

A typical statement of strategic objectives contains elements of both positioning and distinction. Consider the following statements of strategic goals from DIRECTV, a unit of Hughes Electronics Corporation that markets direct broadcast satellite systems (DBSS).

- ▲ Continue expanding marketing efforts in the United States to increase subscriber base.
- ▲ Increase customer value with superior programming choice, quality, and additional programming packages.[2]

Think Along

Can you identify the elements of quality, cost, and time implicit in DIRECTV's strategic goals?

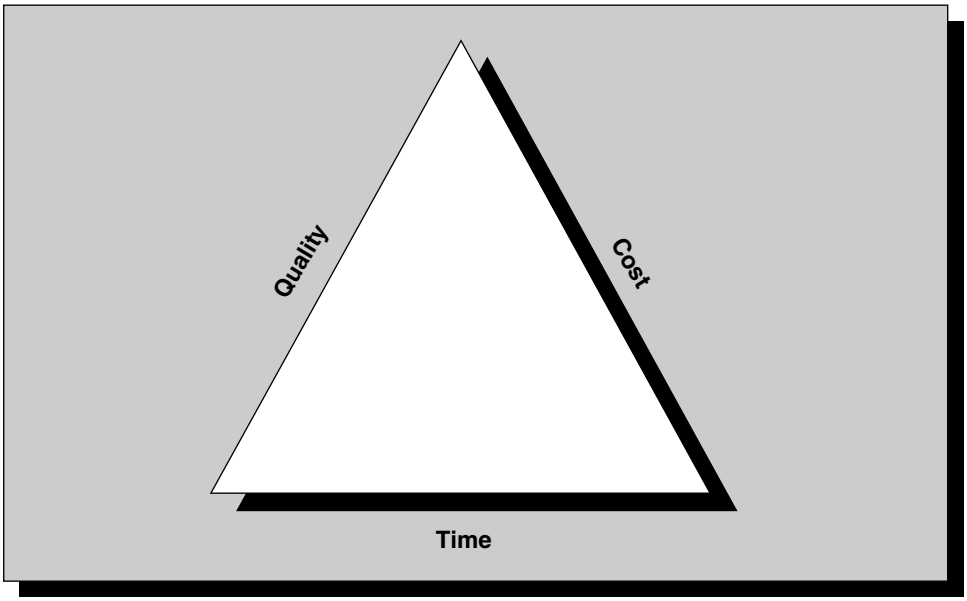
DIRECTV is positioned to compete for subscribers currently served by cable TV companies and sellers of traditional 12- to 18-foot satellite dish antennas. It plans to distinguish itself from competitors by providing more programming choices at a lower price (cost), multiple start times for the same movie (time), and superior video and sound using digital technology (quality).

Nonprofit organizations make the same types of distinctions. The Guggenheim Museum of Art in New York appeals to patrons and art lovers with an interest in contemporary art. The Metropolitan Museum of Art in New York has a wider range of art work and attracts different patrons and art lovers. Both compete on the quality of the museum visit experience and through the timely introduction of new exhibits.

Historically it was common for organizations to take a one-dimensional approach to strategy. For example, some business firms chose to compete by being low cost producers. Others chose to differentiate their product through quality or service. Still others focused exclusively on the timely introduction of innovative products or technologies. The Reel Tape story shows that today most organizations face stiff global competition. To keep

[2] Excerpted from Hughes Electronics Corporation Annual Report, 1995, p. 22.

Exhibit 1
The Strategic (QCT) Triangle



customers[3] satisfied and meet the demands of other resource providers, contemporary firms must compete ***simultaneously*** on three dimensions: quality, cost, and time. These three elements form a strategic triangle. Each one is quite broad.

- **Quality** is the total experience of a customer with a product. It includes the physical characteristics of a product, such as its *features,* and the reliability of *performance* of these features. Quality also includes service features such as after-sale support and service, and the performance level at which these services are performed by an organization.
- **Cost** includes the resources expended by producers and their support organizations such as suppliers and dealers. Production costs encompass the entire "value chain," that is, all parties from suppliers to after sales service and disposers or recyclers that create value for customers. Cost also includes resources expended by customers. Customer's cost includes the cost of maintaining and disposing of a product. This is often called their "cost of ownership."
- **Time** means that existing products must be available when a customer needs them. Time also means that a firm develops products with new features or innovative technologies rapidly and takes these products to the market quickly. It also encompasses the time it takes to complete a cycle of activities such as start to end of production.

Exhibit 1 is a depiction of this strategic triangle. This triangle is critical in understanding how to design and evaluate management accounting systems, and is used repeatedly when discussing specific management accounting measures.

[3] The term customer is used in a generic sense. The customer may be another department or an outside buyer. Also the customer may be the public at large, as in the case of government agencies. An organization may have many classes of customers. A university's customers include students, alumni, employers, and taxpayers.

Key Point

Management accounting is not an end by itself. It is an important tool for achieving an organization's strategic goals.

The triangle in Exhibit 1 is simply a convenient way to capture the many elements of competitive strategy. While the basic elements of strategy have been in the literature for a long time, the use of a trilogy to represent them is recent. This triangle is very similar to one used by Arthur Andersen.[4] Robin Cooper uses a three-dimensional space represented by price (cost), quality, and functionality to represent competitive strategy.[5]

The three elements of the strategic triangle are relevant to all organizations: business, government, and not-for-profit. These organizations face the same demand for low cost, high quality, and timely delivery of product or services. For example, universities must provide a quality education at an affordable cost while offering classes when students need them.

Finally, note that the *specific* meaning of quality, cost, and time varies by the nature of an organization or product. For instance, quality in the case of a car means features (comfort of ride, safety, music system, etc.) and reliability (frequency of repairs). Quality in the case of education is harder to define. It may be general literacy, job skills, thinking ability, communication skills, and so on. Similarly, time for a manufacturer of semiconductors such as INTEL may mean being first to market on the next generation of microprocessors. For a company such as Federal Express, time means on-time delivery.

▲ THE NATURE OF STRATEGIC MANAGEMENT ACCOUNTING

To have strategic value, management accounting must help accomplish the three strategic objectives of quality, cost, and time by providing information that:

1. Links the daily actions of managers to the strategic objectives of an organization.
2. Enables managers to effectively involve the entire extended enterprise of customers, suppliers, dealers, and recyclers in achieving the strategic objectives.
3. Takes a long-term view of organizational strategies and actions.

Linkage to daily actions.

Achieving strategic goals requires linking the daily actions of everyone in an organization to the larger strategic objectives. The Japanese refer to this as hoshin planning or "policy deployment."[6] The following story illustrates this concept of linkage.

> A computer equipment manufacturer in the Midwestern United States prided itself on communicating its strategies so that every employee at every level of the organization was aware of the company goals. Some skeptical outsiders visiting the plant decided to test this claim. They asked a janitor sweeping the factory loading dock how his job related to the goals of the company. The janitor replied as follows. "My company's goal is to reduce the cost of its

[4] See Steve Hronec. *Vital Signs: Using Quality, Cost and Time Performance Measures to Chart Your Company's Future,* Arthur Andersen & Co., 1993.

[5] Robin Cooper. *Cost Management in a Confrontation Strategy,* Harvard Business School Press, 1994.

[6] For a discussion of hoshin planning and strategy deployment in general, see S. Ansari, J. Bell, and J. Blumenthal. *Strategy Deployment In Organizations,* Research Monograph, Arlington, Texas, CAM-I, 1993.

products. A major cost for us is inventory. We recently shifted to just-in-time production to reduce inventory stocking cost. This means that our suppliers deliver products to us every two hours. If I do not clean this loading dock before the next load arrives, we are unable to accept delivery. This would set back the production schedule in the plant and increase the cost of production. We would also have the added cost of returning the materials to the supplier."

A key point of this story is that successful communication allowed the janitor to link his daily actions to the organization's strategy. It encouraged him to behave in ways that helped the company reach an important objective of reducing inventory. In addition, the linkage allowed the janitor to give meaning to his work. He was important to the accomplishment of a larger strategic objective!

Management accounting performs a similar function for individuals in an organization. It provides operational and higher management with the information that helps them do their job and achieve the quality, cost, and time objectives of the organization.

- ▲ Management accounting information helps managers achieve ***quality*** goals by measuring and reporting the resources used in preventing defects; the cost of reworking defective units; the cost of doing warranty repairs; lost sales from selling poor quality products; new investment needed for increasing product quality; and by determining whether the spending on quality is producing tangible financial benefits.
- ▲ Examples of information that helps managers attain the strategic objective of ***cost*** management include reporting resources consumed by the products produced during a period; measuring resources consumed by activities performed in a period; analyzing factors that drive or cause costs to be incurred; analyzing product profitability; analyzing suppliers' cost structures; and comparing (benchmarking) their cost against competitors' costs.
- ▲ Management accounting helps attain the strategic objective of ***time*** by measuring and reporting lost sales and profits from late product introductions; costs of delayed deliveries from suppliers; sales from new versus old products; response time to ship customer orders; and unused capacity available for new product introductions.

Exhibit 2 captures this interactive relationship between organizational strategies, management accounting, and the daily activities of individuals in the organization. The information flows in both directions.

Exhibit 2
Role of Management Accounting In Strategy Deployment

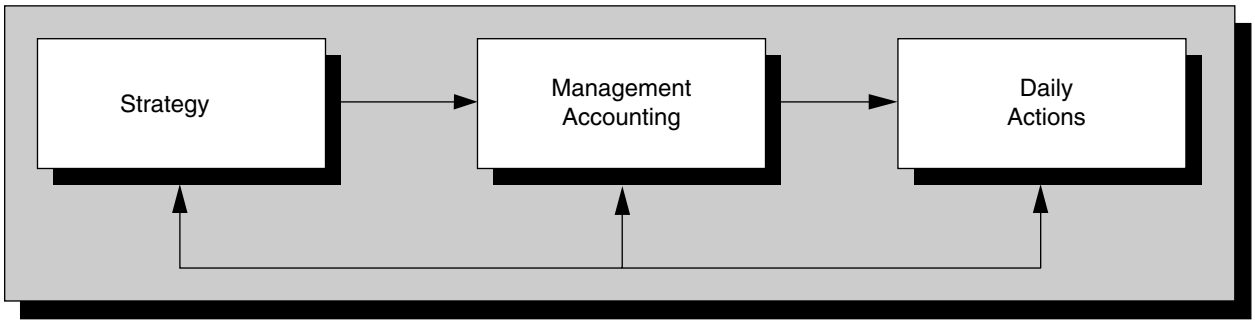
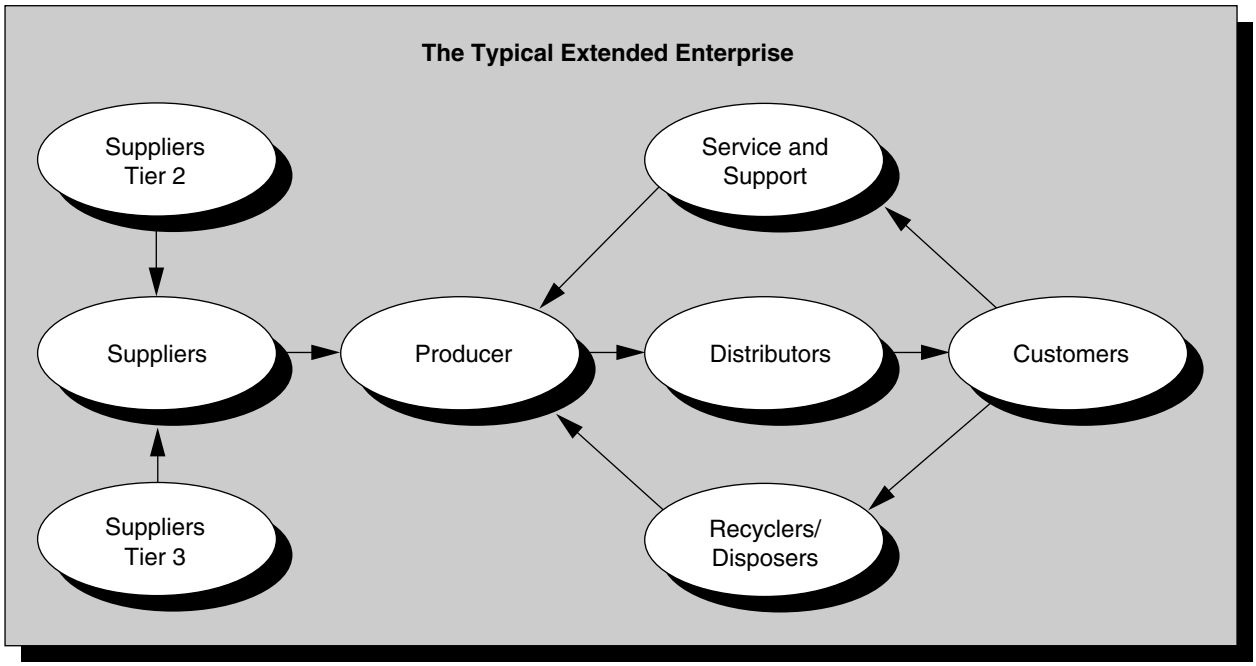


Exhibit 3
Value Chain or the Extended Enterprise

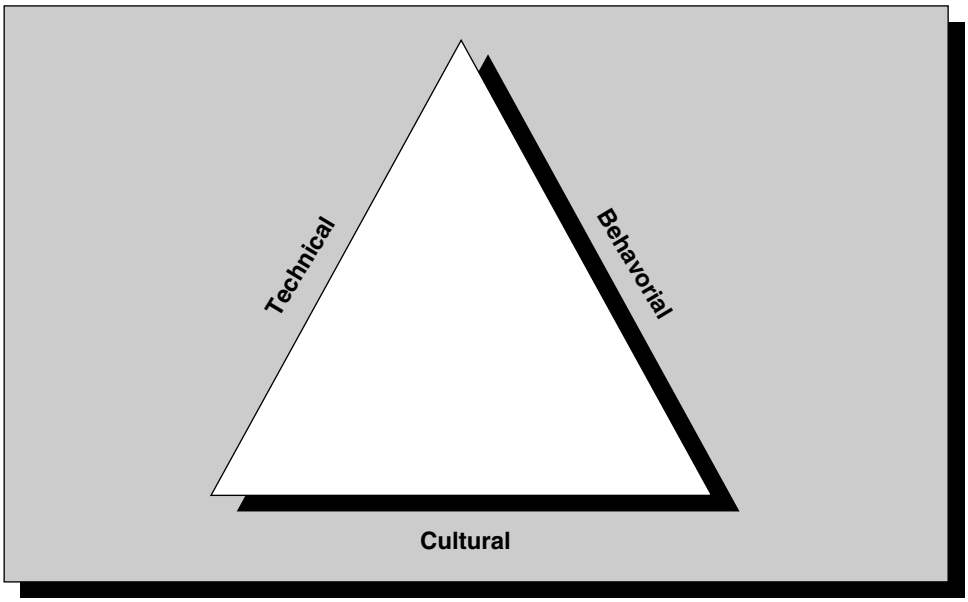


Extended enterprise.
Most organizations are dependent on their suppliers, dealers, and recyclers to meet the quality, cost, and time requirements of their customers. These interdependencies are part of a firm's value chain and represent the extended enterprise that is involved in serving customers. Exhibit 3 shows the typical extended enterprise for a business firm.

Management accounting must help management focus beyond the legal organizational boundaries by providing pertinent information from or about the extended enterprise. Some examples of the type of management accounting information needed about the extended enterprise are: customer expectations of features and price; percent distribution of cost between internal and external parties; impact of management's actions on suppliers' costs and margins; dealer's cost of marketing and servicing the product; dealer's data on customer perception of quality; and environmental disposal and recycling costs.

Long-term view.
Actions taken to reduce short-term costs may adversely affect the long-term interests of an organization. For example, using cheaper materials or environmentally unsafe materials may save in the short term, but create higher costs or poorer quality in the long term. A management accounting system should provide information that makes the long-term impact of management decisions visible. A good example is measuring life cycle costs, or the cost of owning a product over its life. In making its own product and choosing its suppliers, a firm needs to consider customers' operating, repair, maintenance, and disposal costs as well as their initial purchase cost.

Exhibit 4
Attributes of a Good Management Accounting System—The (TBC) Triangle



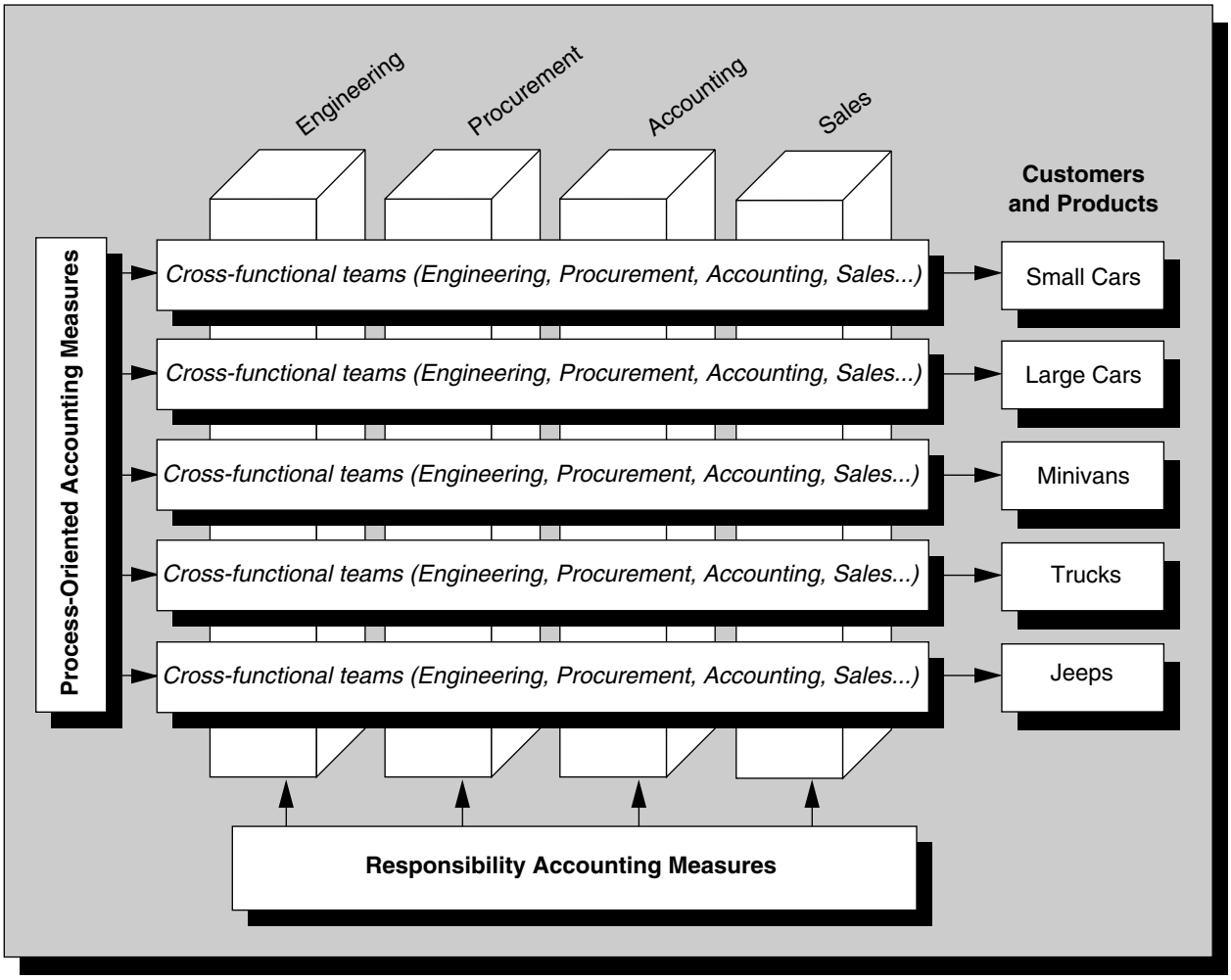
▲ ATTRIBUTES OF A GOOD MANAGEMENT ACCOUNTING SYSTEM

Our definition of management accounting emphasizes three key attributes of good management accounting information: the technical, behavioral, and cultural attributes. These three attributes represent the attribute triangle shown in Exhibit 4. The attributes are explained in the following text.

Technical attributes refer to *the measurement related qualities* desired in management accounting information. All good measurements have two key technical properties: decision relevance and process understanding.

- ▲ *Decision relevance*. A measure is decision relevant if the information it provides changes and improves decisions. Further, the change should be positive, that is, it improves payoff from that decision. If management information is ignored or does not enter into management decisions, then it lacks decision relevance. For example, many accounting systems continue to collect and report detailed information about labor usage in a factory even after automation has made labor costs an insignificant proportion of total costs. That information is processed and stored, unused by anyone.
- ▲ *Process understanding*. Traditionally, management accounting was based on the principle of "responsibility accounting" which focuses on measuring results and assigning them to individuals or organizational units. This reflects a philosophy of managing people and units. Today managers understand that results are a function of how work processes are organized. A work process is a connected set of tasks performed to produce products or services. Since work flows horizontally, that is, across organizational units, and a responsibility accounting system measures

Exhibit 5
Responsibility Versus Process Focused Management Accounting



results by departments (vertically), the system does not provide the information needed to manage work. A process-oriented management accounting system is needed. Exhibit 5 uses Chrysler Corporation as an example to show the difference between responsibility-focused and process-focused management accounting.[7]

As Exhibit 5 shows, making cars requires specialists from various functional areas such as production, procurement, engineering, accounting, and sales to work together to meet customer needs. At Chrysler, the work teams are called "platform teams." Each platform team includes people from all major functional areas. The team is responsible for a product family such as small cars, jeeps, and so on. They carry out all the work on the product from design, sourcing, manufacturing, sales, service, and support.

[7] Exhibit 5 shows only some of the many organizational units that are part of Chrysler's platform teams. It is only to emphasize cross-functional nature of work and not provide a complete work flow diagram for Chrysler.

A responsibility accounting system measures the outputs and results of the specialized organizational units, such as engineering, purchasing, manufacturing, or sales. A good example of a responsibility oriented measure is whether engineering has designed a car within the engineering design budget. A process-oriented accounting system measures the results of the platform teams and how their work processes satisfy customer needs. An example of a process-oriented accounting measure is whether a car design meets a customer's (price-cost) target.

Key Point

> Responsibility accounting systems focus on the goals of individual organizational units. Meeting these goals does not guarantee customer satisfaction. A process-oriented accounting system measures the outputs of cross-departmental work processes relative to customers' needs.

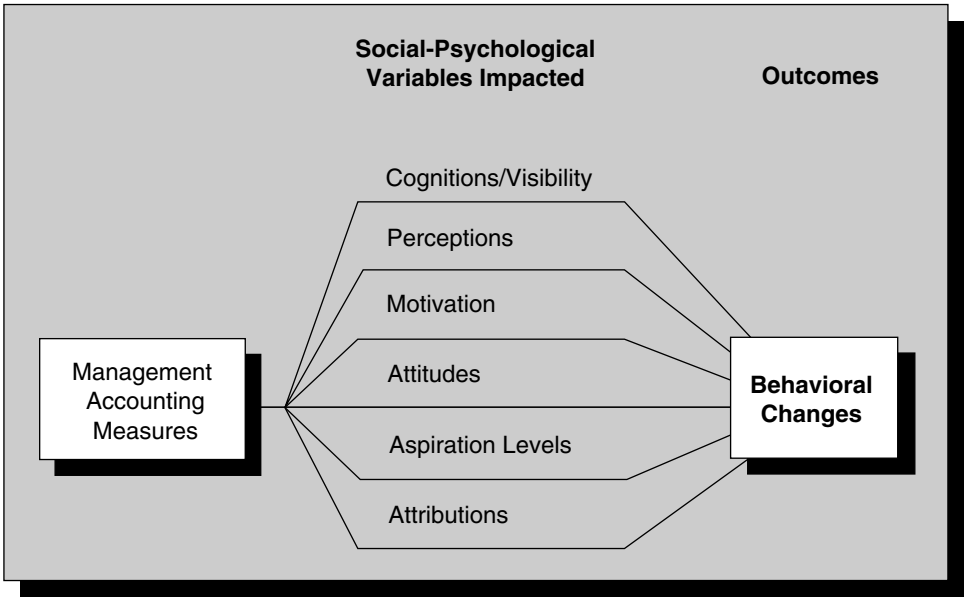
A good process-oriented management accounting system helps managers to:

- ▲ Understand *causal relations*. For example, management accounting can aid in understanding what *drives* or *causes* costs or why there is unproductive or idle capacity.
- ▲ Identify *nonvalue-added* or *dysfunctional* activities. For example, management accounting assists work process redesign by identifying unsynchronized or redundant tasks or activities that do not address customer requirements.
- ▲ Comprehend *relationships* between the various parts of a value chain. For example, management accounting information can show the impact of supplier or dealer actions on what a customer ultimately pays for a product.
- ▲ Isolate *process bottlenecks* inside or outside a firm. For example, management accounting can show what parts of a work process (machine or human) constrain the productivity of a system and result in customer dissatisfaction.

Behavioral attributes refer to the ways that measurements affect behavior. There are several ways in which management accounting measures can impact the behavior of people in organizations. Management accounting:

- ▲ *Changes cognitions and alters perceptions* by making things visible. What is measured takes on an air of importance and precision. People attend to measures; they assign greater decision weight to measured items. For example, measuring environmental costs highlights their existence and makes them visible to decision makers.
- ▲ *Motivates* behavior. When items are measured, they also signal desired behaviors. People typically respond to these measures by changing behavior. Measuring the percent of deliveries made on time motivates purchasing agents to select suppliers who have good delivery records.
- ▲ Changes *attitudes* and *aspirations*. Measures, particularly evaluative, have a tendency to change attitudes and aspiration levels. For example, a time standard for performing a task establishes a target which employees expect to be able to achieve with reasonable effort. When they succeed, they may revise their aspiration level upward resulting in even better performance next time. When they fail, their aspirations and performance may be lower in the next period.
- ▲ Changes *attributions*. People have a tendency to attribute success to their decisions and actions while they attribute failure to environmental factors beyond

Exhibit 6
Behavioral Impact of Management Accounting



their control. Research shows that these causal attributions can be changed by management accounting measures and ultimately can lead to changed behaviors as well.

Exhibit 6 summarizes how management accounting impacts the behavior of people in organizations by influencing several intervening social-psychological variables.

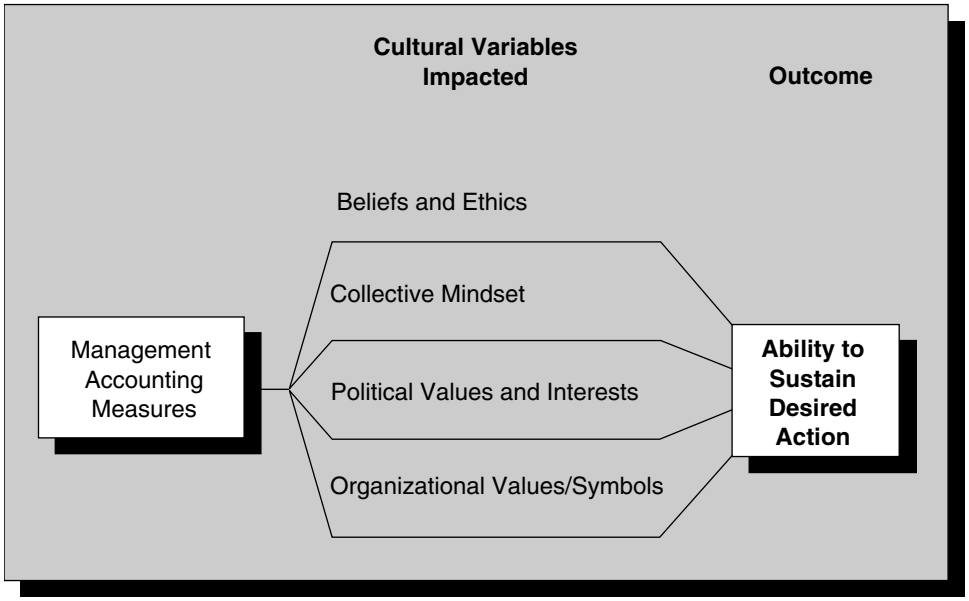
Cultural attributes refer to the beliefs, values, and mindsets imbedded in a measure. Management accounting measures are symbols that reflect and support values, beliefs, and mindsets of members of an organizational or societal culture. These collectively shared beliefs guide the behavior of people at the *subconscious* level. The resulting behaviors are easier to sustain because they are not driven by the threat of punishment or the lure of rewards, but because people believe in them.

Values are used to interpret the meaning of accounting measures. If these measures are consistent with the beliefs, values, and symbols important to the groups people belong to—family, firm, community, ethnic group, or country—then it is likely these measures will be acceptable as a basis for action. For example, if individuals believe that meeting budgets reflects that they are disciplined, hard working, and responsible, then they will try very hard to achieve the budget.

Accounting measures can signify *different* cultural dimensions. Four important ones are:

- ▲ *Beliefs and ethical values* are used to interpret and decide whether an action is worthwhile. Fiscal prudence is a strongly held belief in many cultures. Honesty and integrity are ethical values in most societies. Measures that support these beliefs and values are likely to provide a better base for action than those that conflict with beliefs and ethical values.
- ▲ *Mindsets* represent the collective world view that dominates the thinking of a group, culture, or society. Measures that are at odds with the collective mindset are not accepted. The use of financial measures of quality are likely to be

Exhibit 7
Cultural Impact of Management Accounting



unacceptable in a hospital that has a collective mindset that quality health care cannot be measured.

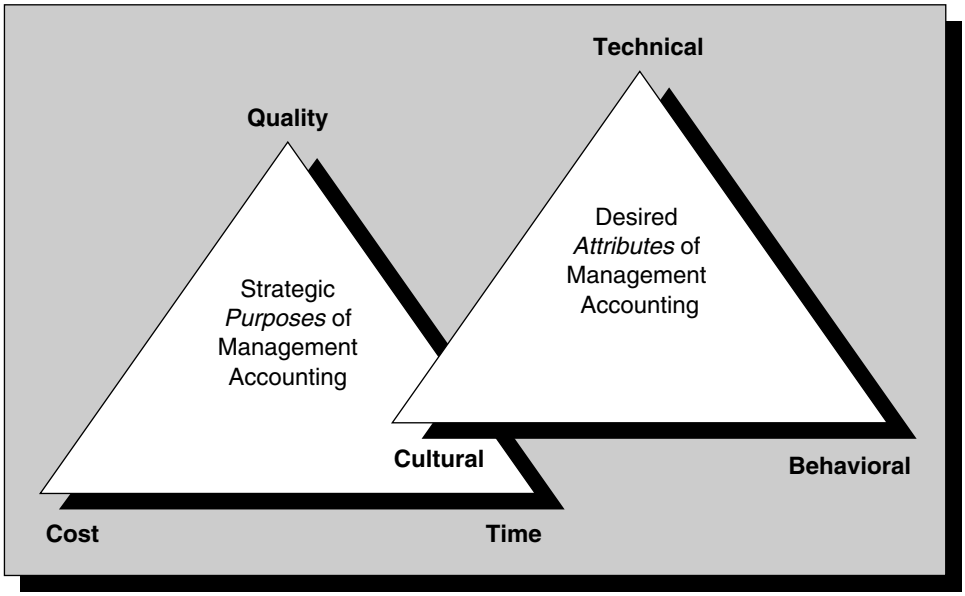
- *Political values* are a special type of cultural values. These deal with values that impact resource distribution or other interests of groups in society. For example, measures such as cost per patient or cost per student reflect a political value of efficiency and influence the amount of resources available to a hospital or a university. When measures violate the political values and interests of certain groups, resistance will be generated.
- *Organizational values* are another special case of cultural values. These reflect the image and focus of a particular organization. An organization whose culture is built around tradition, stability, and formal authority is less likely to accept accounting measures that promote change and egalitarian work processes.

Exhibit 7 shows the cultural variables impacted by management accounting measures and how this affects the ability to sustain desired action by an organization.

▲ USING THE TRIANGLES TO EVALUATE MANAGEMENT ACCOUNTING METHODS

How are the strategic and attribute triangles used to evaluate alternative management accounting methods, measures, and systems? The two triangles are intimately linked together. The strategic triangle focuses on what is important for organizational success. The attribute triangle pinpoints properties needed in management accounting information to attain strategic goals. The strategic triangle provides a concrete way to define the technical, behavioral, and cultural attributes of accounting information. The two triangles,

Exhibit 8
The Mutual Dependence Between the Strategic and Attribute Triangles



therefore, are mutually reinforcing and dependent upon each other. This mutual dependence between the two triangles is depicted in Exhibit 8. It is used to examine and explain specific management accounting topics in the other modules.

This mutual dependence can be illustrated in several ways. The attribute triangle shows that management accounting information should have the technical properties of decision relevance and process understanding.

Consider some typical information and measures provided by management accounting systems:

- ▲ Costs to produce products.
- ▲ Resources used by activities.
- ▲ Deviations between budgeted and actual cost for factory rent.
- ▲ Sharing (allocation) of common costs between products.
- ▲ Costs of using a distribution channel.
- ▲ Profitability by customers.
- ▲ Lost sales from lost customers.
- ▲ Production cycle time (time from start to finish) for products.
- ▲ Fines from improper material handling.

Think Along

Are these measures decision relevant? Why?

The strategic triangle defines decision relevance as the ability of a method to provide information about the way costs, quality, or time variables are managed. The decision relevance of the items listed above can be evaluated by simply asking:

- How does this management accounting method, measure or information help to manage cost, quality, and time?

If a management accounting information or method of the type listed above helps manage cost, improve quality, or reduce time, it has decision relevance. Otherwise it does not. Use this question to test the decision relevance of the techniques discussed in subsequent modules.

The same thing holds for process understanding. A measure provides process understanding if it clarifies the drivers, causes, relationships, and activities that create cost and value for customers. A management accounting system or method is process-oriented if it can address questions such as:

- What causes or drives costs to be incurred?
- What causes defects? How can sources of defects be eliminated?
- What actions or decisions cause budget variances?
- Why is there unused capacity? What can be done to reduce this cost?
- What actions increase time to market?

The QCT triangle also helps define the type of behaviors desired. As the behavioral effects of management accounting measures are examined, think about how the measures make items visible or impact motivations, aspiration levels, and attitudes relative to QCT goals. Here are some examples:

- Do methods for measuring cost of quality help focus attention on quality?
- Does rewarding employees for purchasing at the lowest cost motivate them to purchase poor quality materials?
- How does budget achievement impact aspiration levels and future budget achievement?
- How will the use of activity-based costing impact the cost reduction and quality improvement attitudes of employees?

The QCT triangle also allows culture to be dealt with in a concrete way. It questions whether the values, symbols, beliefs, ethics, and political values imbedded in a management accounting system create a long-term base for sustained action that helps to improve quality, reduce cost, and decrease time. Here are some examples:

- Are cost allocations using "ability to pay" fair?
- Does the term "nonvalue-added activity" used in activity-based costing violate beliefs of workers about the importance of work?
- Are methods that create pressure to meet budgets ethical?
- How would the use of life-cycle cost impact the interests of industries that produce toxic waste?
- Should a measurement method be changed to support or rationalize a decision made by a manager?

Taken together, the two triangles provide a powerful basis for evaluating alternative management accounting methods and for choosing between them in different circumstances. They avoid doing accounting for its own sake.

▲ LESSONS LEARNED

- ▲ The purpose of management accounting is to help an organization meet its strategic goals of providing high quality products or services at a low cost at the right time. This is the strategic QCT triangle.
- ▲ This strategic focus differs from traditional responsibility accounting by providing information which:
  - ▲ Links daily actions of employees to strategic objectives.
  - ▲ Involves the entire extended enterprise in achieving these objectives.
  - ▲ Focuses attention on the long-term strategic implications of management decisions.
- ▲ Management accounting information has three attributes—technical, behavioral, and cultural. This is called the TBC attribute triangle. Good management accounting information guides decisions, provides process understanding, motivates proper behaviors, and reflects the values and beliefs that are important to an organization and to society.
- ▲ The two triangles are mutually dependent. The QCT triangle provides a concrete framework for the attribute triangle and provides criteria by which to evaluate and choose between alternative management accounting measures, methods, and systems.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

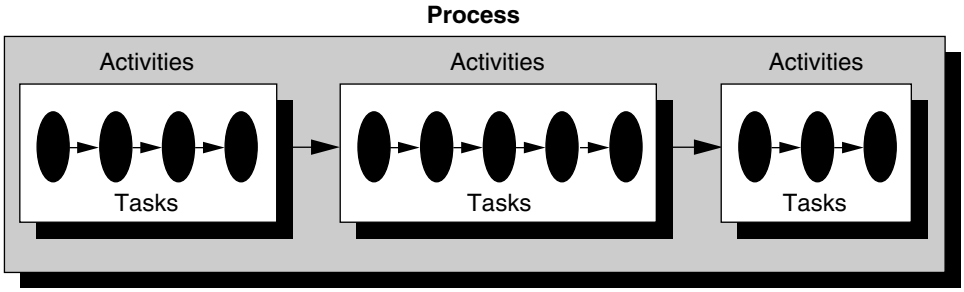
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self-test questions.

a. Explain how the definition of management accounting in the module differs from the definition used by the Institute of Management Accounting.

b. An implication of the definition of management accounting used in the module is that employees' know the purpose of the organization. What steps would you suggest a firm take if employees do not have a good understanding of an organization's purpose?

c. List several reasons it is important that every individual in the organization be able to link his or her job to the organization's strategic objectives.

d. Wal-Mart advertises "low-price always." Is this inconsistent with the module idea that a firm must compete on quality, cost, and time? Explain.

e. Explain the difference between measuring costs and understanding what drives or causes costs.

f. Kodak manufactures film for the consumer market. Identify specific elements of Kodak's value chain.

g. Think about purchases you have made. Give a specific example of a purchase you made where the low purchase price was offset by a very expensive life cycle cost. Would a product with a higher initial purchase price been less expensive over the life of the product?

h. Accounting has traditionally been about financial information, such as cost. Assume you are an accountant for a local plumber. Explain to the owner why you should be concerned about (i) quality and (ii) time.

2. The *Reel Tape* story that opens this module describes a successful company that failed. After reading this story one of your friends asks you to explain how this could happen.

a. Prepare a list of five (or more) factors that you believe were significant contributing factors in Reel Tape's failure. Use what you learned from reading the module and your general knowledge of business to develop this list.

b. Be prepared to discuss why you included each item on your list.

3. Provide a specific example (from the customer perspective) of why (i) quality, (ii) cost, and (iii) time matter to:

a. A government entity

b. A nonprofit charity

c. An educational institution

d. A small business

4. Provide two specific examples of (i) financial measures and (ii) nonfinancial measures the following organizations would use:

a. A fire department

b. The YMCA

c. The athletic department of a university

d. A local shoe store

5. Measurements affect how people behave. For a person working in the jobs listed below, provide a specific example of a financial or nonfinancial measure that would (i) focus attention, (ii) motivate behavior, and (iii) change attitudes and aspirations.

a. An automobile mechanic
b. A grocery checkout clerk
c. A restaurant manager

6. Review the story of how the janitor at the computer equipment company tied his job to the company's strategic objectives. Use your current job (or your most recent job if you are not currently working) to answer the following questions.

a. Try and explain, in a manner similar to the janitor, how your job links to the strategic objectives of your organization and why it is performed.
b. If you are unable to make this linkage, identify what additional information you would need before you could make the linkage.

7. For each of the products listed below indicate two of the most obvious examples of (i) quality, (ii) cost, and (iii) time.

a. A breakfast buffet
b. An airplane flight
c. An automobile replacement tire
d. A commercial bookstore that emphasizes hard cover, new edition sales
e. A used car dealership

8. Measurements may have several attributes. For each of the following indicate whether the primary attribute of this measurement is (i) technical, (ii) behavioral, or (iii) cultural. Explain your reasoning.

a. A large sign in a department store reading "this rack 50 percent off."
b. A banner noting a month without a lost time accident.
c. A computer model that allows the sales force to quickly determine the cost of a feature requested by a customer.

9. Large camera manufacturers such as Kodak and Olympus have operations in many countries of the world. Can you think of some specific ways in which the cultural differences across countries might influence the type of management accounting data collected, reported, or used by management.

10. L.L. Bean is a well-known manufacturer of outdoor equipment and clothing that has employees test clothes and equipment such as tents and sleeping bags in actual environments. L.L. Bean ensures quality with a 100 percent money-back guarantee.

a. Explain how L.L. Bean is likely to compete on the basis of (i) quality, (ii) cost, and (iii) time.
b. Provide a specific example of a measurement that L.L. Bean would probably want available about quality. Explain the technical, behavioral, and cultural attributes of this measure that help L.L. Bean meet its quality strategy.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

11. Listed below are items of information produced by the management accounting system of a major bank's branch:

i. Cost of processing a loan application
ii. Total deposits
iii. Ratio of loans to deposits
iv. Cost of linking customers so they can do "home banking"
v. Bad or unrecoverable loans purchased from other mortgage companies
vi. Time taken to process a loan application

a. Explain the decision relevance of each item. Which of these items also helps you understand work processes aimed at customer satisfaction?
b. How might each measure impact the behavior of customers or the bank's employees?
c. What symbols might each information item convey to customers, employees, or society in general? (Think about the beliefs, values, or mindsets embedded in each measure.)

12. Visit a local business of reasonable size. Try to talk with an accountant and an executive in another functional area such as production or marketing.

a. Diagram specific elements of its value chain.
b. Discuss the role of management accounting in this company with several employees.

13. The purchasing manager of a local university ordered 100 personal computers (PC) for faculty offices from a new supplier because each PC was $300 cheaper than the other leading brands. One reason is that this brand uses a cheaper hard disk drive and a lower quality video card. The internal auditor of the university, who has extensive training in modern management accounting, has just sent the purchasing manager a note suggesting that purchasing reconsider practices that were costly for the university. He cited the PC purchase as an example of costly practices. The purchasing manager is confused and has asked you to explain the internal auditor's comments.

a. Discuss some reasons why the internal auditor may believe the new PCs may be costly for the university.
b. Assume the auditor is correct. Why would the existing accounting system not show this higher cost?

14. Collect examples of the strategic purpose of one local organization in each of these categories.

a. Small business
b. Local charity
c. Government agency

15. Identify two competing firms that are well known in your area. (Your professor may provide you with a list of possible firms.)

a. Explain how each firm positions itself strategically in the market.
b. Illustrate how the firm you selected distinguishes itself from the named competitor.

16. Assume you own a five-acre blueberry farm. Blueberries ripen over a period of weeks and must be picked as they reach the proper blue color. Traditionally, blueberries have been picked by hand, usually with migrant labor. Laborers are currently paid $.10 a pint. In a typical year it is necessary to pick the same bush four or five times to get 90 percent of the potential crop. Each time the field is picked it takes approximately three twelve-hour days. An acre of blueberries will typically yield between 10 and 15 thousand pints if 90 percent of the crop is picked. Three supervisors must be available throughout each day of picking to log in picked berries, help with basic sorting, and keep track of equipment. Each of these individuals receives $8 an hour. More recently a blueberry patch owner has had the option of having the field machine picked. This process will typically allow the owner to harvest 60 percent of the crop if the mechanical picker is used twice. A third pass will raise the yield to 75 percent. Rental on the picking machine is $2,400 for each use. One supervisor at $8 an hour is needed for the eight hours it takes to pick the berries mechanically.

a. How does the cost to pick blueberries differ if you use the machine instead of hand picking the berries? List the assumptions you are making and show computations.
b. Is quality an issue in your decision of how to pick? If yes, why? If no, why not?
c. How is time likely to be a factor in your decision about whether to pick mechanically or by hand?
d. What other factors would influence your decision about how to pick the blueberries? Explain.
e. How would you choose to get the crop picked? Why?
f. List the type of management accounting information you would collect for the hand picking operation. Explain why you chose this information using the technical, behavioral, and cultural attribute triangle.
g. Explain how the accounting information for a mechanical picking operation would differ from the hand picking one.

17. Choose a car manufacturer, or compare several different manufacturers, and answer the following questions:

a. Explain how the manufacturer competes on the basis of (i) quality, (ii) cost, and (iii) time.
b. Provide a specific example of a measurement that the car manufacturer (or the dealer) would probably want available about (i) quality, (ii) cost, and (iii) time. Explain the technical, behavioral, and cultural attributes of this measure that helps the manufacturer or dealer meet their strategies in each area of (i) quality, (ii) cost, and (iii) time.

18. The following quotation is taken from a paper reporting the results of a cross-cultural study by Professors Birnberg and Snodgrass on the differences in control systems in the U.S. and Japan.[8]

> " . . . the presence of a culture which is homogeneous and possesses the critical dimension of cooperation would lead to less emphasis being placed on the 'enforcing' of management's

[8] Jacob G. Birnberg and C. Snodgrass. "Culture and Control: A Field Study," *Accounting Organizations and Society,* Vol. 13, No. 5, 1988, pp. 447–464.

wishes. In turn, greater emphasis and resources can be spent on communicating across organizational levels and directing information to the proper individual or work group."

a. Can you think of some examples of how management accounting data can be used to enforce management's wishes?
b. For the examples in part a above, how might the same information be used to enhance communication between organization levels?
c. What role does culture play in these different uses of management accounting data?

Case 1: Vincent's Cappuccino Express.[9]

Three years ago, Vincent Chow completed his degree in accounting from a California university. The economy was in a depressed state at that time, and Vincent managed to get an offer of only $20,000 per year as a bookkeeper. In addition to its relatively low pay, this job had limited advancement potential.

Since Vincent was an enterprising and ambitious young man, he declined this offer and started a business of his own. He was convinced that because of changing lifestyles, a drive-through coffee establishment would be profitable. He was able to obtain backing from his parents to open such an establishment in the center courtyard of a major office complex. The office complex had several large buildings and was located in the inland valley where temperatures in the summer can reach 100° plus in the summer time. Vincent named his business The Cappuccino Express and initially decided to sell only two types of coffee: cappuccino and decaffeinated.

As Vincent had expected, The Cappuccino Express was very well received. Within a year he had done well enough to think about opening another location in an office complex north of the town. However, several problems had surfaced during the first year of operations. First, his sales were primarily during the morning period. He did little the rest of the day. Summer months were even slower. Due to the heat, coffee demand was lower. His customers also wanted snacks to go with coffee.

Vincent decided that he needed to hire site managers so he could better focus his own attention on strategic issues. He hired an assistant to do record keeping and other administrative tasks.

a. What factors can be expected to have a major impact on the future success of The Cappuccino Express? Classify these factors in the categories of quality, cost, and time.
b. Describe the work process relationships that are important for satisfying the customers of The Cappuccino Express.
c. What are the major decisions that Vincent must make in order to grow and manage his business? What management accounting data does he need to improve these decisions?
d. What behaviors does Vincent need from his employees? How can management accounting help him to foster these behaviors?
e. What values or mindsets does Vincent need to create in his growing organization to sustain the behaviors he needs? How can management accounting help to sustain these values?

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[9] This case has been adapted by permission from the original case that was published in *Issues in Accounting Education,* Vol. 10, No. 1, Spring, 1995. We thank Professor Chee Chow for allowing the original case to be changed into the present version.

NOTES

M O D U L E

The Organizational Role of Management Accountants

Version 1.0

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The Organizational Role of Management Accountants

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FORD REORIENTS THE ROLE OF MANAGEMENT ACCOUNTANTS

"The problem you have, as with any finance organization, is that finance is viewed as the keeper of the keys, the money, the one who holds the budgets, the monetary strength of the company. And, therefore, when something financially doesn't measure up and it gets turned down…it is viewed as, well, this was a great idea, and it would have made a great contribution to our product, but the finance guys turned it off."

These words were spoken by Stan Seneker, former Chief Financial Officer (CFO) of Ford Motor Company. Seneker was commenting on the traditional role of management accountants (referred to in corporate terminology as the "financial staff" or "financial managers") at Ford. Ford viewed management accountants as technical accounting experts whose jobs were to keep score and to safeguard the assets of the company both against fraud and by saying no to risky management ventures.[1]

Like other companies in the 1980's, Ford discovered that to regain its competitive position, it had to operate cross-functionally. That is, it could no longer afford to have management accountants operating as technical accounting specialists, keeping score and monitoring expenditures against budgets. Ford needed them to participate and advise cross-functional teams before cars and trucks were built instead of criticizing their work after the cars were built.

Seneker explained that today the management accounting function at Ford is "driven very much by being a service organization… We're not a scorekeeper so much. We obviously have to keep score. We have to maintain the company's financial records and report on financial results. But the emphasis really is on providing a service and on being a business consultant to line management, to the operations, rather than trying to second guess them and trying to review and critique what they're doing—joining in as a member of the team."

Management accountants are playing different roles and performing different tasks than they have in the past. A recent survey of firms conducted on behalf of the Institute of Management Accountants[2] (IMA) shows six major roles for management accountants:

1. Become business and strategic partners to management. Be their trusted financial and operational advisers.
2. Provide strategic understanding of business so nonfinancial managers and workers can tie the results of their actions to business strategy.
3. Participate in problem solving with managers and workers.
4. Be team members who can provide other team members with the information they need to perform their tasks.

[1] See P.J. Keating and S.F. Jablonsky, *The Changing Roles of Financial Management: Getting Close to the Business* (Morristown, New Jersey: The Financial Executives Research Foundation, 1990).

[2] See G. Siegel, *Practice Analysis of Management Accounting* (Chicago: Gary Siegel & Associates, 1996).

5. Provide information that supports the critical quality, cost, and time decisions of the business.
6. Help organizational members to improve their understanding of the processes they use to do their tasks and help them to eliminate costly processes that do not add value for customers.

These new roles for management accountants will create exciting management accounting jobs.

▲ MANAGEMENT ACCOUNTANTS AND THE STRATEGIC TRIANGLE

For students of management accounting, the Ford quote and the IMA study show the strategic role of management accountants in today's organizations. Accountants are more than third-party advisers and consultants to line managers who make decisions about products and services. Accountants are active participants on the business decision-making team. To be creditable members of the business team, accountants must think of themselves as business people first and as technical specialists second. They must be every bit as knowledgeable about business as other team members. To succeed, management accountants must share responsibility for making the tough choices and taking the risks involved in running a business. Above all, they must not simply be neutral observers and recorders but active participants who help their organization provide a high-quality product at a reasonable cost on a timely basis.

- ▲ **Quality.** Customers' perceptions of quality are based on their total experience with a product or service. Quality includes product features as well as its performance (reliability). A firm can meet or exceed desired levels of quality only if it knows what dimensions of quality are important to a customer and what they are willing to pay for these dimensions. Management accountants must base business decisions on what customers need and not on satisfying narrow financial criteria.

- ▲ **Cost.** These are the resources expended by producers and their support organizations such as suppliers, distributors, service providers, and recyclers (value-chain members). Cost also includes resources expended by a customer over the life of a product. The customer's cost of ownership includes the cost of buying, using, and disposing of a product. Global competition is increasing pressure on firms to be cost-efficient. Management accountants can help by analyzing work activities and reporting measures that help to manage costs across the value
chain and over a product's life. AT&T, GE, Hewlett Packard, and Ford have reengineered their managerial accounting function, reducing costs by more than 50 percent between 1984 and 1994.

- ▲ **Time.** Time is an increasingly important strategic variable. Measuring cycle time (the time it takes to convert inputs into outputs) and coordinating the timing of activities across the organization to prevent bottlenecks from occurring are critical to meeting customers' needs. In product development, time overruns can have a much greater impact on profitability than cost overruns. Being late to market can

significantly hamper the ability of a product to turn a profit. Management accountants can help line managers to understand the economics of time and develop systems to actively manage this critical strategic variable. In addition, management accountants can manage time for their own activities. For instance, the accounting and finance departments of Applied Materials have set a goal for the year 2000 of reducing cycle time by 50 percent for all tasks they perform.

▲ PURPOSE OF THIS MODULE

This module discusses the role of management accountants in contemporary organizations. It shows the evolution of management accountants from neutral scorekeepers to business advocates who proactively shape and support strategic objectives. When you complete this module, you should understand:

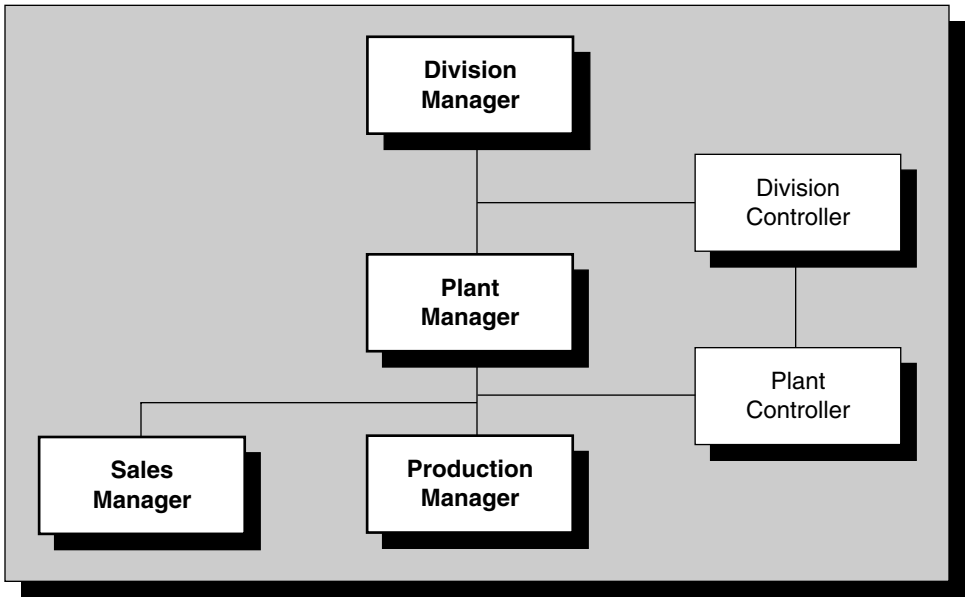
- ▲ The historical role of the management accountant.
- ▲ Forces causing change in the role of the management accountant.
- ▲ The dual role of management accountants as business advocates and corporate cops.
- ▲ The paths for becoming a management accountant.
- ▲ The knowledge, skills, and experiences required for being a successful management accountant.
- ▲ The technical, behavioral, and cultural attributes of the new management accountant.

▲ THE CHANGING NATURE OF MANAGEMENT ACCOUNTING WORK

Management accountants traditionally occupy a staff position in an organization and are not responsible for business decisions regarding the products or services that an organization produces. Senior management charges line managers with the responsibility for formulating and executing business strategy. Various staff functions provide specialized expertise and advice to line managers in areas such as law, accounting, and personnel. For example, a plant manager often consults with a financial analyst in making a decision to invest in new plant capacity or in assessing how to improve the manufacturing productivity of a particular product.

The organization chart in Exhibit 1 shows the traditional line and staff functions for a typical business unit of a company. A business unit, often called a *division,* is any unit that has responsibility for profits. A division manager heads the unit, and her staff includes a controller. For instance, within General Motors, Chevrolet, Cadillac, and Saturn are divisions that have profit responsibility. The divisions typically have several plants. Each manufacturing plant has its line managers and staff professionals as well. The plant marketing and production managers are line managers who make operating decisions about what to produce and sell. The plant controller is a staff position that assists these line managers in their decisions. Note that the plant controller also reports to the division controller.

Exhibit 1
Traditional Relationships between the Line Manager and the Controller



Historically, a management accountant's work has been consumed by two major activities (1) performing bookkeeping necessary for day-to-day transaction processing, cost accounting, and periodic reporting and (2) preparing budgets and reviewing performance against the budget. In a small company accountants spend most of their time on day-to-day transaction processing and financial reporting activities. Even in some large companies, accounting staffs spend the majority of their time on these activities and on implementing financial controls and internal auditing. This work load leaves little time for management accountants to engage in business analysis and consultation.

Two factors in contemporary society are causing a fundamental shift in the nature of management accounting work: (1) advances in information technology and (2) the existence of global competition.

Advanced Information Technology.

As the cost of advanced information technology (IT) declines, many traditional management accounting jobs—reviewing transactions, consolidating data from disparate information systems, and running special reports requested by managers—are disappearing. Technology automates such bookkeeping activities. This migration from manual to automated systems is reducing the need for management accountants. Those who remain enable the work of line managers and front-line workers. Enterprise databases and client-server computing are particularly noteworthy new forms of information technology. Both deliver integrated business information directly to a manager's desktop.

Enterprise databases involve the integrated reception and reporting, in real time, of information from all areas of the enterprise including purchasing, sales, and manufacturing. Users of databases have immediate access to all information they need without the

intervention of programmers, management accountants, or assistants. Managers can query the database directly and "drill down" to any level of detail they wish.

The leading supplier of integrated databases is a German company, SAP AG (Systems, Applications and Products in Data Processing). Founded in 1972 and based in Walldorf, Germany, SAP's databases are installed currently in 7,000-plus sites in more than 50 countries. Their databases can manage information on every facet of the supply chain including customer sales, inventory, production, financial reporting, and human resources. Other major companies that offer integrated databases include Oracle, Arthur Andersen, PeopleSoft, and Computer Associates.[3]

Companies are also developing their own integrated databases. Relying on its own in-house database technology, Hewlett Packard has implemented a system called DOLFIN (Distributed On-Line Financial Information Network). DOLFIN gives senior-level managers fingertip access via their desktop PCs to their respective business unit expense reports. Managers report great satisfaction with this system. Another product, that has similar capability to DOLFIN, is Microsoft's BACKOFFICE.

Client-server computing refers to having a PC on every desktop, supported by data servers and connected by local and wide area networks. When implemented with enterprise databases, client server systems enable the paperless electronic workflow of business transactions. For example, using client-server computing, a sales person can submit a travel reimbursement request while on the road using an electronic form resident on his or her laptop. The form is then reviewed and processed electronically using e-mail. Within a few days, the salesperson receives an electronic deposit in his or her checking account. As with the desktop access provided by enterprise computing, automated workflow enabled by client server technology dramatically reduces the number of bookkeepers and management accountants needed to process and review business transactions.

Together enterprise computing and client-server technology enable the end user to process transactions and gain access to information without the help of intermediate personnel. This technology is called *self-service computing*. Workflow is streamlined, users are more in control, and overall business overhead costs are lower. The impact on the traditional work of management accountants is quite dramatic. The bad news is that the required number and demand for traditional management accountants per firm is shrinking. The good news is that these advanced technologies make business information more readily available throughout the firm. Therefore, the demand for more sophisticated management accounting expertise is growing.

Global Competition.

Global competition is forcing firms to become more flexible, respond rapidly to customers, and continuously improve their standards of performance. Decisions that follow the traditional organizational chart offer neither the flexibility nor the speed with which firms must respond to changes in their environment. To increase response time and generate flexible solutions, companies have adopted a team approach to problem solving. Teams made up of marketing, engineering, suppliers, production personnel and accountants are expected to integrate financial and business strategy.

Management accountants participate in product design teams and help designers reduce product and process costs. They also participate in activity-based management and

[3] For more information about SAP see K. Williams and J. Hart, "SAP: Connecting the Enterprise," *Management Accounting*, April 1997, pp. 51–54.

business process reengineering teams that improve quality, cycle-time, capacity utilization, and general business processes.

As members of cross-functional teams, management accountants support line managers and become actively involved in improving service and profitability. They contribute their financial and analytical skills, have in depth knowledge of the business, and work toward improving the bottom line.

Zuly Orjuela, a Decision Support Analyst II at Long Beach Memorial Medical Center (LBMMC), a 760 bed, 1,400 physician, private, not for profit hospital in the greater Los Angeles area, performs many of these new functions. As a team member, she was involved in the implementation of an activity-based costing system; she is a Care-Line analyst for both the OB/GYN and the Neonatal Intensive Care-Lines (product lines); she is responsible for LBMMC's reporting to an industry group collecting data for operational benchmarking; and she is assisting with a supply streamlining initiative where a major supplier is entering a risk sharing agreement with LBMMC. Zuly works on teams with physicians, nurses, administrators, and representatives from ancillary disciplines. The teams are accountable for clinical, financial and patient satisfaction outcomes. Zuly describes teams decisions as "data-driven."[4]

Teaming has lead to an increased demand for accountants who can help managers interpret and use enterprise-wide information to run their businesses. Management accountants who understand business strategy and financial implications of operational decisions help team members use the power of the information at their fingertips. This new role for management accountants is a much more challenging one, but certainly a more rewarding one as well.

Think Along

If the demand for management accounting information is growing, but the demand for the traditional bookkeeping and budgeting work performed by management accountants is shrinking, what kinds of management accountants are still in demand? What kind of work do they do? What kinds of skills must they posses?

▲ THE ROLES OF MANAGEMENT ACCOUNTANTS

In 1990, The Financial Executives Research Foundation (FERF) published *Changing Roles of Financial Management: Getting Close to the Business*. This report was based on case studies of six well-known companies: AT&T, Boeing, Citicorp, Ford, Merck, and 3M. That study outlined the roles played by management accountants in those organizations. It described both traditional scorekeeping roles and emerging competitive team roles for management accountants.

A later survey of 805 managers attending executive management training programs resulted in a 1993 FERF research publication, *Business Advocate or Corporate*

[4] We thank Zuly Orjuela, a California State University, Northridge (CSUN) accounting alumnus, for providing information used in this section. Zuly selected a non-traditional career path upon her graduation from CSUN. Instead of joining a "big six" CPA firm, Zuly joined Baxter, a medical supply company. She entered their Financial Development program, a two-year program with four rotations. Each rotation offered her the opportunity to learn a different area of finance, to function at a different level of the corporation, and to live and work in a different geographic location. Her training provided her with an understanding of the business, the competitors and the industry. In addition, it caused her to continually face change, learn and grow as a professional, and mature as an individual.

Policeman.[5] This research focused on respondent views on the role of management accountants in organizations. Based on the results, the report identified two basic management accounting profiles, a *corporate cop* profile and a *business advocate* profile.

As you read the corporate cop and business advocate profiles, it is important to realize that management accountants have several important responsibilities.

- ▲ Management accountants provide information that management uses to analyze situations and make crucial business decisions. Some of the typical decisions that management accountants analyze for managers include what products to produce, what technology to use in producing them, and whether to make or buy parts and services used in making them. This function has been called the "answering machine" role of management accountants.[6]
- ▲ Management accountants measure and report on the performance of business units and managers. They must prepare scorecards that often serve as a basis for performance evaluation and rewards in an organization.
- ▲ Management accountants are a critical part of process improvement teams that help to increase the quality of current operations and reduce cost. They undertake tasks such as activity analysis and redesign of business processes that reshape the way organizations do their work. Management accountants are also part of target-costing teams that redesign product and manufacturing processes to reduce costs. Burchell et al. call this function the "learning machine" role of management accountants.
- ▲ Management accountants design and administer budget systems that lead to proper resource allocations. Management accountants monitor spending against budgets and provide regular reports on the difference (variance) between actual and budgeted spending.
- ▲ They oversee financial resources. Their job is to safeguard organizational assets against theft or misuse. They are the guardians of the purse.
- ▲ Finally, management accountants ensure the integrity of financial information and its proper disclosure. They design and redesign systems constantly to provide reliable error-free information in many areas. A good example is disclosure about environmental costs. As society takes these costs seriously, management accountants have to make certain that their systems can measure and report these costs to all interested parties.

You will note that these roles run the gamut from information, advice, and support of business operations to oversight and control of those same operations. All roles are essential. However, how a management accountant is perceived depends upon which role or roles she emphasizes.

Key Point

While management accountants perform many roles, a central issue is one of relative emphasis. Is the management accountant preoccupied with budgetary oversight and resource control or is she part of running business operations?

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[5] See P.J. Keating and S.F. Jablonsky, *The Changing Roles of Financial Management: Getting Close to the Business* (Morristown, New Jersey: The Financial Executives Research Foundation, 1990).

[6] See S. Burchell, C. Clubb, A. Hopwood, J. Hughes, and J. Nahapiet, "The Roles of Accounting in Organizations and Society," *Accounting, Organizations and Society* 5, no. 1 (1980), pp. 5–28.

Corporate Cops.

Corporate cops define their job primarily in terms of oversight and surveillance, administration of rules and regulations, and the performance of impersonal procedures. Given the emphasis on enforcement of corporate policies, corporate cops tend to see line management and regulators as the greatest threat to an organization. They tend to identify closely with their accounting training. Corporate cops use auditing and accounting skills, are primarily involved in budgeting and variance analysis, and are very concerned with accurate financial reporting. The importance of this role has diminished at Ford.

Management accountants who emphasize the corporate cop role tend to fall into two categories: those who focus on internal accountability and those concerned with external accountability. Accountants concerned with internal accountability focus primarily on achieving quarterly budgets and controlling costs. They use traditional accounting expertise, communicate in accounting reports, and are closely aligned with and support top management. Rather than take an active role in the business, corporate cops maintain their independence from operations. They use measurements and accounting reports to review performance and manage business risk. Management accountants concerned with external accountability are not intimately involved with the daily work of the organization. They are virtually invisible to business units and focus on financial reporting to external agencies such as the Securities and Exchange Commission. Their primary concern is conformance to external reporting rules.

Business Advocates.

Business advocates see their job as helping the management team meet and beat the competition by integrating business strategy and business operations throughout the firm. Business advocates tend to think of themselves as business people first and as management accounting professionals second. They are integrators and think in terms of service and involvement. Thus business advocates see competition as the greatest threat to an organization. They have a detailed knowledge of and are actively involved in the business. They focus on improving the bottom line by using their financial and analytical skills, by monitoring the operating and capital budget, and through providing service to internal customers (other managers and teams in need of support). Seneker discribes this role as the emerging role for management accountants at Ford.

Business advocates also have two subgroups. One specializes in *business support* and the other in *business strategy.* Business advocates involved in support define organizational success in terms of increasing market share. They identify closely with business units and support them with financial models. They focus on business risk and market threats to specific business units. They provide financial leadership to the units and are heavily involved in implementing the business strategy set by corporate headquarters.

Instead of the market perspective of business support types, business strategy accountants focus on resource utilization. They are very concerned with capital risk and underutilized capacity. This group is closer to top management than it is to business units and supports upper management with sophisticated operating and capital budgeting models. The analysis and support of business strategy accountants is crucial to formulating business strategy and the management of strategic issues.

Organizations in which the corporate policeman role dominates tend to have a formal hierarchical organization structure. In these organizations information tends to flow vertically along the formal lines of command and control. The information itself is heavily

biased in favor of review and oversight of line management. Organizations in which the business advocate role dominates typically organize around competitive teams. The teams emphasize cross-functional cooperation, and the information is oriented toward analytical and strategic relevance.

Think Along

Do both roles exist in all organizations? Are both equally important in today's environment? Should a management accountant give equal weight to both roles? What role would you like to play?

The FERF study argues that the business advocate role enables the management accountant to play an effective, constructive, and influential role in the business. Nevertheless, given the prevalence of the corporate cop profile, this position is certainly subject to debate. However, the number of management accountants performing the corporate cop role is expected to diminish, and the business advocate role is expected to become more important.

It is worth a moment to speculate about the cross-cultural roles of management accountants. Would we expect management accountants in Britain, Germany, or Japan to emphasize the same set of responsibilities and roles as they do in the United States? How much of the role of the management accountant is culturally determined? Although we have very little cross-cultural research on this topic, anecdotal evidence suggests some very strong cultural influences.

For instance, research has uncovered significant differences in operating philosophies and management practices when comparing Japanese and U.S. firms. Why should these differences not extend to the role of management accountants? Two factors that may come into play are (1) differences in white-collar occupational specialization and (2) differences in the level of trust between managers. Regarding the first factor, in Japan management accounting is not the specialized or recognized occupation that it is in the United States. Consequently, engineers in Japanese companies perform many of the specialized duties performed by management accountants in U.S. firms, such as cost estimation and cost analysis. Japanese firms seem to have fewer management accountants than their U.S. counterparts have. The financial work is there, but it is distributed to groups other than management accountants.

On the second factor, trust, because of the homogeneity of the Japanese culture and the emphasis placed on group harmony, Japanese firms tend to demonstrate higher levels of trust between managers. Given this higher level of trust, we would speculate that management accountants in Japan would be less predisposed to emphasize the independent review role of the corporate cop. The cop role takes on greater salience in low-trust environments that require a separate cadre of professionals to conduct surveillance and enforce the letter of corporate policies.

▲ THE CHALLENGE OF DUAL ACCOUNTABILITY

As the FERF study shows, management accountants help line management run the business, provide useful information, and serve on cross-functional business improvement teams. These activities are part of their business advocate role. In their role as business advocates, management accountants act as *enablers* of business strategy and help line managers and front-line workers to understand the economics of a firm's business strategy.

Exhibit 2
The Dual Role of Management Accountants

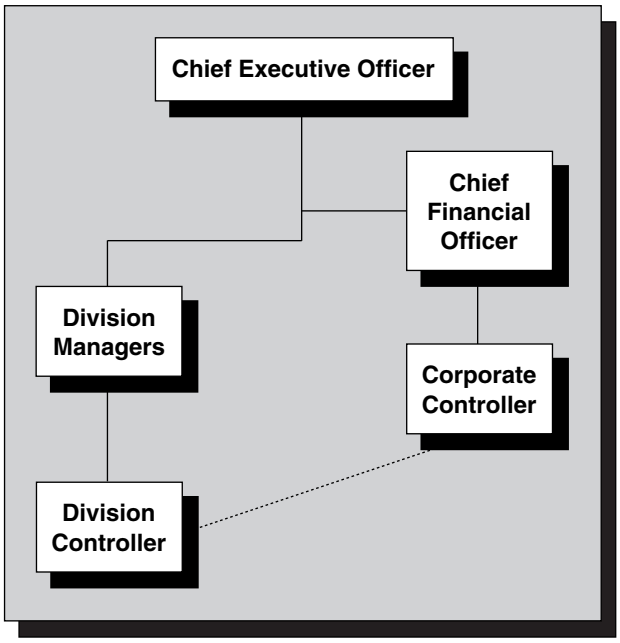
Management accountants also act as custodians of the corporate purse strings and assist top management in evaluating line management's performance. This function is the corporate cop role. In their role as corporate cops, accountants must control corporate resources and employee actions through budgeting and reporting systems and oversee the same managers that they are helping. Thus management accountants perform conflicting duties: They assist line managers in carrying out their day-to-day responsibilities and, on behalf of top management, review the performance of these very same managers.

This duality of *service* and *oversight,* depicted in Exhibit 2, often creates tension between line management and staff accountants and can create ethical dilemmas for the management accountant. For example, assume a management accountant is deeply involved in a business decision, such as adding a new product line. If that product line is failing, it may be hard for a management accountant to acknowledge failure. Similarly, the closer a management accountant is to line management, the harder it will be for him to objectively assess the actions of line managers. These types of situations create a conflict of interests for management accountants. Their self-interest is with their unit, but their ethical obligation is to their corporate superiors. Later in the module we return to the ethics of management accounting practice.

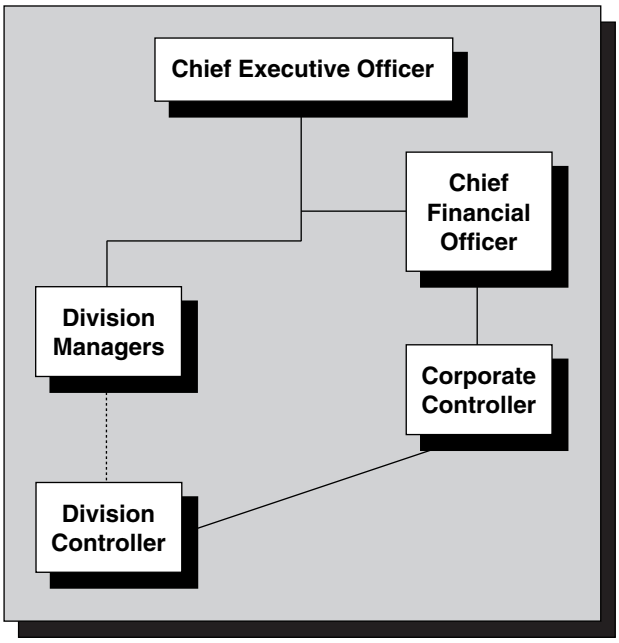
Firms address dual accountability in the way they formally structure job descriptions and reporting relationships between management accountants, business unit management, and senior management. As Exhibit 3 shows, at the corporate headquarters level, the chief financial officer (CFO) is the senior financial staff person and typically serves on the executive management team. The CFO also has responsibility for overseeing the financial affairs of the firm and for ensuring reliable financial reporting to outside parties. The chief management accountant for the firm has the title of corporate controller and reports directly to the CFO, as do the treasurer, the director of taxes, and the director of internal auditing.

At the division or business unit level, divisional controllers serve as the chief management accountants. Their job is to support the division much as the corporate controller does for the corporation as a whole. The divisional controller typically has a number of management accountants on his or her staff.

Exhibits 3a and 3b
Dual Accountability of the Management Accountant:
Primary and Secondary Reporting Relationships of Divisional Controller



Key: Solid line indicates that Division Controller reports directly to Division Manager and indirectly to Corporate Controller.



Key: Solid line indicates that Division Controller reports directly to Corporate Controller and indirectly to Division Manager.

Think Along

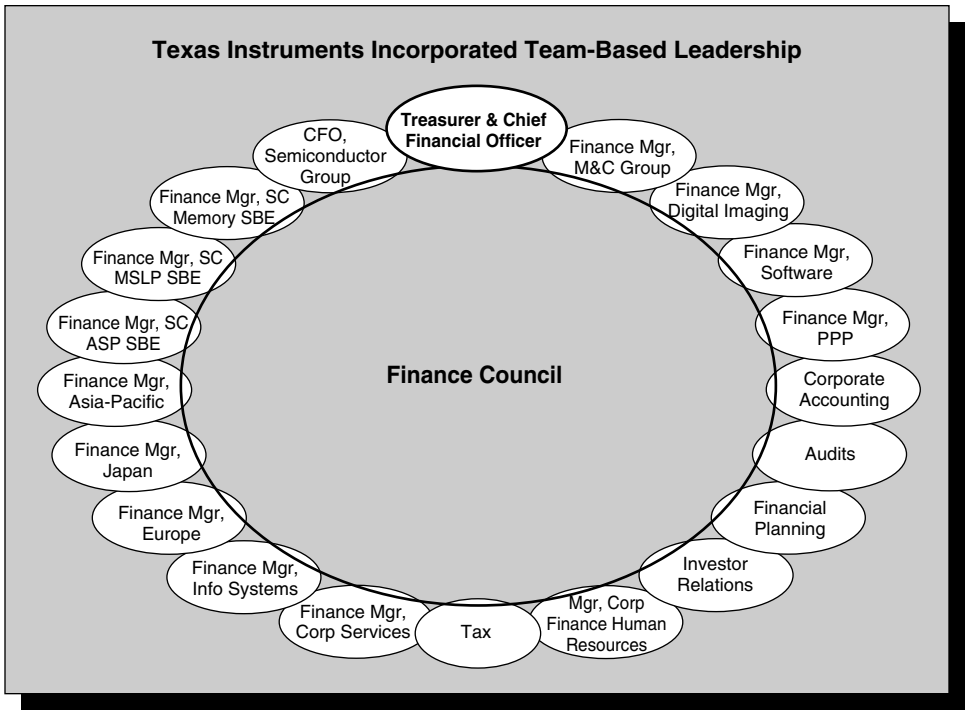
In the context of dual accountability, who do you think the divisional controller should report to—the corporate controller or the division manager? Remember that the person you report directly to is the person who evaluates you and may even make decisions regarding your career path and promotions.

Both reporting relationships exist in practice. In some firms the division controller reports directly to the division manager in a primary (hard line) mode and to the corporate headquarters controller indirectly (dotted-line mode). Examples of firms that use this reporting format include Boeing, Caterpillar, Citicorp, and Ford. In other firms the division controller reports to the headquarters controller directly (hard line) and to the divisional president indirectly (dotted-line). ITT was one of the first corporations to introduce this form of dual reporting. Examples of firms that operate in this manner today are 3M (maker of Scotch Tape and Post-It Notes), Merck Pharmaceuticals, and Applied Materials.

Many companies today are moving away from the formal lines of command and control to team-based organization. A good example is the recent reorganization at Texas Instruments. Exhibit 4 reproduces the organization chart for Texas Instruments.[7] A team called the Finance Council includes not only divisional and unit controllers but also many other accounting functions such as investor relations, tax, and information systems.

[7] We are grateful to Tricia Dears, finance manager at Texas Instrument, for sharing this information with us.

Exhibit 4
Team-Based Finance Organization at Texas Instruments



As Exhibits 3 and 4 show, companies have different philosophies for handling the issue of dual accountability. However, dual accountability is not an either/or proposition. It represents an enduring tension in the way management accountants carry out their responsibilities. They are expected to involve themselves deeply in the management of the business yet to remain sufficiently independent to properly carry out their management review responsibilities with the objectivity senior management expects. To do so effectively, management accountants must maintain credibility with business unit and corporate management. Ultimately, this credibility is based on the personal integrity, interpersonal skill, financial expertise, and business acumen that the management accountant brings to the management process.

To summarize, the business advocate and the corporate cop represent competing models of the role management accountants should play in an organization. The business advocate role stresses the involvement of management accountants in business operations. The corporate cop role stresses the importance of management accountants as independent reviewers of business operations.

Interestingly enough, management accountants do not see their own preoccupation with the corporate cop role. The FERF research report shows that management accountants and line managers give conflicting assessments of the role that management

Think Along

While both roles are important, which function of the management accounting staff do you think has been emphasized historically: independent scorekeeper or involved team player and advocate?

Exhibit 5
The Role of Accounting Staff
Differing Perceptions of Accounting Staff and Line Managers

	Accounting Staff	*Line Managers*
Role	Business advocate (63%)	Corporate cop (61%)
Influence	Service & involvement (61%)	Oversight & surveillance (65%)
Involvement	Team player on the field (63%)	Expert commentator or scorekeeper (59%)
	Close to the business (49%)	Close to top management or not involved (75%)
	Involved in business strategy (44%)	Budgeting, cost control, & reporting (86%)

Think Along

Why does this great disparity between the perceived and actual roles of management accountants exist?

accountants play and their involvement in and influence over strategic business decisions.[8] Exhibit 5 shows the perceptions of a sample of 800 line and finance managers about the role of management accountants. The first line of the exhibit tells us that while about two-thirds of the responding accounting staff members view themselves as business advocates, line managers hold a diametrically opposed view. About two-thirds of the line managers view management accountants as corporate cops who spend most of their time gathering data and enforcing corporate policies and external reporting rules.

A further look at Exhibit 5 provides additional evidence of these perceptual differences. As the first column shows, about 60 percent of accounting staff members perceive themselves as concerned primarily with service and involvement in the business. However, the same percentage of line managers (column 2) perceives the accounting staff as concerned primarily with oversight and surveillance. *Oversight* involves activities such as monitoring for transaction approvals and making sure that department managers do not overspend their budgets. Whereas 63 percent of accounting staff members identified themselves as team players, 59 percent of line managers answering the same question perceive the accounting staff to be expert commentators or scorekeepers. Interestingly, less than 50 percent of the accounting managers perceive themselves as being close to the business. Only 25 percent of line managers perceive management accountants as being close to business; the other 75 percent perceive the accounting staff as close to top management or not involved at all in the business. On the matter of business strategy, 44 percent of accounting managers perceived senior accounting executives as being involved in the formulation of business strategy. Only 14 percent of line managers hold this view. The other 86 percent perceive top accounting people as more preoccupied with budgeting and reporting.

This disparity exists for two reasons, one pertaining to the predominant management style of American corporate managers and the other to information technology.

First, the predominant style of management that prevailed in most firms emphasized top-down direction and control over operations by senior management. When operating according to this model, management accountants have typically functioned as the company's financial conscience and senior management's corporate watchdogs.

Second, until the application in the 1980s of truly advanced information technology, the basic recordkeeping chores required to maintain accounting systems were done

[8] See S.F. Jablonsky, J. Patrick, and J.B. Heian, *Business Advocate or Corporate Policeman: Assessing Your Role as a Financial Executive* (Morristown, New Jersey: Financial Executives Research Foundation, 1993).

manually. These bookkeeping chores consumed most of the time of all but the most senior members of the accounting staff in a typical company.

▲ THE MAKING OF A MANAGEMENT ACCOUNTANT

To build and operate accounting systems that support an organization's strategic and day-to-day business decisions, to provide sound advice to managers, and to oversee operations is unique and challenging work. Individuals take many paths as they develop into valued management accountants. Many firms, small and large, recruit for their entry-level management accounting positions from undergraduate accounting and/or finance programs. Examples of larger firms who follow this approach are Boeing, 3M, and Caterpillar. Other companies, such as Ford, Merck, and Citicorp recruit individuals with an average of six to eight years of work experience beyond the bachelor's degree.

Professional Knowledge and Certification.

Candidates for corporate-level financial positions have either an advanced degree or a certification in addition to experience. The primary advanced degree is an MBA; Master of Science in accounting also qualifies for this position. Sometimes an undergraduate degree, professional certification, and six to eight years of accounting experience are considered adequate for these positions.

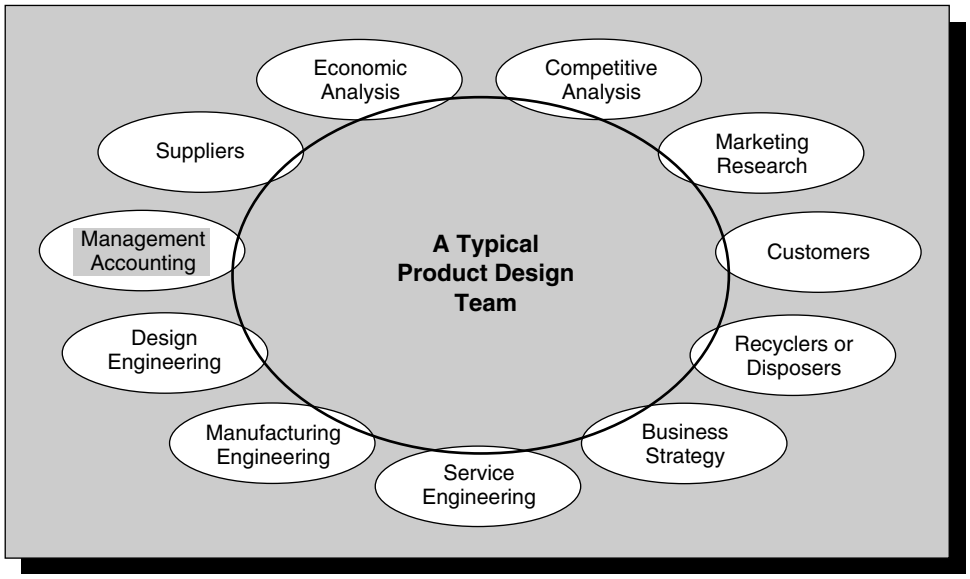
When people think of professional accounting, they tend to think of a **CPA.** The **CPA,** which stands for **Certified Public Accountant,** is the certification held by professional auditors who reassure the public about the reliability of financial statements complied by private companies. Private firms often recruit the CPAs who have been their auditors. However, the CPA is not the only certification for management accountants. In most states only accountants who have two or more years of audit experiences are eligible to obtain a CPA. Many management accountants do not have this audit experience. In addition, not all management accountants need detailed audit knowledge and experience to perform their jobs effectively. Certainly, accountants who focus on corporate police roles, particularly *external accountability* roles, would benefit from CPA experience and certification.

In recognition of the need for certification applicable to other management accounting roles, the **Institute of Management Accountants** has developed two certifications more suited to the work of business advocate management accountants.[9] These are the **Certified Management Accountant (CMA)** and the **Certified Financial Manager (CFM).**[10] As should be expected, some commonality exists between the examinations for these certifications and the CPA exam. One area of overlap is public reporting standards. There are also important differences. Rather than stressing auditing, the examinations associated with these certifications stress economics and business finance, organizational behavior, ethics, public reporting standards, internal reporting and analysis, information modeling, and decision analysis. The CMA certification is particularly relevant to accountants focusing on *business support*. The CFM certification is more appropriate for accountants involved in *business strategy*. There is also a **Certified Internal Auditor (CIA)** certification. The exam for becoming a CIA concentrates on the audit environment, the internal

[9] To learn more about the IMA's programs, publications, and examinations, visit its Web site at www.imanet.org. (No period at the end.)

[10] The CMA exam is expected to be on-line at Sylvan Centers beginning January 1998.

Exhibit 6
Management Accountants in Product Design Teams



audit process, and auditor skills as well as management control and information technology. This exam is probably most appropriate for an accountant concerned with either *internal or external accountability.*

Skills and Abilities.

Formal knowledge gained from university education and professional certification are important means for developing and demonstrating technical professional competence. However, success in management accounting comes to those who combine technical expertise with business savvy, who can work with others as part of a *business team,* and who have an *ability to communicate* effectively. Also critical are an appreciation for *life-long learning, integrity,* and *ethics.*

To develop business knowledge and breadth, an increasing number of firms are encouraging management accountants to take assignments outside the finance function as part of their professional development. It is quite common, particularly in Japan, to find accountants working in sales and production before they start their accounting jobs. To help them develop the depth of business understanding, the employees receive first-hand experience on the shop floor and the sales floor.

Accountants today serve on various business teams. For example, they participate in strategy formulation, product and process design, quality improvement, business process reengineering, and benchmarking. Management accountants must learn to work as effective team members.

Exhibit 6 shows the composition of a typical product design team. As a member of this team, the management accountant has to communicate with experts from engineering, marketing, and manufacturing, as well as with important suppliers. The management

accountant must know how to communicate accounting results or logic to these non-accounting disciplines clearly and succinctly.

Another key to success is life-long learning. Because the only constant of business life is change, the way to retain value is to hone one's skills and to continue education. Existing tools must be sharpened and new tools, such as financial modeling, systems analysis, or interpersonal tools, must be added to the professional tool chest.

Finally, integrity and ethics are very important to the management accountant. These are personal characteristics. However, business classes can teach them, and the profession's code of ethic can reinforce them. A management accountant must be strong enough to evaluate critically and honestly the financial dimensions of plans and actions. He or she must be trusted to communicate in an honest manner without divulging confidential information.

The knowledge, skills, and abilities described here are the keys to successfully performing the multiple roles demanded of management accountants today. They must be actively involved in the business, be technically competent, retain an independence of perspective, and be faithful to the profession's ethical values. This profession requires a special blend of expertise and strength of character. By adhering to the core values of teamwork, professional competency, and personal integrity, management accountants can make their contribution to their organization's success.

Judy Lewent, CFO of Merck Pharmaceutical, describes the ideal characteristics of management accountants as follows:

> My view of the divisional controllers is that they should be considered confidants and members of the team, not selling their soul, but respected for their credentials and their judgment…Credibility built on expertise permits you to take a stand on controls without being perceived as a policeman…If you have respect in your business acumen, and they know you have concern for corporate assets, there can be mutual respect.[11]

Think Along

How has your college education and prior experience prepared you for the management accountant's role?

▲ ATTRIBUTES OF THE NEW MANAGEMENT ACCOUNTANT

To function effectively, the management accountant today must acquire technical skills, attitudes and behaviors, and cultural values that supplement the traditional way that management accountants have approached their jobs.

Technical Attributes.

In 1994 the Institute of Management Accountants released a study titled *What Corporate America Wants in Entry-Level Accountants*. This study documented the gap between traditional accounting training provided by universities and the needs of corporate

[11] See S.F. Jablonsky, J. Patrick, and J.B. Heian, *Business Advocate or Corporate Policeman: Assessing Your Role as a Financial Executive* (Morristown, New Jersey: Financial Executives Research Foundation, 1993).

employers.[12] The study's main conclusion about university-prepared, entry-level management accountants was that they "lack practical experience, have little understanding of the big picture or how the real world works, have poor communication and social skills, and have insufficient preparation in manufacturing accounting."

A later study in 1996 analyzing the practice of management accounting shows that the skills required of today's management accountants are quite different from the past. They need broad training and must have the following assets:

- ▲ A strategic understanding of business.
- ▲ The ability for analytical problem solving.
- ▲ A focus on providing decision-relevant data.
- ▲ An understanding of business processes.
- ▲ The skill to use advanced information technology.
- ▲ Good computer skills.

Providing decision-relevant data and understanding business processes mean that management accountants must know a great deal about business operations. To help managers, management accountants must think like managers. They need to know the product or service a firm produces, and they should understand its business strategies. *To succeed, management accountants must get into the game and not simply keep score.*

A good example is a controller at the car assembly plant of Ford. This particular person is responsible for ensuring the quality of all door locks and mechanisms. If a production or supplier-related quality problem occurs, it is his job to resolve it! This operational involvement in everyday production is a good example of how the skills needed today go beyond just knowing the numbers and accounting procedures. The latter skills are important, but no longer guarantee success.

Behavioral Attributes.

The example of the Ford controller we cited in the previous paragraph also shows an important behavioral requirement for today's management accountants—the ability to function as effective team players. With his operational involvement, the Ford controller was able to establish his credibility with other members of the plant team. No one on the team questioned his understanding of the business when he made financial recommendations!

Success as a team member is ultimately a function of how a management accountant relates to other members of the business team. This process requires good interpersonal skills, communication skills, and leadership abilities. Again, these requirements represent a major change for management accountants. Many chose the profession because they were more comfortable with numbers than with people. However, the behavioral dimension of management accounting today is about exerting influence over people.

A major behavioral change required of management accountants is the ability to deal with "soft" future-oriented numbers. Accountants traditionally have been more comfortable with "hard" historical and verifiable numbers. Decisions, however, are future oriented; they require forecasting and planning. For example, the cost data used by product design teams are projections of costs associated with a future product. Accountants cannot simply provide past product costs and walk away. They must project these costs and bear

[12] See G. Siegel, *What Corporate America Wants in Entry-Level Accountants* (NJ: IMA, 1994). To view the full text, visit IMA's Web page at www.rutgers.edu/Accounting/raw/ima/entry/entry3.htm#chapter2www.rutgers.

the risks that go with decisions made on future cost projections. Consequently, accountants need to develop a new tolerance for ambiguity.

In a traditional hierarchical organization, management accountants could exercise their influence over business affairs by virtue of their position in the chain of command as agents of top management. As gatekeepers/guardians of corporate assets, they possessed the power of veto over how those assets are used. In a world of teamwork, influence requires top-notch communication skills. Influence results from the power of persuasion, rather than position. All members of a team mutually exercise influence over each other. No one has formal authority over other members.

Influence based on persuasion requires leadership, expertise, and interpersonal skill. Students who choose management accounting because they believe they are strong with numbers rather than with people will find it difficult to succeed in today's environment. For example, consider National Semiconductor.[13] National's CFO wants his staff to move away from being processors of information to educators and interpreters of information. National Semiconductor has identified three skills sets for its accounting staff: interface skills, system skills, and accounting skills, in that order. For National Semiconductor interface skills include

- ▲ The ability to speak and write concisely.
- ▲ Direct but tactful communication.
- ▲ The willingness and ability to challenge and ask the right questions.
- ▲ Personal integrity and security.

Chrysler Corporation's management accounting staff is making a similar shift. Chrysler communicates this change very explicitly in its guidelines for the behavior of cost analysts. The guidelines state the following:

- ▲ Be a business partner and not a policeman.
- ▲ Learn and use value engineering (the art of providing the essential functions of a product at less cost without compromising its quality or reliability).
- ▲ Provide cost leadership
- ▲ Meet with suppliers and help perform supplier cost analysis.

Notice the emphasis on service and knowledgeable involvement in the business. Chrysler expects cost analysts and engineers to be partners. Cost analysts are expected to learn and use value engineering, a discipline traditionally considered to be the domain of engineers.

Key Point

> Walking the tightrope of dual accountability to the business team and to corporate management takes consummate interpersonal and political skills. Furthermore, as management accountants shift from processors of information to educators of line managers and front-line workers, their communication and presentation skills become paramount.

Cultural Attributes.

The values that people hold and the mind-set they use to make sense of events are the cultural attributes that are the basis for sustained long-term behavior. Values and mind-sets

[13] Many organizations refer to the management accounting function as the finance function. Corporate finance departments often include individuals with accounting degrees as well as finance degrees.

Exhibit 7
Code of Ethics
Institute of Management Accountants, United States

Management accountants have an obligation to the organizations they serve, their profession, the public, and themselves to maintain the highest standards of ethical conduct. In recognition of this obligation, the Institute of Management Accountants has adopted the following standards of ethical conduct for management accountants. Adherence to these standards is integral to achieving the objectives of management accounting. Management accountants shall not commit acts contrary to these standards nor shall they condone the commission of such acts by others within their organizations.

Competence
Management accountants have a responsibility to
- Maintain an appropriate level of professional competence by ongoing development of their knowledge and skills.
- Perform their professional duties in accordance with relevant laws, regulations, and technical standards.
- Prepare complete and clear reports and recommendations after appropriate analyses of relevant and reliable information.

Confidentiality
Management accountants have a responsibility to
- Refrain from disclosing confidential information acquired in the course of their work except when authorized, unless legally obligated to do so.
- Inform subordinates as appropriate regarding the confidentiality of information acquired in the course of their work and monitor their activities to assure the maintenance of that confidentiality.
- Refrain from using or appearing to use confidential information acquired in the course of their work for unethical or illegal advantage either personally or through third parties.

Integrity
Management accountants have a responsibility to
- Avoid actual or apparent conflicts of interest and advise all appropriate parties of any potential conflict.
- Refrain from engaging in any activity that would prejudice their ability to carry out their duties ethically.
- Refuse any gift, favor, or hospitality that would influence or would appear to influence their actions.
- Refrain from either actively or passively subverting the attainment of the organization's legitimate and ethical objectives.
- Recognize and communicate professional limitations or other constraints that would preclude responsible judgment or successful performance of an activity.
- Communicate unfavorable as well as favorable information and professional judgments or opinions.
- Refrain from engaging in or supporting any activity that would discredit the profession.

Objectivity
Management accountants have a responsibility to
- Communicate information fairly and objectively.
- Disclose fully all relevant information that could reasonably be expected to influence an intended user's understanding of the reports, comments, and recommendations presented.

that are consistent with the needs of the management accounting profession ensure success. This section describes some of values and mind-sets that management accountants must possess.

Desired Cultural Values.

Management accountants must uphold the ethical values of their profession. These values are part of the profession's code of ethics. Exhibit 7 reproduces selected excerpts from the

Code of Ethics issued by the IMA in the United States. The complete text is on-line on IMA's home page. Other countries have similar codes of conduct for their professional accountants.

Note that the code emphasizes four main values: professional competence, confidentiality, integrity, and objectivity.

Competence requires staying abreast of changes in the profession and acknowledging the value of life-long learning. In the last two decades, the field of management accounting has changed dramatically. Many of our long-held assumptions and taken-for-granted knowledge has come under critical scrutiny. Management accountants who have not stayed current with these developments are unlikely to be able to help their organization in today's highly competitive environment.

Confidentiality means not using information for personal gain or disclosing it to further one's personal political agenda. For example, management accountants are privy to improvement plans of their divisions. One easy way to derail plans they do not agree with is to "leak" the information or bias it in a way that may create political problems for the division manager. For example, an accountant can kill an initiative designed to improve work activities by characterizing it as cost reduction through a "head count" reduction initiative.

Integrity is reflected in several facets of a management accountant's work. He or she must weigh and balance the interests of all users of financial data. Another area is avoiding conflict of interest. For example, assume a favorable sales forecast can enable a firm to look good and obtain a bank loan. However, does this favorable forecast have a reasonable basis in fact? Suppose the management accountant differs from other members of the management team in believing that the forecast in overly optimistic and unlikely to be realized. Is she/he being too conservative? Is this conservatism objective or just the reflection of a weak stomach? How do management accountants put the firm in the best light in its bid for the loan without overstating, and possibly misrepresenting, the facts to the bank? Management accountants routinely encounter this type of ethical dilemma.

Objectivity requires disclosing all information without favoritism or bias to any party. For example, early disclosure of a product design may give certain suppliers a bidding advantage.

These ethical situations are often difficult to manage. As management accountants become business advocates, they will confront an increasing number of ethically difficult situations. There is no easy answer to how to resolve these situations. The code is only a start. Management accountants must work to develop their own inner ethical compass and remain true to it. Remember that one of the few things no person can strip from another is his/her integrity. Only you can strip yourself of this precious piece of personal character!

Mind-set.

As we discussed earlier, traditional accounting training encourages an *observer* rather than a participant mind-set. Accountants are supposed to be neutral observers who report "financial reality." They enforce objective financial reporting and cost accounting rules and procedures. The audit background of many management accountants reinforces this role of detached, independent observer of business affairs.

This mind-set is not appropriate for the business advocate role and cross-functional team player roles. Management accountants must understand that they are not just observers. They must shift their mind-sets from an orientation toward independence to an orientation toward involvement. Their work does not end with providing information and analysis. They must participate in the decisions and share the attendant business risks. The challenge is active participation, not neutral observation.

Another mind-set that is common to management accountants is a bias toward being "cost constrained" instead of being "profit conscious."[14] These two organizational mind-sets influence how management accountants perceive their roles. In a cost-constrained approach, the management accountant's focus is on cost overruns, budgets, and financial measures. This mind-set places the management accountant in the role of a corporate cop. It leads to distance and aloofness from other organizational members, and all discussion is through financial numbers.

A profit-conscious mind-set focuses on increasing profitability, even if it means sacrificing budget accomplishment. The mind-set encourages greater focus on factors such as customer satisfaction. It recognizes that financial improvement requires operational improvement and therefore reports both operational and financial measures.

[14] A.G. Hopwood, "An Empirical Study of the Role of Accounting Data in Performance Evaluation," *Journal of Accounting Research,* 1972, pp. 156–182.

▲ LESSONS LEARNED

There are several important lessons you should take from this module.

- ▲ A typical management accountant occupies a staff position in the organization. He or she provides business analysis to line managers and assists top management in evaluating that same manager.
- ▲ Management accountants have a dual role. They function as financial advisers, or the "business advocate" role, and as overseers of corporate assets, or the "corporate cop" role.
- ▲ Historically, firms have emphasized the corporate cop role over the business advocate role because of the hierarchical structure of the organization and the need to keep books manually.
- ▲ Management accountants and line managers have different perceptions of the role of management accountants. Management accountants see themselves as business advocates, but line managers see them as corporate cops.
- ▲ Advanced information technology and global competition are forcing management accountants to act more as business advocates than as corporate cops.
- ▲ Various educational and professional certification paths lead to careers in management accounting.
- ▲ The criteria for success in the management accounting profession have changed. As business advocates, management accountants can no longer seek refuge as neutral observers and leave decision making to line management. Management accountants are part of a business team and are expected to
  - Know the business and be involved in daily operations.
  - Participate in shaping and implementing business strategy.
  - Provide decision-relevant data to front-line workers and business unit managers.
  - Understand and improve business processes.
- ▲ Management accountants must possess both business acumen and financial expertise.
- ▲ Management accountants must be able to communicate clearly and be effective teams members.
- ▲ To succeed, management accountants must possess the core ethical values of professional competence, confidentiality, personal integrity, and objectivity. They must have a mind-set that encourages participation and learn to focus on profits, not just on costs.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what we do such as loading a truck or responding to a customer complaint. (See Process diagram.)

Activity-Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments, or processes) that share that common cost. An allocation involves dividing the cost we want to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Competitive Analysis Tools that enable companies to quantify how their performance and costs compare against competitors, understand why their performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost, or time in small incremental steps on a continuous basis.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred is called its driver.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object A cost object is any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Culture The collective values, beliefs, ethics, and mind-sets of the members of an organization, clan, or society that is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

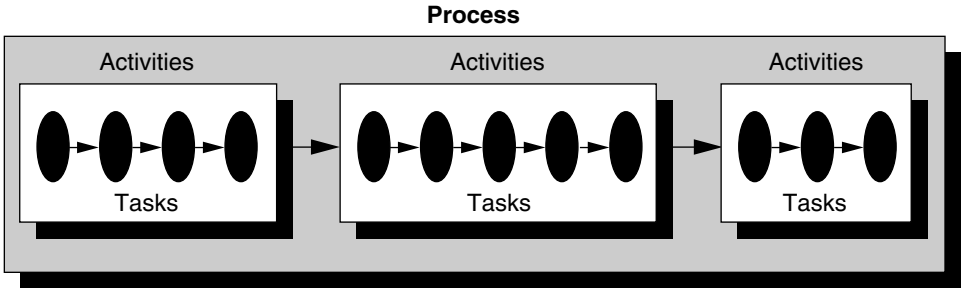
Fixed Cost A cost element that does not vary with changes in production volume in the short run. Property taxes on factory buildings is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as the difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Value Chain (See Extended Enterprise.)

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self-test questions.

a. How can the management accountant assist a business trying to upgrade the quality of its products?
b. A firm is trying to determine how it can reduce cycle time by 20 percent in the next two months. How can the management accountant assist in accomplishing this goal?
c. How do the conflicting roles of management accounting arise?
d. Providing product costs used to be the management accountant's primary role. Why is this function now insufficient?
e. As a student, how can you best prepare to become a management accountant?
f. Where do management accountants fit in the organizational structure? What level of managers do they work closely with?
g. What has led to the corporate cop role of the management accountant?
h. How must controllers consider quality, cost, and time objectives within their own department?
i. A recent survey of firms conducted on behalf of the Institute of Management Accountants (IMA) shows six major roles for management accountants. The first role is "Become business and strategic partners to management. Be their trusted financial and operational advisers." Explain how management accountants would perform this role.
j. How can a management accountant help incorporate the strategic time dimension into decision making?
k. Explain the phrase *value chain members*.
l. Explain the phrase *cost of ownership*.
m. What is *cycle time*?
n. Global competition is forcing firms to become more flexible and respond rapidly to customers. Companies have adopted a team approach to problem solving to respond to global competition. How do teams help companies respond to competition?
o. Accountants seem to view themselves as being team players and involved in corporate strategy, while line managers seem to still view accountants as performing a corporate cop role. Why does this disparity exist?
p. Which skills does a recent IMA study identify as important for today's management accountants?
q. Which professional organization in the United States issues a professional code of ethics that management accountants must follow?

2. Bob Gerard has been employed at Zintech Corporation for the last 17 years. He began in the accounts payable department and worked his way up to assistant controller. After five years in that slot, he was promoted to controller when the previous controller retired. He has now been in that position for eight years. His primary focus is on cost control. To keep production costs down, Bob maintains a database that calculates all possible variances (difference between budget and actual costs) on a daily basis. As soon as a cost appears too high, Bob notifies the production manager. Bob considers his job done well whenever costs are at or below budget.

Bob recently attended a professional conference to update himself. (Bob normally does not attend many conferences or meetings because his job is so demanding.) At this conference the presenters kept referring to the "business advocate" role of the management accountant. As a result, Bob realized that although his actions were good at keeping down costs, he was not really helping the company from a strategic or productivity level.

Required:

a. What kind of role was Bob performing in his company?

b. What actions could Bob take to move to a "business advocate" role? Be specific in your answers.

c. Review the competence section of the standards for professional ethics. Many changes are occurring in management accounting. New reports, new roles for accountants, and new measurement issues have arisen in the past decade. How might someone like Bob, a very busy professional, maintain an appropriate level of professional competence? What are the consequences of not keeping up with the profession?

3. You were recently hired as a consultant to help increase productivity at a large plastics manufacturer. In your initial meeting, you made notes of the following remarks:

- Brent, the production manager, says he can answer all your questions and you do not need to bother with visiting the plant.
- Jenise, the controller, is in the downtown office building; says she does not get out to the plant much.
- You've been told that Joe, the night shift production line manager, has been there "forever" and "knows everything about the place." He can explain all the production procedures to you.
- Corporate headquarters receives cost variance (difference between planned cost and actual cost) reports from Jenise and sends a corporate-level team to "visit" if negative cost variances exceed 15 percent in any quarter.

Required:

a. Which positions are considered staff positions? Which are considered line positions?

b. What information should be gathered to assist in you in measuring existing productivity?

c. What information might you need to suggest how to improve productivity?

d. What conflicts or problems might arise in gathering this information?

e. Describe the culture that exists in this organization.

f. How would you respond to Brent's statement concerning the plant visit?

4. This module stresses the importance of the management accountant as a business advocate. It discusses how many organizations are redefining the role of the management accountant within the company. However, this role does not have much to do with the preparation of external financial statements. Therefore, many people tend to underestimate the importance of the business advocate role.

Required:

a. Describe the roles of the management accountant in a manufacturing business.

b. If a management accountant worked for a service entity, such as a hospital, would your answer apply? If not, how would his/her role be different?

c. Explain the importance of the management accountant and the importance of the role in the organizations to someone who says, "Nothing a management accountant produces ends up on the financial statements, and those are the only numbers that matter."

5. Look through the classified section of a large newspaper or the *Wall Street Journal* for advertisements for controller, assistant controller or financial analyst positions. Gather 5 to 10 of these ads and summarize the job descriptions based on skills required, job responsibilities, or any other important information. How do these ads describe the responsibilities of the management accountant? Would a corporate cop role or a business advocate role be most appropriate? What skills would be most helpful for you to learn in school in order to be able to fill this type of position? (You can also conduct a search on the Internet).

6. A production manager is upset with the plant controller because "those accountants who don't know anything about how to make a product" keep interfering by asking lots of questions and requiring new measures on things like process time and quality. He contends that the accountants' job is to stay in their office and "play with their numbers" and to stay out of his way and let him run his own department.

Required:

a. What role is the controller's office engaging in?
b. What is occurring that is causing the production manager to be upset?
c. How would you suggest the controller reply to the production manager's claims?

7. A charitable organization publishes internal monthly reports listing the top donors, the amount given, and the fund-raiser who solicited the donation. The controller's office collects this information and summarizes it for upper management to use for performance evaluation.

Required:

a. How can the reports published by the controller's office affect the behavior of a fund-raiser?
b. How could the controller's office restructure its reports to encourage fund-raisers to raise more money from working class contributors?

8. In "The Practice Analysis of Management Accounting," a research project of the Institute of Management Accountants (March 1996), management accountants were surveyed on several areas of their work activities.

They were asked to evaluate the most critical work activities performed by management accountants. The results shown identify the top five work activities and the percentage of respondents who identified that work activity as most critical.

Work Activity	*Percent*
Accounting systems and financial reporting	47
Long-term strategic planning	32
Managing the accounting/finance function	29
Internal consulting	27
Short-term budgeting process	25

The respondents were also asked for their opinion of the knowledge, skills, and abilities (KSAs) important for **competent performance of a management accountant's work.**

The five most important KSAs for work and the mean response on a 1 to 5 scale, with one being "not at all important" and 5 being "very important," are listed below:

KSA	*MEAN*
Work ethic	4.67
Analytical/problem-solving skills	4.66
Interpersonal skills	4.64
Listening skills	4.58
Use of computerized spreadsheets	4.51

The five most important KSAs for **entry-level competence** and their mean response on a 1 to 5 scale are listed below:

KSA	*MEAN*
Work ethic	4.56
Listening skills	4.15
Accounting system: the "books," cost flows, double entry, etc.	4.04
Use of computerized spreadsheets	4.03
Analytical/problem-solving skills	3.98

Required:

a. How do the most critical work activities relate to the business advisor role of the management accountant as described in this module?
b. From the listing of most critical work activities, do you believe that most management accountants are in a corporate cop or business advisor role?
c. How do the most important KSAs relate to the business advisor role of the management accountant as described in this module?
d. From the list of most important entry-level KSAs for work, do you believe that most entry-level management accountants are in a corporate cop or business advisor role?
e. How do you explain the difference between the items listed most important KSAs for work and those listed as necessary for entry-level competence?
f. Analyze the courses for an accounting major at your university and determine where the necessary skills for entry-level competence are developed within those courses.

9. You are the file maintenance manager for Mercy Hospital, a 1,000-bed hospital in a major metropolitan area. Files maintenance needs new computers, and you recently solicited bids from several suppliers. You requested the controller to assist you in evaluating the bids. The controller compared your specifications to those in the bids and evaluated the terms and cost of each bid. He made a recommendation to accept the bid of Medical Systems, Inc. Based on that recommendation, you placed an order for the computers.

Several weeks after placing the order, you see the controller on a local golf course with the president of Medical Systems. The next day at work, you phone the controller to

ask him about his relationship with Medical Systems. He states that the president is his neighbor, and both serve on their homeowner's board of directors. He had not mentioned that fact to you when he did his analysis because he based his analysis strictly on the bid proposals and was not influenced by his relationship.

Required:

a. Has the controller violated any of the ethical standards issued by the IMA?
b. How do you believe that the controller should have handled this situation? Why?
c. What would you do if you were the file manager?

▲ PROBLEMS AND CASES—ADVANCED

10. Marine Products produces ski boats, bass boats, patio boats, houseboats, jet skis, wave runners, outboard motors, and a line of boating trailers and accessories. It is divided into product groups. Each product group has a controller, assigned by the corporate controller's office. The product group controller manages the group's accounting system and provides an analysis of the financial performance of the group for the group vice president. The vice president evaluates the performance of the group controller and makes a recommendation for salary increases to the corporate controller, who is ultimately responsible for making the decision.

Each group is responsible for new product design, marketing, pricing, and operating expenses. Group vice presidents are evaluated based on the group's profits. Corporate headquarters tightly controls investment decisions and financing. All capital expenditures over a modest amount must be submitted to and approved at the corporate level. Each group's controller also submits an independent evaluation of the group's performance and its capital budget requests directly to corporate headquarters.

Required:

a. Group vice presidents have complained that group controllers function as spies for corporate headquarters. What role do you think the group controller is performing?
b. Do you think that the reporting structure (group controller to corporate headquarters) is appropriate?
c. If Marine Products were concerned with increased competition in the boating industry, how would you suggest it reorganize its management accounting function? Why?
d. If your suggestions were followed, what do you believe would be the result? Do you foresee any difficulty in getting group vice presidents and management accountants to accept the new arrangements?
e. Suppose that the controller and the president of Marine Products know each other personally because they went to the same high school and live in the same neighborhood. What kind of ethical dilemma does this situation pose for the controller?

11. Arleta Consuelo, a member of the product development team and a management accountant, is concerned that the design production process will lead to quality problems after the customer has used products and the standard warranty period has expired. She has expressed this concern in team meetings and has argued for a changed process. Other team members have explained that they are not worried because quality problems after the warranty period do not lead to increased company cost. Process redesign is costly and will slow the product launch.

Required:

How might the management accountant handle this issue and gain the respect and cooperation of other team members?

12. TEAM PROJECT. Contact a local mid- to large-size company and request a copy of its organization chart. Where does the controller fit into the structure? Are management accountants involved in problem-solving teams? What roles are the various management accountants engaged in?

Case 1: New Age Manufacturing, Inc.

New Age Manufacturing, Inc., sells motherboards for personal computers (PCs). It also has its own assembly plant in which it assembles its own PC brand. The assembly unit buys motherboards from the fabrication facility of the company and purchases all other components and parts from outside suppliers.

The assembly operation is labor intensive and uses very simple tools and test equipment. A typical PC takes 45 minutes to assemble. The process consists of attaching a motherboard to the bottom of the chassis or tower case. A hard disk, a floppy disk, and a CD-ROM drive are slipped in and screwed into slots provided in front of the chassis. The next step is to insert the video card and the drive controller cards. The three drives are then attached to two controller cards, one for the CD-ROM and the other for the hard and floppy drives, using the pin connectors and cables that come with the drives. The hard disk is formatted, and the unit is then turned on for burn-in testing. This process usually takes 24 hours. A reliability test is done after the burn-in test. If all components are good and reliable, additional items requested by customers, such as sound cards, are attached and tested. The final step is to install any software bundled with the computer and then to assemble the chassis and pack the unit for shipment.

Because of the intensely competitive nature of the PC industry, New Age's profit margins have been shrinking for the past five years. Leading manufacturers such as COMPAQ, AST, DELL, and ALR have met this challenge by redesigning their computers to reduce costs without sacrificing quality and functionality.[15] New Age, however, has focused most of its cost-control efforts on reducing labor cost by using cheaper labor.

In an effort to revive the company, the shareholders have just appointed Michael Tsung as the new CEO. Tsung realizes that the company must reduce costs while maintaining high-quality product, service, and support. The company's controller has decided to take early retirement to allow the new CEO to choose his own finance staff.

The controller's office has six accountants, one of whom performs the duties of an assistant controller. The retiring controller focused on accurate product costing, budgeting, and identifying instances when costs exceeded budgeted amounts. The controller communicated areas in which costs had exceeded budgeted amounts in a weekly report to the CEO, prior to the CEO's staff meeting with the production manager. The new CEO is not confident that costs are truly under control. He is doubtful about the assembly plant's efficiency and its ability to increase profits.

Working with the human resources department, Tsung has narrowed down the candidates for the controller position to two individuals—James Harrison and Roxsana Bentley. Their backgrounds are briefly described here.

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[15] See "Penny Pinching PCs: How They Did It" BYTE Magazine, Nov. 1992, p. 131.

James Harrison is in his late 40s and has three grown children. He joined a Big 6 national CPA firm after earning his undergraduate degree and has been with the firm for 20 years. Currently he is an audit partner with the electronics industry group within the firm. He has extensive background in the design of internal control systems and auditing of electronic firms. Harrison was involved with the audit of disk manufacturing firms and is very familiar with the inventory valuation problems that arise in the electronic industry. He also has prior experience in budgeting for the audit division and is very capable at handling the budget process. Harrison currently serves as an advisor to the firm's electronics industry manufacturing and consulting group. He has helped numerous electronic companies set up internal control systems, implement accounting procedures, and ensure compliance with generally accepted accounting practices (GAAP) and generally accepted auditing standards (GAAS). As a partner, Harrison has managed junior members of the accounting staff and has communicated effectively with investor groups. He likes to specialize and "do a few things extremely well instead of spreading too thin." After being with the CPA firm in the Northeast for 20 years, Harrison has expressed a desire for "a change in location and a company that can use my specialized knowledge of accounting and auditing in computer manufacturing."

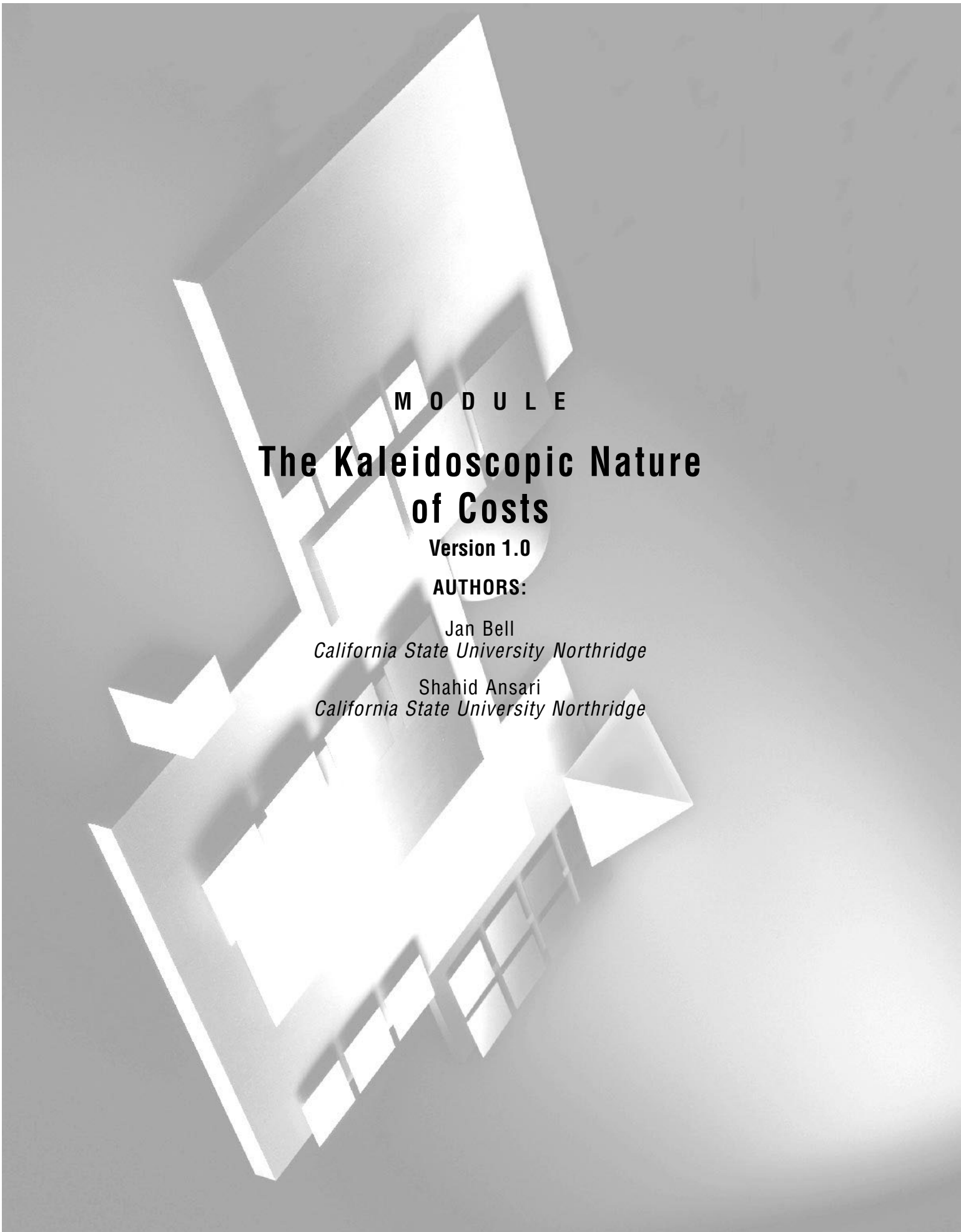
Roxsana Bentley is in her early 40s. A mother of two teenage children, she worked for a medium-sized CPA firm affiliated with a large accounting firm out of Europe immediately after graduation. While there, she worked on audit and consulting assignments. After six years with the firm she resigned and earned an MBA in information systems from a leading business school. While in school she got married and had children soon after graduating. After a five-year absence, she returned to the work force and joined a large circuit board manufacturer as a senior operations accountant. The manufacturer has several plants in the Far East. After two years Bentley was transferred to Osaka, Japan as an assistant plant controller (three years) and then to Singapore as plant controller (three years). Bentley's primary experience has been with the design of product-costing systems, implementation of activity-based costing, and development of capital budgets. She has dealt extensively with production and engineering personnel, and she is quite well liked. For the last three years, she has served as regional controller for Far East operations. She described her role as regional controller as "initially helping the company articulate its overall strategy and then helping it focus on total performance rather than having each unit set its own measures."

The CEO has checked references on both candidates and received very positive recommendations. Harrison has been praised for a sharp intellect, his uncanny ability to analyze financial information, and management of the staff in his office. Bentley is portrayed as a likable individual, a good team player, and one who has a good feel for manufacturing.

Required:

a. Identify the important strategic success factors that New Age needs to turn around its PC business. (You may want to do some background research on the PC industry and the critical strategies that the firms in this industry use.)
b. What are the important qualities that New Age needs in its new controller?
c. Match the qualifications of the two candidates against your list of qualities in the prior question.
d. If you were in Tsung's position, which candidate would you hire as controller? What makes this candidate a better choice than the other candidate?

NOTES



M O D U L E

The Kaleidoscopic Nature of Costs

Version 1.0

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The Kaleidoscopic Nature of Costs

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THE MANY FACES OF COST

Alberto Mantillab, president of Andean Jewelry Inc., opened the weekly staff meeting of his top officers with the following news. "Folks, our distributors want further price reductions from us. I have explained to them that we're operating on razor-thin margins, but they tell us they have no choice. They tell me that they are competing for jewelry counter space in stores. Many of their competitors are importing from suppliers from the Far East. Without price reductions, they're not competitive. That means that we must find a way to reduce our costs further."

"Yes," broke in Maria Davidson, marketing manager of Andean Jewelry. "I've had the same complaints from almost all our customers. They tell me that while our unique Peruvian-styled gold and silver jewelry designs remain popular and customers frequently ask to see items, most are put off by the price and buy something else."

"Well," said Sham Patel, production manager, "we have invested a great deal in new capital equipment and I do not know how I can reduce these costs. Also, a large part of our costs is for gold and silver purchases. I have been trying to buy our materials and parts in large quantities to get purchase discounts and produce finished items in large batches to lower unit fixed costs."

"Maria, perhaps our costs are high because we make too many and too elaborate designs," interjected Alberto Mantillab. "Robert, I wonder if having huge amounts of inventory is a cost-effective solution." He then turned to Thomas Kim, the company's accountant. "Tom, do you know what we might save if we simplify designs? How much does it cost us to maintain these high inventory levels? Can we do something about reducing our marketing and administrative costs? Which reminds me, what is our margin compared to the distributors and the stores that sell our jewelry?"

"Mr. Mantillab," replied Tom, "I am not sure I can answer your questions from our existing accounting records. We have never systematically collected or analyzed our cost data, let alone the costs of outsiders like distributors and storeowners. Our cost statements are designed only for our banks and shareholders."

"The customer is speaking to us; we'd better respond," replied Mantillab. "We need to study our costs carefully and classify them in ways so we can determine where and why our costs are incurred and how to reduce them while still making quality jewelry."

The term *cost* refers to a sacrifice of resources. Whether we barter, pay cash, or finance our acquisitions, the amount expended for an item is its cost. For example, when you sign a lease and live in an apartment for a month, that month's rent is the cost of using the apartment. It does not matter whether you pay the rent in advance, at the end of the month, or in services rendered.

As the opening story illustrates, to manage costs, we must first measure and classify them. As you will see in this module, there are many different ways of classifying costs. Each classification provides useful information; each also has its limitations.

▲ STRATEGIC IMPLICATIONS OF DIFFERENT COST VIEWS

In all organization, service, manufacturing, not-for-profit, and for-profit, managers are interested in using cost data for making strategic decisions and for managing costs. This requires measuring costs and classifying them by products, services, work processes, departments, and other cost objects of interest to managers. A good cost classification scheme provides a manager with insights about an organization's cost structure that enable him or her to achieve the strategic objectives of quality, cost, and time.

- ▲ **Quality.** To ensure that products meet customer requirements, a cost system must measure and report the cost of providing the features and functions that customers want. Costs must be matched to customer willingness to pay. Only then can firms design products that maximize customer value.
- ▲ **Cost.** To manage costs, managers must understand their cost structure. The cost classification system must help them answer questions such as: What causes costs to vary? Which costs are internal and under their control? What costs are outside with suppliers and others? What does it cost per unit to produce, sell, and administer the company? What is a customer's lifetime ownership cost for a product?
- ▲ **Time.** The way a firm organizes its work processes to produce, market, distribute, sell, and service its product impacts the time it takes to meet customer orders. Rearranging work processes impacts time, and that in turn impacts cost. A cost classification system must make visible the impact of time on the cost of a product.

▲ PURPOSE OF THIS MODULE

This module introduces and illustrates cost terminology and cost classification schemes. The primary purpose is to acquaint you with the language of managerial accounting and to show that various cost classifications are essential to understanding and managing an organization's cost structure. After studying this module, you should understand

- ▲ The meaning of some basic cost terms.
- ▲ The historical evolution of cost terms and classifications over time.
- ▲ Cost classifications used for external financial reporting.
- ▲ The difference between cost classification for external and internal managerial reporting.
- ▲ The traditional management accounting cost classifications.
- ▲ The emergence of new cost classifications in response to the changed business and manufacturing environment.
- ▲ The technical, behavioral, and cultural impact of cost classifications.

▲ THE KALEIDOSCOPIC NATURE OF COST

Remember as a child when you played with a kaleidoscope? Each turn of the lens presented a unique pattern. You may not have been aware at the time, but the kaleidoscope used the same pebbles to create each unique pattern. The turn of the lens caused the delightful variations. Each new view, however, obscured a previous pattern and hid from view the endless other

patterns. **Costs are very much like the pebbles in a kaleidoscope. Each time we arrange them in a different pattern (classification scheme), they give us a different insight. Each pattern, however, obscures others and can create the impression that it is the total picture.**

The accountant's classification system is the lens that arrays costs into different patterns. Unclassified, the cost pebbles simply tell what object was acquired, such as materials, supplies, wages, and rent. With each change in the accountant's classification system, costs array differently and give a new perspective that helps a firm's management to make strategic decisions and manage costs.

Key Point

> Since accountants can array the same costs in many ways, how a cost is to be used determines what cost classification is relevant. Different cost classifications reveal different information about a company's cost structure.

Accountants accumulate and classify costs with respect to different *cost objects*. A cost object is any item (i.e., activity, function, segment, product, or service) whose cost is to be determined. In practice, there are many different cost objects of interest to users and decision makers. This leads to many different ways of classifying costs.

To understand the most popular cost classifications used in practice, it is useful to look at their historical evolution. Different cost classifications we see today can be traced to three distinct time periods.[1]

- ▲ The first period coincided roughly with the beginning of the industrial revolution and goes through the first half of the 20th century. During this period, cost classifications were dominated by the needs of external financial reporting.
- ▲ The second era lasted roughly from the late 1950s to the late 1970s. This period saw the emergence of traditional management accounting cost classifications that were heavily influenced by mass manufacturing systems.
- ▲ Finally, the modern era, which started in the late 1970s, saw the advent of modern cost classification systems influenced by the introduction of modern manufacturing methods and the changed global business environment.

Think Along

> What are the cost classifications and terms you would expect to be important from an external financial reporting perspective? Why is it important to understand them?

▲ EARLY COST CLASSIFICATIONS—THE EXTERNAL (FINANCIAL) PERSPECTIVE

Historically, cost classifications emerged as an offshoot of external financial reporting in the manufacturing sector. The primary purpose of cost data was to record and report the value of inventories on external financial statements. During these early years, cost data used for preparing external financial statements was also used for internal reporting to

[1] Our division of the emergence of cost classifications into these three time periods is only for convenience of exposition. It is not a strict historical recounting and represents when these cost classifications gained popular acceptance across a large number of organizations.

Exhibit 1
Andean Jewelry Ltd.
Income Statement
For the Year Ended December 31, 1999.

Net sales revenue	$7,913,900	100.0%
Cost of goods sold	4,537,806	57.3%
Gross margin	$3,376,094	42.7%
Operating expenses		
Marketing	858,709	10.9%
Administrative	1,313,618	16.6%
Total operating expenses	2,172,327	27.5%
Income before tax	$1,203,767	15.2%
Income taxes (40%)	481,507	6.1%
Net income	$722,260	9.1%

managers. Even today, as an external party, you probably will not have access to a firm's internal cost data. The language used in external statements is the basic language that you will have to understand if you want to analyze the cost structure of a firm. To illustrate the basic cost classifications used by a manufacturer on their external financial statements, we will use Andean Jewelry's income statement for this last year shown in Exhibit 1.

External financial accounting and reporting are governed by a set of rules known as generally accepted accounting principles (GAAP) in the United States. Most countries have similar rules that govern financial reporting. Accountants must follow these rules when reporting to external parties such as shareholders and creditors.

Cost classifications required to prepare external statements classify costs as assets or as expenses. An *asset* is a resource such as land, buildings, or machinery that has not been used up in producing goods or services for sale. It is sometimes referred to as an *unexpired cost*. An *expense* is a measure of resources used up in producing goods or services for resale. An expense is sometimes called an *expired cost*.

The income statement in Exhibit 1 is prepared in accordance with GAAP. It lists all the expenses (costs used up) in a period for generating revenues. The expenses or costs are classified by the major functions of a business—production and operations.

Cost of Goods Sold.

This category contains the cost of producing the products or services sold during the current period. For a typical manufacturer, this category contains a number of different sub-cost categories. The three most used are *direct materials, direct labor,* and *manufacturing overhead*.

Direct materials become part of the finished products. For Andean Jewelry, the direct materials cost would include the cost of gold, silver, precious stones, clasps, and chains used in jewelry.

Direct labor is the cost of laborers who directly work melting, forming, and finishing jewelry. In general, if workers "touch" a product to manufacture it or if they work directly providing a service, then their wages and benefits are directly traceable to the product or service.

Manufacturing overhead includes all other costs incurred in the production operation. Other names for manufacturing overhead are *factory overhead, indirect manufacturing costs,* and *factory burden*.

Exhibit 2 shows the typical manufacturing costs incurred by Andean Jewelry in 1999.

Exhibit 2
Manufacturing Costs Incurred
For the Year Ended December 31, 1999.

Cost Item	*Amount*
Direct materials used	$3,069,986
Direct labor	1,025,412
Total direct costs	4,095,398
Manufacturing overhead (indirect)	
Equipment depreciation	73,814
Rent and utilities	203,439
Repairs and maintenance	51,269
Supplies and tools	25,570
Supervision and maintenance wages	425,590
Factory employee benefits	83,525
Total indirect manufacturing costs	863,207
Total manufacturing costs	**$4,958,605**

Conversion cost is another term often applied to manufacturing costs. It refers to the sum of direct labor and manufacturing overhead. In Exhibit 2, the amount of conversion cost is $1,888,619 (1,025,412 + 863,207). Finally, the sum of direct materials and direct labor ($4,095,398) is often called *prime costs*.

Think Along

Why is the total manufacturing cost incurred in this period ($4,958,605) not the same as the cost of goods sold for this period ($4,537,806) shown in Exhibit 1?

The difference between the two numbers is due to inventories, that is, materials purchased but not used, units started but not finished, and goods produced but not sold. **Appendix A demonstrates how to calculate the cost of goods sold from the amounts spent on manufacturing costs in a period.**

Accountants often classify the three costs, materials, labor, and overhead, into *direct* and *indirect costs*.

Direct costs are costs that can be traced uniquely to a cost object. Since the cost of materials used in a product and "touch" labor (workers who work on the product) can be traced uniquely to products, the word *direct* is added before materials and labor costs.

Indirect costs are common to more than one cost object and either cannot be uniquely traced to a particular cost object, or the cost of tracing them to products exceeds the benefit of doing so. Traditionally, accountants consider all production costs other than materials and labor and all operating expenses as indirect costs.

Operating Costs.

This category includes the cost of other business functions such as marketing and administration.

Marketing costs include both the cost of obtaining orders from customers, *order-getting costs,* as well as costs to complete the sales transaction, *order-filling costs*. Order-getting costs include costs to advertise products, salesmen's commissions and salaries, and travel and entertainment expenses as well as other items. Order-filling costs include warranty repairs and office expenses associated with granting credit, invoice preparation,

Exhibit 3
Schedule of Marketing Costs
For the Year Ended 12/31/99.

Sales commission	$282,766
Sales salaries	191,295
Shipment and delivery	318,550
Telephone	16,725
Occupancy Costs	49,373
Total marketing expenses	**$858,709**

Exhibit 4
Schedule of Administrative Costs
For the Year Ended 12/31/99.

Design fees*	$130,703
Accounting and legal	67,986
Insurance and risk analysis	60,605
Office supplies	132,246
Administrative salaries and benefits	706,625
Office equipment and furniture depreciation	92,162
Taxes and licenses	50,214
Telephone	33,501
Miscellaneous	39,576
Total administrative expenses	**$1,313,618**

* Some students might classify design fees as a product cost. The classification in this module follows generally accepted accounting principles that require classification of research and development costs as a period and not a product cost.

shipping of merchandise, and payment collection. Exhibit 3 contains Andean Jewelry's cost report for marketing.

Administrative costs include the costs of other business support functions. This cost category typically includes executive and support salaries, research and development, accounting fees, information processing system costs, legal expenses, and so on. Exhibit 4 contains Andean Jewelry's administrative costs for last year.

The terms *product* and *period costs* are often used to distinguish between manufacturing and operating costs. This classification determines when costs are expensed on the income statement or classified as inventory on the balance sheet.

Product costs become expenses as products sell; they are included as inventory on the balance sheet if products remain unsold. Product costs include the manufacturing costs of units.

Period costs are the operating costs incurred to market products/services or administer the company. Period costs are expenses in the period the cost is incurred.

The basic criterion for cost classification from an external financial statement perspective is whether a cost is an asset or an expense. Manufacturing costs of unsold units are assets even if we have **paid** for all these costs. They are also called *product* costs. Operating costs are expenses in the period incurred even if we have **not paid** for them. They are also called *period* costs.

Exhibit 5
GAAP Classification of Costs.

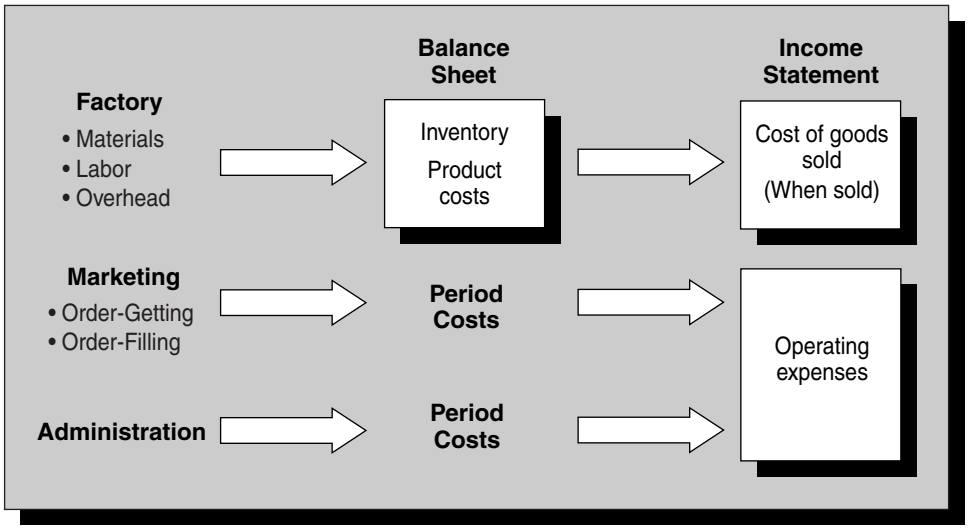


Exhibit 5 provides an overview of manufacturing and nonmanufacturing costs and their GAAP classification.

This distinction between product and period costs does not occur in service organizations, because services are not inventoried. Consider a haircutting establishment such as Regis or Super Cuts. The cost of providing a shampoo and haircut includes materials, supplies, equipment, labor, and other support costs; all these are expensed in the period in which they are incurred.

Think Along

Would you expect different cost classifications and terms for internal (management) reporting? If so, why? How might they be different?

▲ TRADITIONAL MANAGEMENT ACCOUNTING COST CLASSIFICATIONS

A manager cannot run his or her business with the cost classifications developed for external financial reporting. As the opening story pointed out, a manager needs to know, among other things, whether a product or service is being produced at a competitive cost, what the cost impact is of increasing production, which customers or channels are profitable, and what the cost is of alternatives not adopted. None of these questions can be addressed by the cost classifications described so far. They require different cost classifications.

This is the role of management accounting cost classifications. Management accounting views costs from a much broader lens than external financial reporting does. In the early years, the cost classifications developed by management accountants were heavily influenced by the economic theory underlying mass production systems. This thinking encouraged managers to understand the difference between an *actual* outlay and *opportunity* costs, the *behavior* of costs, the *traceability* of costs, and the *responsibility* for costs.

Actual and Opportunity Costs.

An *outlay cost* is an out-of-pocket sacrifice. The financial accounting system captures outlay costs. The timing of the cost outlay can vary. The costs may have occurred in the past, or they could occur in the present or in the future.

For example, if a health care provider uses existing medical equipment to examine a patient, a portion of the equipment cost is a cost of providing patient care. It represents an outlay cost incurred in the past. The cost of wages of the health care provider is also a cost of providing patient care. It represents a present outlay cost. If the health care provider discards medical supplies and wastes in a bio-hazardous materials disposal unit, the facility will incur a cost in the future to have these wastes disposed of properly. This future outlay cost is also a cost of providing patient care. Management accountants carefully measure the cost of a health care episode considering all these outlay costs.

An *opportunity cost* is a different cost of concern to management accountants. The financial accounting system does not capture these costs. Opportunity costs recognize that by taking one course of action or alternative, you give up others. An opportunity cost measures the sacrifice you incur by forgoing your next best alternative course of action.

For example, assume that you buy a $5 power-ball lottery ticket for a chance at a $120 million jackpot. Prior to the lottery, a person in a state not selling lottery tickets offers you $500 for your ticket. If you keep your ticket, the cost of playing the lottery is $500, not the $5 outlay cost. The amount that you forgo by not selling the ticket is its opportunity cost.

Management accountants often consider opportunity costs in decision making. Consider an offer from a company to rent a portion of your warehouse space for $5 per square foot. You built this space for $2 per square foot several years ago. If you decide to use this space internally, then the cost of using the space is $5, not $2. The relevant cost measurement is the opportunity cost, not the past outlay cost.

Cost Behavior.

Management accountants are very interested in knowing how costs behave when production volume changes. They want to know whether a cost is *fixed, variable,* or *mixed.*

A *fixed cost* is constant in total regardless of the number of units produced within a relevant range of operations or within a certain time period. Think about a "forming" machine. Assume that it cost $50,000 and has an expected life of five years. Using a systematic method of charging some of the cost to each year of its use (*depreciation*), an accountant might calculate the cost of its use to be $10,000 per year. This $10,000 is the same regardless of the number of units Andean Jewelry produces. Similarly, the rent on the factory building is fixed by the lease term and will not change no matter how many units are produced in that year.

A *variable cost* is a cost whose total changes directly and *proportionally* with volume produced. Consider the raw materials used to manufacture jewelry. Assume that a necklace requires $235 per piece for gold, clasp, and stone. The total material cost is $235 if we make one unit and $23,500 if we produce 100 units.

A *mixed cost* has elements of both fixed and variable costs. A mixed cost typically has a fixed base and then increases above that base with volume changes. Consider

Andean Jewelry's utility bill. Even if Andean Jewelry doesn't operate, some utility costs are incurred. However, as they produce more products, they use more machinery, heat, air conditioning, and lights. Thus, above a fixed base cost, utilities will vary with production volume. Many retail store leases contain a clause that includes a base rent and an additional rent above a certain sales volume.

Think Along

Why are management accountants interested in knowing which costs are fixed and which ones are variable?

Management accountants are interested in fixed and variable costs because of what economists call *economies of scale*. This concept captures the fact that as the number of units produced increases, the cost per unit declines since only variable costs increase and fixed costs remain the same. For example, in the case of the "forming" machine, the cost per unit is $10 ($10,000/1,000) if we produce 1,000 pieces of jewelry and $5 per unit if we produce 2,000 pieces of jewelry.

The idea of scale economies is tied closely to the another economic concept—*marginal cost*. Marginal cost is the additional cost incurred when a company produces one additional unit. Typically, variable and marginal costs are the same. However, if a company is at its maximum production capacity, then marginal cost and variable cost are not equal. The additional cost to produce one more unit at maximum capacity includes both variable cost and an increase in fixed costs. Management accountants label as *incremental* the increase in costs (or revenues) that includes all elements that change.

Exhibit 6 shows how management accountants might classify the manufacturing costs in Exhibit 2 into the three categories of fixed, variable, and mixed costs. The exhibit further classifies mixed costs into fixed and variable elements.

Exhibit 6
Behavior of Manufacturing Costs.

Cost	*Amount Incurred*	*Nature*	*Variable Cost*	*Fixed Cost*
Materials used	$3,069,986	Variable	$3,069,986	0
Labor	1,025,412	Variable	1,025,412	0
Depreciation	73,814	Fixed	0	$ 73,814
Rent	150,000	Fixed	0	150,000
Utilities	53,439	Mixed	43,000	10,439
Repairs & maintenance	51,269	Variable	51,269	0
Supplies & tools	25,570	Variable	25,570	0
Supervision & maintenance wages	425,590	Mixed	104,350	321,240
Factory employee benefits	83,525	Variable	83,525	0
Total	**$4,958,605**		**$4,403,112**	**$555,493**

What would you predict total costs to be if volume (number of units produced) increased by 20 percent next year?

Many people would answer this by increasing variable cost by 20 percent, or $4,403,112 × 1.20 = $5,283,734, and adding that amount to fixed cost of $555,493, to yield a cost estimate of $5,839,277. This is the conventional way of using these costs. We feel it is too simplistic. A proper analysis is to consider the *decision horizon, cost divisibility,* and *management policies.*

Decision horizon.

When the planning period or decision horizon is short, all costs are fixed. When the planning period or decision horizon is long, all costs are variable. For example, consider a decision that affects production during the next hour. Labor costs are fixed. They will not vary with whatever production level workers achieve. All services are contracted for in the next hour. If, on the other hand, the managers at Andean Jewelry are looking at decisions that affect production five years from now, then all costs are variable. Managers can change the entire cost structure, given a long time. In Exhibit 6, we use a one-year time period since managers normally plan for a 12-month period. A one-year time horizon is normal when classifying costs as fixed, variable, or mixed.

Cost divisibility.

The term *divisible* means that a cost can be acquired in relatively small increments. Supervision is an example of divisible fixed costs. The $321,240 in the fixed column is the salary of several supervisors. To handle the increased volume, additional workers will be hired and we will need additional supervision time. Assume we need two additional supervisors to handle the workers hired to produce the 20 percent additional volume. However, we can hire the supervisors one at a time. That is, if the volume increases by 10 percent, we can hire only one supervisor. Highly divisible fixed costs behave more like variable costs than fixed costs.

Indivisible means that the cost item can be acquired only in large chunks. Consider the case of the forming machine. The forming machine is indivisible. Assume it can produce 100,000 units and we are using it fully. Then a 20 percent increase in volume can be met only by acquiring another forming machine (with a capacity of 100,000 units) even though we need only 20,000 units. If we assume that capacity is available, a 20 percent increase in volume may mean no increase in cost.

Management policy.

Management decisions can make a cost that is fixed for one business variable for another. For example, when a law firm has documents copied by an external provider (like Kinkos), its copying costs are variable. If the law firm acquires its own copying equipment and hires personnel to run a copy shop internally, a portion of the cost becomes fixed. Similarly, many businesses do not like to lay off workers. For these businesses, direct labor would not be considered a variable cost.

Key Point

Costs are not inherently fixed or variable. Their behavior depends on the decision period, cost divisibility, and management decisions.

A Responsibility View of Costs.

Management accountants are very interested in reducing the costs of operations. Traditionally, they have done this with responsibility accounting using controllable costs, budgets, and standards.

Responsibility accounting is a vertical look at costs along formal organizational lines. Most organizations use the formal lines of authority to report actual spending. A *responsibility center* is a unit in an organization with a manager who is responsible (accountable) for outcomes. This means that there are several responsibility centers within each functional area. For instance, within production, accountants prepare separate reports showing the melting and forming department managers how much each spent on materials, labor, and overhead items. Note that the GAAP cost classifications in Exhibit 1 reflect basic functional responsibility for cost. The plant manager is responsible for cost of goods manufactured, the marketing director is responsible for marketing costs, and the president is responsible for administrative costs.

Controllable and *noncontrollable costs* are closely related to the idea of responsibility. A controllable cost is defined as a cost that can be influenced by the actions of a manager. For example, if the purchasing manager requests a contract review by a corporate attorney, accountants classify the legal charge as a controllable cost, since management had the right to request or not to request a review. It does not matter that the purchasing manager cannot control the number of hours of review spent by the attorney, or the wages paid to the attorney. Under the concept of responsibility accounting, it is argued that managers must not be held accountable for costs that are not under their control.[2]

Standard costs and *budgets* are another traditional means by which management accountants manage costs. A standard cost is a predetermined cost for a product or service based on estimates using assumed levels of efficiency. Consider the situation at Andean Jewelry. Assume that the workers in the assembly department normally assemble two necklaces per hour, and that the hourly wage and benefit rate is $12 per hour. If 160,000 necklaces were produced, the direct labor cost should be $960,000 at this standard cost per unit (($12 per hour ÷ 2 pieces per hour) × 160,000 necklaces). The $960,000 is the standard labor (or the *budget earned*) for the assembly department.

Assembly's actual direct labor was $1,025,412 (see Exhibit 2) for the 160,000 pieces of jewelry. That means that workers spent $65,412 more than their budget. The $65,412 is called an unfavorable cost *variance,* and the manager of the assembly department is accountable for this variance. Top management evaluates a lower-level employee partly by how well he/she controls costs in his/her responsibility center. If the production cost of jewelry exceeds the expected or budgeted cost, an unfavorable evaluation may result.

Think Along

Is knowledge of who is accountable for a cost and establishment of a standard cost or budget sufficient to manage costs?

▲ CONTEMPORARY MANAGEMENT ACCOUNTING COST CLASSIFICATIONS

The cost classifications from the mass production era were based on two important ideas, economies of scale and responsibility accounting. These cost classifications worked as long as firms produced identical (or nearly identical) products in large quantities with dedicated, indivisible production equipment and specialist functional departments. The usefulness of these classifications is greatly diminished in modern manufacturing environments in which firms use divisible capital equipment, produce a large variety of

[2] In actual practice, if a cost is on a responsibility center's report, the manager is often evaluated on it whether or not he controls the cost.

products, and have a flexible workforce organized into teams. Increasing volume (scale economies) is no longer the only or even the most important way to reduce unit costs. Furthermore, responsibility for cost lies with teams and not functional managers.

The growth in service organizations, as well as new manufacturing methods, and the increasing global competitive business environment require managers to understand costs. They need to know what causes costs and how to focus spending so value to customers is maximized. A number of different cost concepts have emerged during the last two decades. These new cost classifications focus on cost drivers, recognize the horizontal work-flow linkages within and across organizations, take a long-term view of costs, and put customer value at the center of cost analysis. Six cost classifications of particular importance for modern cost management are *cost driver analysis, value chain costing, activity-based costing, life-cycle costing, and feature* and *function costing*.

Cost Driver Analysis.

A *cost driver* is any factor that causes a systematic variation in costs. As demonstrated earlier, production volume is an example of a cost driver. There are many other cost drivers. They include the number of production batches, number of orders, number of shipments, experience with a product or process, the type of technology being used, and many others.

The purpose of cost driver analysis is to classify and analyze costs by common drivers. This helps managers understand which factors are critical for their cost performance and should be the primary focus of their cost management efforts.

Consider the case of state universities. They are typically funded by a formula based on *"full-time equivalent students" (FTES)* enrolled. An FTES is measured by adding together student credit hours (15 student credit hours equals one FTES). For example, assume that a university has two students, one student taking a 9-unit course load and the other taking a 6-unit course load. The university will receive funding for one FTES [(9 units + 6 units)/15]. Its costs, however, do not increase in proportion to increases in FTES.

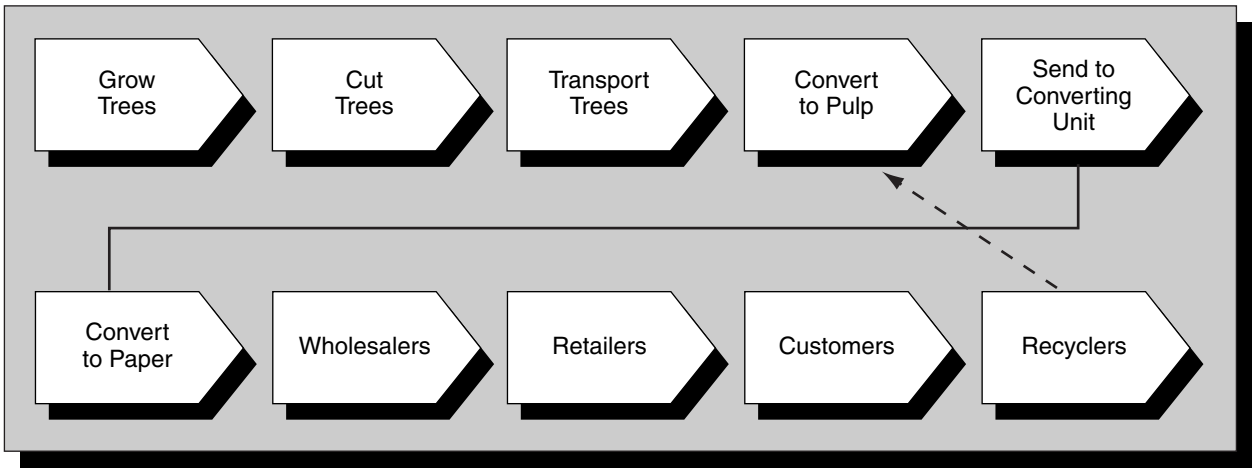
One cost driver in a university is the *variety of course offerings*. This will drive the cost of hiring teachers. For example, if the student with the 9-unit load takes the same two courses as the student with the 6-unit load, then we need to staff only three 3-unit course sections. If they take different courses, we need to staff five 3-unit courses. The *number of students* drives the costs of registration and parking. Thus, we have higher costs if we have two part-time students as opposed to one full-time student with a 15-unit load. *Capital intensity of a discipline* is another cost driver. If one of our two students is a science major and the other is a humanities major, then the science student is more costly since his or her instruction requires more capital equipment.

Consider circuit board manufacturing. Some important manufacturing cost drivers are number of chip insertions, type of chips inserted, and number of test hours. If designers can design circuit boards that require fewer insertions, use simpler chips, and take less time to test, the cost of the boards can be reduced.

Value Chain Costing.

Value chain costing is the process of decomposing the cost of a product or service into the various steps involved in providing that product from the most elementary raw material to its disposal. For example, the value chain for writing paper starts with growing *trees* in the forest. The trees are *cut* and *transported* to a mill where they are *converted* into pulp. Further *processing* turns pulp into paper. Finished paper is *distributed* wholesale, and then

Exhibit 7
A Simplified Value Chain for White Paper.



retail, and to final customers. Finally, the paper is *recycled* after it is used. Exhibit 7 depicts the value chain for writing paper.

Sometimes the same organization performs several value chain steps, and sometimes these steps are spread across multiple organizations. For example, Weyerhaeuser Corporation performs all of the steps in Exhibit 7 from growing trees to selling to wholesalers. Other paper companies rely on a network of suppliers, dealers, and retailers to perform these same steps. These legally separate organizations are interdependent with respect to satisfying the ultimate customers' product and service needs. These legally separate organizations comprise an *extended enterprise*.

Regardless of how many firms are involved in the value chain, the final price customers pay is a function of the costs and profit margins added at each step of the value chain. A value chain approach to cost management analyzes costs across the linked extended enterprise. From the viewpoint of an individual firm, such as a paper converter, *value chain cost analysis* shows what part of a customer's price is the converter's internal cost and profit margin and what part is the cost and margin of other firms in the extended enterprise.

Assume that customers pay $3.00 for 1,000 sheets of white paper at a retail store. Assume further that the converter finds out that their own cost is $0.286 and their profit margin is $0.0144. The total, $0.30, accounts for only 10 percent of the total paper price and includes a 5 percent profit margin on sales. Assume that value chain analysis further reveals that the profit margin of the paper mill is 20 percent, and that transportation of pulp accounts for 50 percent of the converter's production cost.

Think Along

If customers think that the price of white paper is too high, how can the converter use value chain information to manage costs?

Even the simple example of value chain analysis above helps a converter get two major insights. First, it shows that since most of the cost for white paper is outside the conversion process, the converter alone can do little to reduce costs. The converter must work with other members of the extended enterprise. Since pulp producers have a higher profit margin, the converter may try to persuade pulp producers to reduce their margins, or the converter may

buy a pulp operation to become an integrated producer. Second, since transportation of pulp accounts for the bulk of their cost, they may want to relocate next to the paper mill.

In general, value chain analysis helps to determine

- ▲ What part of the value chain accounts for most of the costs and therefore is the best place for cost management efforts.
- ▲ How actions by upstream value chain members (such as tree growers and pulp and trucking companies) impact downstream costs (such as converting, storing, and packing).
- ▲ Whether some part of the value chain has more profitability so vertical integration may be an appropriate cost management strategy.

Performing value chain analysis is not an easy task. Not all suppliers share information, and performing value chain analysis takes skill. A detailed discussion of how to perform this analysis is beyond the scope of this module.[3]

Activity-Based Management and Costing.

Value chain analysis shows the larger picture of how organizations and major functional units within organizations (such as production, distribution, and support) are linked to provide customers with products and services. *Activity-based management* and *costing* show the linked set of work tasks within and across an organization that produce products and services.

An *activity* is a series of work *tasks* that have a defined input and output. For example, "serving food" in a restaurant is an activity. It starts with a customer order (input) and includes tasks such as writing down the order, giving it to the cook, and picking up the plates when ready. It ends with placing the food on the table (output). Activities use *resources* such as people, space, materials, supplies, utilities, computers, and so on. The resources consumed by an activity are the cost of that activity.

A set of linked activities is a process. In the restaurant example, the four activities of "reserving tables," "serving food," "cleaning table," and "billing customers" constitute the customer-service process.

Activity-based management (ABM) is the systematic documentation of the major activities in an organization. The documentation is designed to uncover what causes each activity to begin (its *driver*), the cost of the activity, how much time it takes, and how well it is performed (quality). ABM allows organizations to redesign work and improve the cost, quality, and time for performing activities.

One way in which ABM helps cost management is by eliminating unnecessary tasks in activities. For example, filing paperwork that no one uses is unnecessary and can be eliminated. Another way to reduce cost is to eliminate activities that are not of value to customers (*nonvalue-added activities*). Inspection is the classic example of an activity that customers don't value. They want quality products, not inspected products.

Think Along

How might Andean Jewelry use ABM to reduce costs?

Assume that Andean Jewelry conducts an analysis of its manufacturing activities.[4] The results of the analysis are presented in Exhibit 8. To understand these results, review the

[3] For a comprehensive discussion of the value chain concept as a way to manage costs, see John Shank, *Strategic Cost Management,* Wiley, 1993.

[4] This module simply introduces the concept of ABM and its managerial usefulness. For a detailed discussion of this topic, including how to derive the cost of activities, see the *Activity-Based Management* module in this series.

Exhibit 8
Activity Classification of Manufacturing Costs.

Activity	*Cost*	*Cost Driver*	*Cost per Unit of Driver*
Melting	$218,100	Melting hours (Total 21,810)	$10 per melting hour
Forming	588,834	Number of forming hours (Total 32,713)	$18.00 per forming hour
Inspection	157,024	Number of inspection hours (Total 9,814 hours)	$16 per inspection hour
Rework of defective units	924,661	Number of defective units (Total 10,468 units)	$88.33 per unit

Think Along

What insights do you gain from Exhibit 8?

manufacturing costs in Exhibit 2. Total manufacturing costs are $4,958,605. Classified by object of expenditure, they consist of $3,069,986 for direct materials, $1,025,412 for direct labor, and $863,207 for manufacturing overhead. Exhibit 9 reclassifies the direct labor and manufacturing overhead costs (the *conversion costs*) of $1,888,619 according to four manufacturing activities.[5]

It is clear that reworking defective units is a very costly activity. Andean Jewelry can cut their conversion costs by more than half if they could eliminate rework and inspection. Both of these are nonvalue-added activities. Customers want quality products, not inspected and reworked products. If the company can build quality jewelry without inspecting and reworking, they can increase customer satisfaction (quality) and lower costs.

Activity-based costing extends the information obtained from ABM analysis to compute the cost of cost objects such as products, customers, distribution channels, environmental compliance, and so on. Assume that Andean Jewelry produces two different types of necklaces—silver and gold. A silver unit requires 8 minutes to melt, 20 minutes to form, and 6 minutes to inspect. Approximately 8 percent of the units have to be reworked. Assume further that it takes twice as much time to melt and form a gold necklace but the same time to inspect and rework them.

What is the conversion cost for a silver necklace and a gold necklace?

The cost for the two units is shown in Exhibit 9.

Exhibit 9
Activity-Based Product Costing.

Activity	Conversion Cost of Silver Necklace	Conversion Cost of Gold Necklace
Melt	$10 × 8/60 hours = $1.33	$10 × 16/60 hours = $2.66
Form	$18 × 20/60 hours = $6.00	$18 × 40/60 hours = $12.00
Inspect	$16 × 6/60 hours = $1.60	$16 × 6/60 hours = $1.60
Rework of defective units	$88.33 × 8% = $7.07	$88.33 × 8% = $7.07
Conversion costs per unit	$16.00	$23.33

[5] To keep the example simple, this analysis focuses only on manufacturing activities performed by Andean Jewelry. It does not include marketing and administrative activities within Andean Jewelry, nor does it extend to Andean Jewelry's extended enterprise.

Think Along

How might you use the data in Exhibit 9?

This data might be used to assess product profitability or to redesign necklaces to use less of each activity and cost less. Further, the information might be useful to benchmark the unit cost of the activities against other organizations.

Life-Cycle Costing.

Modern organizations recognize that costs have to be managed over the life of a product or a process. This has given rise to the importance of *life-cycle costing*. Life-cycle costing can be from the perspective of a customer or a producer.

A *customer's life-cycle cost* is the total amount of outlay over the entire life cycle of a product from its inception to its abandonment. It includes both *one-time* and *recurring* costs and is called the *cost of ownership*. Consider a car from a customer's perspective. Life-cycle costs include the one-time purchase price; the recurring outlays for gas and oil, repairs, maintenance, taxes, registration, and insurance; and the cost of abandonment or resale value. Car companies often advertise lower cost of ownership to win customers.

Exhibit 10 shows the typical cost of ownership for a car in the state of California under a number of assumptions. The car is driven 15,000 miles per year and is serviced twice at 7,500-mile intervals at a cost of $75 per service. The average gas price is $1.45 per gallon over the five-year life and the car averages 20 miles per gallon. Repairs will be nothing in year one, $250 in year two, and will increase to $350 a year thereafter. Insurance runs approximately $900 per year and taxes and licenses are $650 per year. At the end of the five-year life, the owner will receive $2,500 from selling the car.

Note Pad

What is the cost of ownership of the car?

A *producer's life-cycle cost* is the cost for all activities that occur over the entire life cycle of a product from its inception to its abandonment. It considers both *one-time* and *recurring* costs. One-time costs are costs such as those associated with product and process design or with designing a marketing plan. Recurring costs include manufacturing costs and the costs of selling and supporting the product. A product will yield a return only if lifetime sales revenue exceeds life-cycle costs.

Exhibit 10
Cost of Ownership of a Typical Four-Door Sedan in California.

Purchase price	$14,200
Gas (1.45 × 15,000/20 × 5)	5,438
Maintenance (2 × 75 × 5)	750
Repairs ((350 × 3) + 250)	1,300
Insurance (900 × 5)	4,500
Taxes & licenses (650 × 5)	3,250
Salvage value on sale	(2,500)
Total cost of ownership	$26,938
Cost of ownership/mile	$0.3592

For example, an oil company incurs a one-time cost of finding oil and drilling a well, the ongoing operational cost of pumping the oil out of the ground, and finally a one-time cost of returning the site to an environmentally suitable condition. In its early years, the oil well is more productive. The ratio of oil pumped to other substances, such as water, is high. As the well ages, more water and other substances are pumped and less oil is recovered. Drilling this oil well is economically good only if the lifetime yield of oil at the market price is more than the lifetime cost of drilling and pumping it.

Exhibit 11 shows the assumed life-cycle cost of an oil well. Assume that an oil company spends $54,500,000 to explore for oil and develop a field. In this development stage, no oil is pumped. In its first year, the field produces 20,000,000 barrels/year at a cost of $5.84 per barrel. In the last productive year, only 5,000,000 barrels are pumped, at a cost of $19.90 per barrel. Note that over time, it costs more to produce oil. Finally, there is a $10,000,000 environmental clean-up cost to abandon the field.

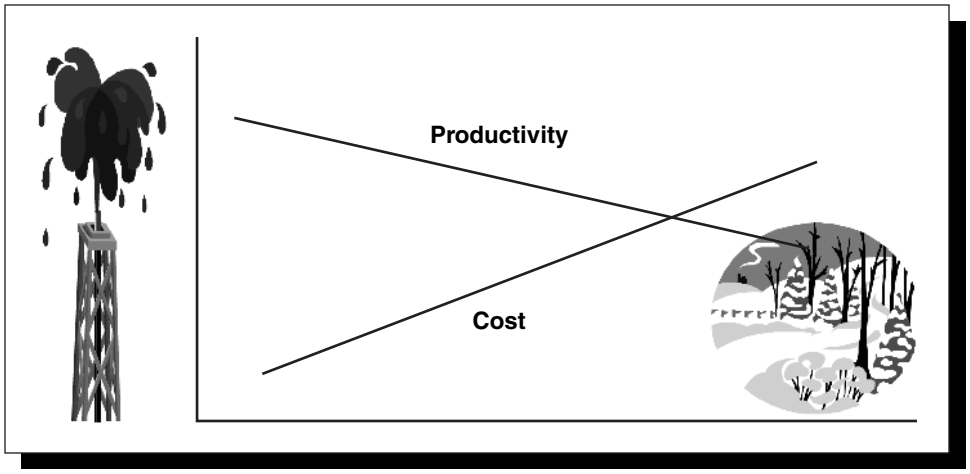
If oil sells for an average of $13 per barrel over the field's life, sales revenue is $520,000,000 (40,000,000 barrels times $13), life-cycle cost is $416,500,000, and life-cycle revenue is $103,500,000, or a 25 percent return on sales. This information is more valuable than any one year's results in evaluating the field's profitability.

Exhibit 11
Life Cycle Costs of Oil Wells (000s omitted)

Activity	*1998*	*1999*	*2000*	*2001*	*2002*	*Total*
Find & develop field	$50,000					$50,000
Production		$100,000	$115,000	$90,000		305,000
Transportation		15,750	20,250	9,000		45,000
Business support	4,500	1,000	500	500		6,500
Abandonment					$10,000	10,000
Total cost	$54,500	$116,750	$135,750	$99,500	$10,000	$416,500
Barrels produced		20,000	15,000	5,000		40,000

Exhibit 12 shows how the productivity and cost of operations behave over the life of an oil well.

Exhibit 12
Life-cycle operating costs and productivity of oil wells.



Think Along

Does a customer's cost of ownership or a producer's life-cycle costs provide enough information to develop products and services desired by customers? Does it assure that an organization will spend its resources in a way that satisfies customers?

Feature and Function Costing

Feature and function costing exists to provide customer focus to an organization. It helps an organization assess whether it is spending on features desired by customers. A *feature* is a physical or esthetic characteristic of a product that satisfies a customer's want or need; it is a customer's view of a product. A *function* is an internal property of a product or process; it is the product designer's view of the same product. Consider a product such as a lawn mower. Features that customers may want in a lawn mower are "handles easily," "cuts grass evenly," "large bag capacity," and so on. Functions that product designers build into a lawn mower are "power," "torque," and "rotation."[6]

Function costing informs product or process designers how much they are spending to deliver a particular functionality. Their job is to provide the desired functionality from a product or process at lowest possible cost. Exhibit 13 shows the cost of the functions in a lawn mower. (For simplicity, we will assume these are all of the functions in the lawn mower). To calculate these costs, the lawn mower manufacturer must add together the cost of all materials, components, and activities needed to perform a function. For example, the function "power" comes from the motor. The motor is assembled, tested, balanced, and installed before it can supply power. The cost of all these activities is the cost of supplying power.

Exhibit 13 shows the cost of each function. The function costs include only *attributable* costs—that is, cost items that can be avoided if the function were to be excluded. Exhibit 13 shows the lawn mower manufacturer that providing power is the most costly function in the product. To reduce the cost of lawn mowers, the firm must find lower- cost ways of providing power.

Feature costing relates spending to features important to a customer. Recall that one feature that is important to customers is "cuts grass evenly." Now assume that the engineers tell us that to cut grass evenly, we need power and blade rotation speed. This means that the cost of cutting grass evenly is \$100 (\$80 + 20), or 74 percent of the total cost.[7]

To create value, the lawn mower manufacturer must align spending with features that are important to customers. Assume that marketing research shows that half of the money customers spend on a lawn mower is for the feature cutting grass evenly. (This information may come from a customer survey that asks for the relative importance of each feature). If customers give only 50 percent importance to this feature, then at 74 percent, we are spending too much money. Value creation is negative.

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[6] It is customary to express functions as verb-noun combinations. This helps to distinguish a physical part such as a motor from the function of that motor, which is to supply power or a task such as data entry from its function "update records."

[7] It is not easy to match functions to features, and often one function addresses several features. We have kept this example simple only to illustrate the concept. For a more complete discussion, see the *Target Costing* module in this series.

Exhibit 13
Cost of the Lawn mower's functions

	Functions			
Cost items	***Power***	***Torque***	***Rotation***	***Total***
Materials and parts	$50	$15	$5	$70
Assembly	13	13	8	34
Balance	5	2	5	12
Test	12	5	2	19
Totals	$80	$35	$20	$135

▲ EVALUATION OF A COST CLASSIFICATION SCHEME

How do we evaluate and decide what cost classification scheme best suits our needs? As you have seen, there are many ways to classify costs. A good classification scheme should have good technical, behavioral, and cultural properties. A scheme that works very well on one attribute, but performs poorly on the others, should be avoided.

Technical Attributes.

Technically, a cost classification scheme must provide information that has *decision relevance* and helps us understand how choices and actions in our *work processes drive or cause* costs to be incurred.

Decision relevance.

Until the 1970s, it was common for accountants to respond to internal managerial cost information needs with cost concepts meant for external financial reporting. This practice resulted in seriously flawed management decisions. For example, product cost data for inventory measurement was used to make pricing decisions, resulting in an inward rather than market-based pricing system. Standard costing systems designed to measure inventory costs were used to manage costs. This created a mentality of managing costs after it was too late. During times of economic downturn, managers built inventory even if it could not be sold.[8]

The fixed–variable cost classification also has resulted in flawed decisions. Many managers tend to use variable costs as an excuse for pricing products below full cost. Further, fixed costs are treated as "sunk" and regarded as irrelevant for decision making and cost management. The result is decisions that have hurt the long-term profitability of many corporations. The fixed–variable cost classification also puts excessive focus on production volume as a cost driver. Today, most organizations recognize that costs vary with cost drivers other than volume.

[8] It is beyond the scope of this module to explain fully the link between these flawed decisions and accounting data. However, there are several discussions of this in the literature. See Robert Kaplan and Tom Johnson, *Relevance Lost: The Rise and Fall of Management Accounting,* Harvard Business Press, 1987, for a good discussion of some of the reasons and consequences of providing flawed management accounting data to decision makers.

Contemporary management accounting classifies costs by cost drivers, activities, product features, process functions, value chain steps, life cycle, and many other ways important to management. These classifications are complex and new and require in-depth knowledge of business. They allow managers to turn the cost kaleidoscope whichever way enlightens their strategic decision making.

Work process understanding.
A good classification method helps managers understand what *drives* or *causes* costs to change. Classifications link work-related decisions and actions to costs incurred within the organization. Understanding the link between what we do while we work and the kinds and amounts of costs incurred enables cost management. In a bank, knowing the cost of personal telling versus machine telling activities assists cost management. Bank personnel can offer incentives that redirect customers to use machine telling. Cost classifications by activity, value chain, life cycle, and functions relate cost to work processes in organizations. In addition, cost classifications by cost drivers help managers understand the key causes for cost variation in their systems.

Behavioral Attributes.

Cost classification can affect behavior of people in organizations. This is because each cost classification scheme makes *visible* a different aspect of the cost structure and *focuses attention* on a different management problem. If chosen carelessly, cost classifications can lead to dysfunctional behaviors.

Consider value chain costing. It focuses the attention of managers on the external relationships that cause costs. This often leads to the building of strong ties with suppliers or dealers to improve cost performance. Many companies have managed their value chains to drive costs out of the entire value chain. Wal-Mart is tightly linked to its value chain members. It offers suppliers a price for merchandise based on Wal-Mart's knowledge of quantities and prices that customers desire. Wal-Mart carefully tracks sales volume and restocks merchandise quickly to avoid stock-out conditions.

Life-cycle cost classifications encourage managers to take a long-term perspective of costs and to consider more cost elements in making decisions. Managers begin to understand that to earn a profit, all costs, from birth to death, have to be paid for out of cash flows generated by product sales. This may discourage short-term manipulation of data by those championing a new product or service.

Feature costing focuses attention on the voice of the customer in product design. If customers don't desire certain features or value them as much, then feature costing signals them as cost reduction areas. Similarly, functional costing helps product designers to open their thinking beyond the physical product or process step to the function delivered. The message is that we need to deliver functions cost effectively.

Cost classifications can also lead to dysfunctional behaviors. The best example is the fixed–variable cost classification system so popular in most traditional management accounting texts. The term *fixed* conveys a message that the cost cannot be managed since it does not change. This often prevents managers from looking for creative ways to change fixed costs. This overemphasis on fixed and variable cost classification often obscures the more complex relationships between costs and their drivers and gives managers an overly simplistic view of their cost structure.

Cultural Attributes.

A cost classification scheme is a way of organizing cost data. The organization reflects our mental view of costs and captures the cultural lens through which we view it. You will recall that early cost classifications were heavily influenced by external reporting needs. The terms *inventory costs* and *direct labor* were part of our language. However, they came to be more than language used. These terms shaped the way we viewed these items. For example, we regarded inventory as an asset until we learned from just-in-time manufacturing firms that inventory can be a liability from an operational perspective. Similarly, our unthinking acceptance of direct labor as a variable cost has bred an attitude of people as expendable. Many organizations spend more time and effort analyzing machinery purchases (because they are capital equipment) than they do in hiring and training the right people (because labor is a short-term variable cost). Similarly, classifying a cost as overhead may reduce an employee's perception of the value of the work performed.

Cost classifications also reflect an organization's belief about how to manage work. Responsibility accounting embeds a value of individual responsibility and accountability. Under this mindset, when things go wrong, blame is assigned to people rather than the way we organize work. As opposed to this, activity-based and value chain costing expand the mindset to look beyond people to the processes and extend the reach to organizations beyond our own boundary. Rather than individual responsibility, they are more likely to create a mindset that encourages teamwork.

▲ LESSONS LEARNED

- ▲ Cost classifications are different ways of arraying the same costs.
- ▲ Financial accounting classifications have historically dominated the discourse around appropriate cost classifications.
- ▲ Cost classifications needed for external financial accounting are not very useful and often misleading for managerial decision and cost management needs.
- ▲ Traditional managerial accounting cost classifications emerged during the era of mass manufacturing. They emphasize volume as a cost driver and cost control through individual responsibility.
- ▲ Contemporary management accounting cost classifications better capture the richness of contemporary business environments. They emphasize strategic decision needs and cost management through process management both within and across the value chain.
- ▲ A poor cost classification scheme can lead to dysfunctional behaviors.
- ▲ A cost classification system is also a mental model of cost reality. A good mental model creates the right values for cost management.

APPENDIX

▲ REPORTING PRODUCT COSTS IN EXTERNAL INCOME STATEMENTS

Management accountants traditionally prepare cost-of-goods-manufactured schedules to back up the income statement calculation of cost of goods sold and to compare unit costs of goods manufactured from one period to the next for cost control. In any period, the difference between manufacturing costs incurred and the cost of goods sold is because of inventories—that is, costs spent on units that are not yet ready for sale or have not been delivered to customers.

The three inventories that exist in manufacturing firms are *raw materials, work-in-process* and *finished goods*. Before production begins, raw materials inventory exists. It includes items that will become the final product as well as supplies used in production. For example, Andean Jewelry has approximately six weeks of inventory of gold, silver, and stones at all times. These, along with production supplies, constitute Andean Jewelry's raw materials inventory.

Work-in-process inventory exists if there are partially manufactured items when financial statements are prepared. Work-in-process inventory causes the use of materials, labor, and overhead. The costs associated with the partially completed products are included on the balance sheet in work-in-process inventory. For example, if Andean Jewelry normally has unfinished items on each work bench at the end of each day, then a work-in-process inventory exists.

Finally, when the manufacturing process is complete, items become finished goods. Finished goods inventory includes all jewelry that is awaiting shipment to distributors.

Exhibit 14 shows a typical cost-of-goods-manufactured and cost-of-goods-sold schedule for Andean Jewelry that backs up the income statement shown in Exhibit 1.

Note that total manufacturing costs this period were $4,958,605. Cost of goods manufactured totaled $4,949,173, and cost of goods sold (see Exhibit 1) was $4,537,806. These different terms, while similar in their sound, measure three different variables.

Think Along

When will the manufacturing costs incurred, cost of goods manufactured, and cost of goods sold be the same?

For a modern manufacturing organization that uses just-in-time manufacturing, the inventories of raw materials, work-in-process, and finished good, are negligible. Therefore, the three amounts will be virtually identical. You can verify this by assuming that all of the beginning and ending inventories of raw materials, work-in-process, and finished goods are zero in Exhibit 14.

Think Along

Remember in the opening story that the president of Andean Jewelry was concerned about the cost impact of inventories. Was he right?

Exhibit 14
Schedule of Cost of Goods Manufactured and Sold

Direct materials:	
Beginning inventory, January 1	$ 179,191
Add: Purchases	3,261,273
Direct materials available	3,440,463
Less: Ending inventory, December 31	(370,477)
Direct materials used	$ 3,069,986
Direct labor	$ 1,025,412
Manufacturing overhead:	
Equipment depreciation	73,814
Rent & utilities	203,439
Repairs & maintenance	51,269
Supplies & tools	25,570
Supervision and maintenance wages	425,590
Factory employee benefits	83,525
Total manufacturing overhead	$ 863,207
Total manufacturing costs	**$4,958,605**
Plus: Beginning work-in-process inventory, January 1	188,641
Less: Work-in-process inventory, December 31	(198,073)
Cost of goods manufactured	**$ 4,949,173**
Plus: Finished goods inventory, January 1	1,127,211
Less: Finished goods inventory, December 31	(1,538,577)
Cost of goods sold	**$ 4,537,806**

The president of Andean Jewelry was rightly concerned about the buildup in inventories. Inventories cost money and tie up capital. They also require space to store and security against theft. The higher inventory levels reduce per unit cost temporarily by absorbing more fixed manufacturing overhead. However, if unsold, this cost decrease is actually a long-term cost increase for an organization.

▲ COMMON TERMS*

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See Process diagram.)

Activity-Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

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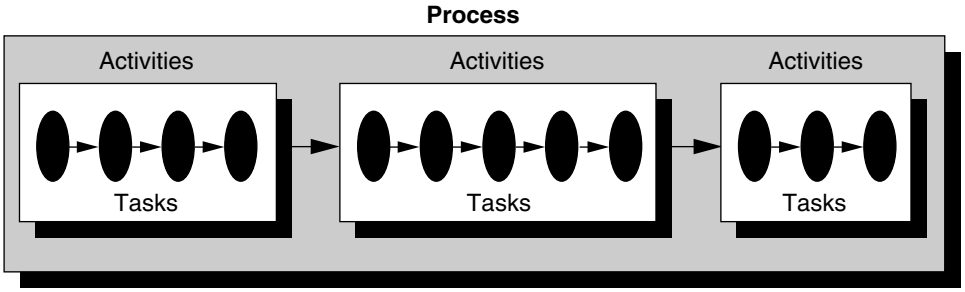
* The list of common terms for all modules is available online at www.mhhe.com/modules.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Value Chain (See Extended Enterprise.)

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self-test Questions.

a. What does the term *cost* mean?
b. Does when or how we pay for an item influence its classification as a cost?
c. What does the kaleidoscopic nature of cost mean?
d. How are costs arrayed in different ways?
e. What determines how to array costs?
f. What is a cost object?
g. Different cost classifications we see today can be traced to three distinct time periods. Identify those and indicate what factors influenced managerial cost classifications during each period.
h. What is an expense?
i. What is cost of goods sold and what items of cost does it contain?
j. What is conversion cost?
k. What do the terms *direct* and *indirect cost* mean?
l. What kinds of marketing costs exist?
m. What are administrative costs?
n. What is the difference between a product and a period cost?
o. What is the difference between an outlay and an opportunity cost?
p. What are fixed, variable, and mixed costs?
q. What is a cost driver?
r. What is value chain costing?
s. What is the purpose of activity-based management and costing?
t. From a customer's perspective, what is life-cycle costing?
u. From a producer's point of view, what is life-cycle costing?
v. What do the terms *feature* and *function* mean?

Problems and Cases.

2. Below are costs that a company might incur. Complete the table by filling in whether the item is a product, marketing, or administrative cost.

Cost Item	*Type of Cost*
Credit check prior to sale	
Rent for finished goods warehouse	
President's salary and benefits	
Lumber used to manufacture bookcases	
Supervisory salaries in the factory	
Depreciation on computers used in administrative offices	
Depreciation of sample displays	
Research costs for new products	
Commissions to salespersons	
Utilities cost for factory	
Shipping cost to customers	
Shipping cost for incoming lumber	
Software cost of a production-scheduling program	

3. Classify the following costs as fixed, variable, or mixed:

Cost	*Classification*
Office salaries and benefits	
Wages of factory workers	
Salaries paid to doctors in a hospital	
Depreciation on computer systems	
Utilities	
Property taxes	
X-ray film in a hospital	
Advertising of products	
Shipping costs	
Depreciation on airplane engines	

4. Below are two columns of information. The first column contains costs for activities. The second contains a list of cost drivers. For each activity cost listed in the first column, choose a driver from the second column that most likely causes the cost of that activity. You may use drivers more than once; not all drivers have to be used.

Cost Item	*Cost Drivers*
Credit and collection cost	Sales dollars
Selecting and packaging merchandise for shipment	Units of products sold
Maintaining personnel files for payroll and benefits	Number of unique products
Cost of assembly operations performed in a production environment with diverse products	Number of batches of products produced
Costs of maintaining a 24-hour support line for a computer software package	Number of assembly operations performed
Inspection of highly diverse products	Number of assembly operations per product
Setting up equipment for different products to be produced	Payroll dollars
Costs of maintaining patents (applying, defending, etc.)	Number of employees
Advertising	Number of unique parts/items ordered
Purchasing merchandise for use in production	Number of items purchased

5. A hotel used its past experience to determine that monthly housekeeping costs are determined by the formula \$18,500 + \$2.50X where X represents the number of rooms rented in the month. During July, 7,200 rooms were rented.

a. What are the activity and activity driver in this problem?
b. What was the expected monthly housekeeping cost in July?
c. What was the housekeeping cost per room?
d. What was the fixed housekeeping cost per room?
e. What was the variable housekeeping cost per room?
f. Brainstorm. What other possible drivers might exist for housekeeping costs?

6. The following costs are for a law firm providing services to several clients. Classify these costs as to cost behavior—fixed or variable—and as to whether they are direct or indirect with respect to a client's case.

Cost	*Fixed*	*Variable*	*Direct*	*Indirect*
Lawyer's salary				
Lexis-Nexis research charges				
Experts and consultants				
Deposition transcription fees				
Service and filing fees				
Secretarial support salary				
Supplies				
Occupancy cost				
Photocopying				

7. Classify the following cost items as either product or period costs.

Cost Item	*Product*	*Period*
Research costs to discover new products		
Seats used on bicycles		
Shipping costs for finished items		
Package (bottle) for spring water		
Warranty repairs		
Factory supervision		
Depreciation on production scheduling software		
Depreciation on an executive conference center		
Costs of setting up machinery to produce different products		

8. Appendix A. Gaines manufactures women's hosiery. At the beginning of January, the following inventories existed:

Finished goods inventory	$ 5,200
Raw materials inventory	10,400
Work-in-process inventory	7,200

During January, direct labor cost was $22,700, manufacturing overhead was $78,000, and raw material purchases amounted to $86,400. The inventories at the end of January were

Finished goods inventory	$ 8,200
Raw materials inventory	12,600
Work-in-process inventory	5,400

a. What were the total manufacturing costs incurred in January?
b. Prepare a cost-of-goods-manufactured statement for January.
c. Prepare a cost-of-goods-sold statement for January.
d. If 370,000 pairs of hose were manufactured in January, what is the per unit cost of goods manufactured?

9. A company that manufacturers candies is adding a new truffles line. They are considering different ways of dipping their truffles in chocolate. Hand dipping and machine dipping are the methods available. If hand dipping is chosen, employees could be paid hourly wages (or given incentive pay based on production) and let go if sales decline. Hourly wages with an incentive would be about $9 per hour. Alternatively, employees could be paid a $1,600 monthly salary and guaranteed full-time employment. An employee typically can dip 100 pounds of chocolate per day. If machine dipping is chosen, the smallest machine costs $750,000 and is capable of dipping 1,000 pounds of chocolate daily for 10 years. This company expects to work 287 days a year and sell 100,000 pounds of chocolate.

a. What is the labor cost per pound if hourly employees hand dip chocolates? How many labor hours would be required?
b. How many salaried employees would be needed to hand dip chocolates?
c. What is the labor cost per pound if salaried employees perform the job?
d. What is the cost per pound if the chocolates are machine dipped?
e. Discuss the cost behavior of dipping chocolates under each of the three alternatives. (Consider the cost per pound if production goes to 115,000 pounds, for example.)

10. Responsibility accounting is a vertical look at costs along formal organizational lines. It captures costs by the responsibility center (RC) that expended it and classifies the items as controllable or noncontrollable by that unit's manager. Using that classification scheme, classify the following items.

Cost	*Assembly (RC)*	*Painting (RC)*	*Purchasing (RC)*	*Controllable*	*Noncontrollable*
Small tools used in assembly					
Occupancy charge for painting stalls					
Paints, oils, and solvents					
Supplies for purchases					
Purchasing manager's salary					
Salary of painters					
Telephone use by purchasing					
Salary for manager of assembly					
Training new assembly workers					

11. Assume that your company has two different circuit boards that it regularly produces. These vary greatly in their complexity. Accordingly, accountants installed an activity-based costing system. Assume that the following cost drivers and costs emerged from that system:

Activity Cost Pools	*Activity Driver*	*Cost per Driver*
Assembly	**Number of pin insertions**	**.18**
Testing	**Number of burn-in hours**	**.22**
Soldering	**Number of dips**	**.11**

Determine the conversion cost of the two different circuit boards, if each board has the following characteristics:

Activity Driver	*Simple Board*	*Complex Board*
Number of pin insertions	**20**	**50**
Number of burn-in hours	**2**	**10**
Number of dips	**3**	**5**

12. An activity-based management study uncovered the following about manufacturing operations:

Activity	*Percent of Total Manufacturing Cost*
Procuring materials	8%
Materials movement	17%
Quality control (inspection, rework, etc.)	37%
Assembly	22%
Final finishing	16%

Think about each activity from a customer's perspective. Which are of value to the customer? Which does the customer not care about? What would you recommend based on your preliminary assessment?

13. The following is a list of departments (a functional view of an organization) combined with activities (a horizontal or work-flow view of an organization). Go through the list and separate the items into departments and activities. Then, place each activity under the department that you believe might be the place where many tasks in the activity occur.

Quality assurance
Credit checks
Picking and packing items for shipment
Human resources
Routing shipments
Defect rework
Credit and collection
Personnel file maintenance
Inspection
Transportation
Preparing customer deposits
Employee selection

14. List the life-cycle costs (from a customer's perspective) of owning a refrigerator. List the life-cycle costs the manufacturer of the refrigerator might incur.

15. From a marketing view, products' lives are divided into stages: introduction, when sales are low; growth, when sales growth is rapid; maturity, when sales have peaked; and decline, when sales are declining. Below is a table of costs that a producer might incur over the life of a product. Think about each cost listed in the table, and indicate whether you think the cost would be high, moderate, or low in each stage of a product's life. Be prepared to discuss your classification in class. Advertising cost is filled in as an example for you.

	Stage of Life			
	Introduction	***Growth***	***Maturity***	***Decline***
Cost				
Advertising	**Moderate**	**High**	**Moderate**	**Low**
Product R & D				
Process R & D				
Product costs				
Warranty costs				
Plant & equipment expenditures				
Business support costs				
Delivery costs				

16. A feature is a physical or esthetic characteristic of a product that satisfies a customer's want or need. A function is the product designer's view of the same product. The following is a list of features or functions of a car. Classify these items by whether they represent a feature or a function.

Description of Item	***Feature***	***Function***
Fun to drive		
Torque		
Seating capacity		
Sporty		
Acceleration rate		
Tensile strength		
Safe		
Handles curves well		

17. For what features do you shop when buying a pencil? What components or parts does the designer use to satisfy the customer? An example of a customer requirement may be comfortable grip. One way product design engineers provide grip is by using rubberized paint.

18. An automotive executive for a luxury car line proposed pricing the cars inclusive of normal purchase price and all service costs for three years (the average life the company's customer owns the car). Gasoline, tolls, parking, and insurance were the only items excluded in the package price. The executive was convinced that their luxury car was less expensive to own than its competitors, and this package price would demonstrate that point. What concept do you think motivated this novel pricing proposal?

▲ PROBLEMS AND CASES—ADVANCED LEVEL

19. Appendix A. Various accounts for the Blooming Rose Company for 1999 follow:

Work-in-process inventory, January 1	34,000
Finished goods inventory, January 1	22,000
Raw materials inventory, January 1	10,000
Sales	515,000
Depreciation, factory	25,000
Depreciation, administration & marketing	12,000
Utilities, factory	25,000
Utilities, administration & marketing	3,000
Maintenance, factory	42,000
Advertising	37,000
Credit & collection	12,000
Delivery	5,250
Sales commissions	25,750
Direct labor	72,000
Indirect labor	15,000
Factory supplies	15,000
Raw material purchases	127,000
Factory insurance	2,000
Finished goods inventory, December 31	42,000
Work-in-process inventory, December 31	40,000
Raw materials inventory, December 31	5,000

a. Calculate the manufacturing costs of the period.
b. Prepare a schedule of cost of goods manufactured for 1999.
c. Prepare an income statement for 1999.
d. Assume that the company produced 14,700 ceramic flower pieces in 1999. What was the product cost per unit? What was the direct materials cost per piece? What was the factory depreciation per piece?
e. Assume that the company expects to produce 17,000 units in 2000. What are the unit and total cost for direct materials and for factory depreciation that you expect? Explain your answer.

20. Appendix A. Marmalade Kitchens had the following account balances at the end of the year:

Purchases of raw materials	$507,500
Selling and administrative salaries and benefits	192,500
Factory maintenance	45,000
Direct labor	?
Occupancy cost, factory	90,000
Advertising	120,000
Factory utilities	67,500
Indirect labor	90,000
Sales commissions	80,000
Factory rent	216,000
Administrative office rent	120,000

Inventory balances and other selected cost categories were as follows:

Item	*January 1*	*December 31*	*For the Year*
Raw materials inventory	**60,000**	**20,000**	
Work-in-process inventory	**72,000**	**88,000**	
Finished goods inventory	**40,000**	**50,000**	
Total manufacturing costs			**1,310,250**
Goods available for sale			**1,334,250**
Cost of goods sold			**1,284,250**

a. Prepare a cost-of-goods manufactured schedule. Hint: You'll have to work all the way through cost of goods sold to fill in all blank items you need.
b. Go through each cost item in total manufacturing cost and classify as fixed or variable. Explain what assumptions you had to make to classify costs into these categories. Refer to the discussion of business practices, time period, and divisibility of cost in the module.
c. Assume that these costs were incurred to produce 165,000 cases of marmalade. Calculate the per unit product cost of a case of marmalade.
d. If production next year falls to 150,000 cases, what would the per unit case cost be?

22. Marketing tests determine customers' importance ranking of the features of a pencil sharpener produced by your company. Accountants and engineers calculated the percent of total cost spent on each feature. That data is provided below. What does it tell you about your pencil sharpener?

Feature	*Percent of Customer Importance*	*Percent of Product Cost*
Attractive desk-top styling	20%	30%
Easy-to-clean filings	25%	5%
Sharpens cleanly & quickly	20%	30%
Automatic stop without breaking lead	30%	10%
Secures to desk without moving during use	5%	25%

23. Assume that you work for a local newspaper as an administrative assistant. The editor is concerned about costs. The accountant has suggested raising the price of the daily paper from $.35 to $.50 because of costs. The editor is concerned about declining subscriptions and cost complaints from local residents if prices increase. The accountant prepared a cost analysis based on an idea from value chain analysis. He explained that he classified each cost incurred by whether it was controllable internally or externally with other value chain members. The editor requested you study the report and write a memo to him making recommendations on how to proceed. (In your solution, focus on your knowledge of cost and where it is incurred. Don't address increasing subscriptions, classifying costs as fixed and variable, or earning revenue from advertisements.)

The Daily Chronicle Annual Costs Classified by Value Chain

Cost Item	*Amount*	*Internal*	*External*	*Comments*
Paper, ink	$375,000		$375,000	**One supplier used**
Administrative salaries & benefits	$40,000	40,000		
Journalist & editorial salaries and benefits	150,000	100,000	50,000	**We use the services of 5 free-lance people whom we pay by the story or picture**
Typesetting & printing	250,000		250,000	**One supplier used**
Subscriptions & wire services	25,000		25,000	**Represents over 100 different suppliers**
Utilities, rent, & operating costs	50,000	35,000	15,000	**Rent is under control of building owner; we control use of utilities, telephones, and other operating costs**
Delivery	200,000	125,000	75,000	**We have our own delivery persons for local daily delivery; other papers are mailed**
Total	**1,090,000**	**300,000**	**790,000**	
	100%	**27.5%**	**72.5%**	
Number of daily subscriptions	**7,500**			

24. The Watermaster Company produces a kayak that is in great demand. The company sells its kayaks through sporting goods stores. It has orders that completely use its 17,000-unit capacity. Customers pay Watermaster $125 per kayak. Annual cost data at full capacity follows:

Cost Item	*Amount*
Materials used (plastics, seats, etc.)	$382,500
Sales commissions	150,000
Touch labor	186,750
Advertising	93,750
Utilities, factory	24,000
Utilities, office	6,000
Depreciation on factory equipment	275,750
Depreciation on office equipment	12,000
Salaries, office	125,000
Salaries, factory supervision	75,000
General office supplies	15,000
Packing and shipping to customers	150,000
Insurance, factory	32,000
Insurance, other	5,000
Warranty repairs	30,000
Total	**$1,562,750**

a. Prepare an answer sheet with the following column headings. Enter each cost item on your answer sheet, placing the dollar amount under each appropriate heading. An example is provided for the first cost item.

	Cost Behavior		**Selling or Administrative**	**Product Cost**	
Cost item	*Variable*	*Fixed*		*Direct*	*Indirect*
Materials used	$382,500			$382,500	

b. From the perspective of management, what does each kayak cost? From the perspective of an accountant, what is the product cost of a kayak?

c. Assume that production drops by 2,000 units. Using the cost behavior classifications above, predict the new total cost. Will the unit cost increase or decrease? Explain the economic theory behind the change.

d. Refer to the original data. Your neighbor, an accountant, would like to buy a kayak from you at cost. What amount might he expect to pay? What cost term could you use to charge your neighbor the same amount that you charge regular customers?

25. Tom Brunridge, a dentist in your area, wanted help in determining the cost of routine dental cleanings in his office. He is uncertain how to proceed, but provided you with some details. Two years ago, he paid about $50,000 for outfitting **each** cleaning room with chairs

and equipment. He pays two dental hygienists an annual salary (with benefits) of $38,000 each. Approximately 50 percent of his total office staff expense, $60,000 a year, relates to scheduling these appointments, filling out dental insurance paperwork, and updating files. About 20 percent of his annual lease payment ($15,000) relates to the space used for dental cleanings. In a typical year, approximately 5,000 dental cleanings occur.

a. What is the cost of a dental cleaning, assuming that each cleaning room will require re-outfitting after five years of service?
b. Classify the costs incurred into fixed, variable, and mixed cost categories.

Cost Item	***Amount per Year***	***Classification***
Outfitting rooms		
Hygienists' salaries & benefits		
Office support		
Leased space		
Total		

c. What other costs might be associated with dental cleanings that are not in the above list?
d. Consider the type of costs Dr. Brunridge has in his list. Compare the nature of the fixed-cost items in terms of their divisibility.

Cost Item	***Amount per Year***	***Divisibility***
Outfitting rooms		
Hygienists' salaries & benefits		
Office support		
Leased space		
Total		

e. Assume that a patient is looking for two different features in obtaining dental cleanings: (1) ease of making appointments and doing insurance paperwork, and (2) sanitary, competent dental hygiene service. Discuss which cost items provide each of these features.

26. Robinson Orthodontics currently performs its own full mouth and cranial x-rays prior to orthodontic service. Most other orthodontists use an outside supplier for this service. Since Robinson had idle space and worker time, it seemed logical to perform x-ray services internally. Dental assistants take the orthodontic x-rays during their regularly scheduled day. An orthodontist approached Robinson with an offer. He would like to rent the space and share the front office administrative staff. The orthodontist offered $48,000 a year in rent (covering space, utilities, telephone, and office staff). The new orthodontist would outfit his own office space. Robinson hired you to analyze the offer and help management decide what action to take. The following is a table of data you put together to help with your analysis.

Item	*Description*
Current annual rental cost	$18 per square foot per year
Number of square feet to use as rental or as x-ray	240 square feet
Charge for orthodontic x-ray series from outside supplier	$125 per patient
Average number of orthodontic x-ray series in a year	135
Cost of x-ray film, development chemicals per series	$25
Number of minutes of assistant's time per series	30
Assistant's salary and benefits	$32,000 annually (assume a 2,000-hour work year)
Depreciation on dedicated x-ray equipment per year	$2,000 annually (this equipment would last about 3 more years and has no resale value)

a. Calculate the full cost of performing a full set of orthodontic x-rays internally.
b. Compare the incremental cost of performing a full set of orthodontic x-rays internally to using an outside supplier. Be careful in your analysis. Remember, if a cost item would be the same regardless of the action you take, it is not included in the analysis. Also, remember to include opportunity costs.
c. What assumptions did you have to make to do this analysis?

27. Texaco evaluates the performance of its managers by comparing budgeted profit to actual profit. Consider the results from the Mobile Refinery:

	Mobile Refinery	
	Budget	***Actual***
Sales	$10,500,000	$10,250,000
Cost of goods sold	6,300,000	6,252,000
Marketing	210,000	210,000
Depreciation on refinery & equipment	1,100,000	1,050,000
Manager's salary	250,000	250,000
Other operating costs	950,000	1,000,000
Share of corporate overhead cost	750,000	786,000

a. Prepare an income statement for the refinery with two columns, one for budget and one for actual results.
b. Calculate the budgeted versus actual return on sales.
c. Is this income statement the one that you would use to evaluate the performance of the manager? Why or why not?

d. If the income statement in (a) is not the income statement that you believe is appropriate to evaluate the manager's performance, recast it into a form that you would use to evaluate the manager's performance. Briefly explain why you included or excluded each item in the table above.

28. General Motors is currently investigating building more flexible manufacturing plants for its small cars. These new plants would use less production line labor and more machinery. Accordingly, their cost structure will change; some items that were previously variable will become fixed. Below is a table showing the old cost factors compared to the new cost factors.

Factors	***Old***	***New***
Robots	Not employed.	Substitute for labor in many repetitive tasks.
Direct labor	Most production jobs performed by hourly workers who work in pace with a production line.	Mostly replaced by robots; remaining labor must be flexible learning to operate multiple machines and change their setup. Paid salary.
Equipment	Dedicated to performing the same task repeatedly; high cost to change setups for model changes.	More flexible. Can switch back and forth between models with minimum setup.
Setup	Performed by engineers; extensive and involves testing on materials for proper settings.	Performed by line workers by changing software and settings.
Direct materials	No change.	No change.
Supervision	Supervisors for every 12 laborers.	Few supervisors. Workers are empowered to make decisions.
Building space	Requires more square feet per car.	Requires less square feet per car.

a. Think about each cost factor listed above. Classify it as fixed, variable, or mixed in the old and in the new production environment.
b. Which cost structure is more susceptible to demonstrating economies of scale, the old or the new production environment? Why?
c. Which cost structure is more suitable for satisfying customer's demand for a wide variety of car models, colors, and option packages?

29. Adventures, Inc., manufactures mountain bikes. Currently, after tube kits are assembled, an inspector checks each assembled frame. The company employs two inspectors; each earns $36,000 a year plus 25 percent benefits. Inspectors use equipment that is depreciated $20,000 per year. Inspection supplies total $4,500 annually. Inspectors use space in the common production facility. Approximately 10 percent of the space is dedicated to inspection. The occupancy cost (rent, heat, light, parking, etc.) for the common production facility is $94,800 annually. (Space cannot be sublet.) Material movers move bikes to and from the inspection area. Approximately 25 percent of material movers' time is devoted to this task. Material movers' cost is $72,000 a year plus 25 percent benefits.

a. Adventures, Inc., is interested in the cost of the activity, inspecting assembled frames. Calculate that amount for them.
b. Consider the cost elements calculated in (a). Divide these into the following four groups: (1) direct costs that will vary with the level of the activity, (2) direct costs that are fixed (indicate whether they are divisible or indivisible), (3) common costs assigned to the activity that are divisible, (4) common costs assigned to the activity that are indivisible.
c. Assume that Adventures is considering reorganizing work by having assemblers inspect their own work. What will be the likely cost impact of this decision in three months and in two years?

Essay or Research Projects.

1. Many organizations place heavy emphasis on how costs behave with changes in production or sales volume. They classify all costs as fixed or variable and use this when modeling costs and profits. Discuss how and when this analysis can lead to bad decisions. (Problem contributed by Dan Swenson, University of Idaho.)
2. Each student should select a term or concept in the module (e.g., economies of scale or cost driver). Use the search engines on the Web to find out more about the term or concept. Students should give no more than a five-minute oral presentation on their topic, using no more than three overhead slides. The presentation should include an annotated list of useful URL. (Project contributed by George Fiebelkorn, Marymount University.)

Case 1: Plant World Inc.©

Plant World sells a complete line of garden products.

Exhibit 15
Product Line Income Statement.

Revenue (1,000,000 cards @ $1.75/card)	$1,750,000
Variable costs	
Sales commissions (10% of revenue)	175,000
Shipping costs	325,000
Printing costs (0.682 unit × 1,000,000)	682,000
Total variable costs	1,182,000
Contribution margin	568,000
Fixed costs	
Order-filling costs (13 employees @ average of $23,040 per employee)	299,520
Product development cost ($88,000 amortized over three years)*	29,333
Marketing/advertising costs	35,000
General business support costs	312,000
Total fixed costs	675,853
Net profit	**($107,853)**
Return on sales	**−6.16%**

* The entire $88,000 is expensed in the first year on the company's external income statement.

Management is concerned about the losses from the laminated card line. All product lines in the company are expected to earn at least 10 percent return on sales. The managers have been discussing ways to improve the profitability of the card line.

One alternative being proposed by the marketing manager would double the sales from its current level of 1,000,000 cards sold. To do this, however, the marketing manager wants to spend an additional $35,000 on advertising and sales promotion, reduce the price to $0.99 per card, and sell through nurseries instead of direct mail. She further indicated that marketing through nurseries means that the average number of cards per order will increase from the current 10 to 100 cards per order. The increase in order size means that Plant World could print the cards in batches of 100,000 instead of the current 20,000.

The owner of the supplier printing press company is currently charging Plant World $0.682 per card. The supplier has indicated that he typically requires a 25 percent profit on sales, and so he marks up all jobs by 33.3 percent above his cost. His variable cost of paper, laminate, and ink is $0.387 and the setup cost for each batch is $2,500. With the larger batch size of 100,000 cards, the supplier calculates that he can lower his price by 15 percent to $0.580 per card ($0.682 × 85%).

A revised analysis based on the new selling price of $0.99 per card, the reduced printing cost of $0.580 per card, and the increased fixed marketing costs of $35,000 is shown in Exhibit 16. The projected income statement increases all other variable costs in proportion to the increase in the volume of sales (that is, double). Fixed costs, with the exception of the incremental marketing costs, are unchanged.

A further analysis of fixed costs shows that the salary costs of $299,520 for order-filling employees is based on an average salary of $18,000 per year plus another 28 percent of this amount for fringe benefits. It takes an employee an average of 15 minutes to fill an order. Each employee works for 50 weeks per year and 40 hours per week.

The "general business support costs" of $312,000 include the costs of providing all employees (including order-filling employees) with space, furniture, utilities, supplies, and computer support. These costs average approximately 60 percent of the salary cost of an employee. These support costs are expensed as general and administrative costs on the external financial statements.

Based on Exhibit 16, the laminate cards are not a profitable item and management feels that this product line should be discontinued.

Exhibit 16
Projected Income Statement

Revenue (2,000,000 cards @ $0.99/card)	$1,980,000
Variable costs	
Sales commissions (10% of revenue)	198,000
Shipping costs (double due to doubling in volume)	650,000
Printing Costs (0.682 unit x 85% x 2,000,000 units)	1,159,400
Total variable costs	2,007,400
Contribution margin	(27,400)
Fixed costs	
Order-filling costs (13 employees @ average of $23,040 per employee)	299,520
Product development cost ($88,000 amortized over three years)	29,333
Marketing/advertising costs	70,000
General business support costs	312,000
Total fixed costs	710,853
Net profit	**($738,253)**
Return on sales	**−37.29%**

Required:

1. In your opinion, are the cost classifications used in Exhibit 16 appropriate?
2. Do you agree with the analysis in Exhibit 16 and the conclusion reached by management?
3. If not, what alternative course of action would you recommend?
4. What is the profit margin for this product line that you will use to evaluate whether the decision to enter this product line was sound?
5. What is the profit margin for this product line that you will use to decide whether to discontinue this product line?

Case 2: Kaleidoscope Inc.©

Kaleidoscope Inc. manufactures three models of decorative brass kaleidoscopes (economy, standard, and deluxe). Its income statement for the year 1998 is shown in Exhibit 17. In 1998, the company sold 163,569 units of all three models combined. The kaleidoscopes are sold through specialty boutiques in major shopping malls. The shops, which are independently owned, typically add a 100 percent markup to their purchase price from Kaleidoscope Inc. The shops send defective kaleidoscopes back to the company for repair. After the warranty period, the costs of repair are charged to the customer. Warranty repairs costs typically average $1 per kaleidoscope. Customers spend approximately $10 per kaleidoscope for repairs, refurbishment after the warranty expires, and $30 each four years to have the brass polish restored. The life of the product is typically 12 years. The *weighted-average retail price* of all kaleidoscope models is $80.

The company assembles kaleidoscopes from purchased parts. The plant is modern and the company operates a just-in-time manufacturing system. It purchases parts from two tier 1 suppliers and one recycler who takes apart old kaleidoscopes and salvages them for usable parts. Both these suppliers have had long relationships with Kaleidoscope and have long-term commitments for supply of parts. Each supplier, in turn, purchases 60 percent of their raw materials from their tier 2 suppliers. The company uses an outside design house for product design and a shipping and distribution company to ship its products to shops.

Internally, the company is divided into three departments: assembly, sales, and administration. The assembly department requires skilled labor. The company has spent a considerable amount for training its workers. Further, because the company operates in a small town, it does not believe in laying off workers. The assembly department occupies 40 percent of the common rented building for space. Sales occupies 20 percent, and administration occupies the remaining. Administration does not include accounting and legal. These services are purchased from independent practitioners as needed.

The company is trying to understand its cost structure and feels that their current income statement format (see Exhibit 17), developed for external reporting purposes, does not provide the insights about their cost structure that they need to manage the business. Kaleidoscope is intrigued by the many different ways of arraying costs and wants to understand the insights each cost view provides.

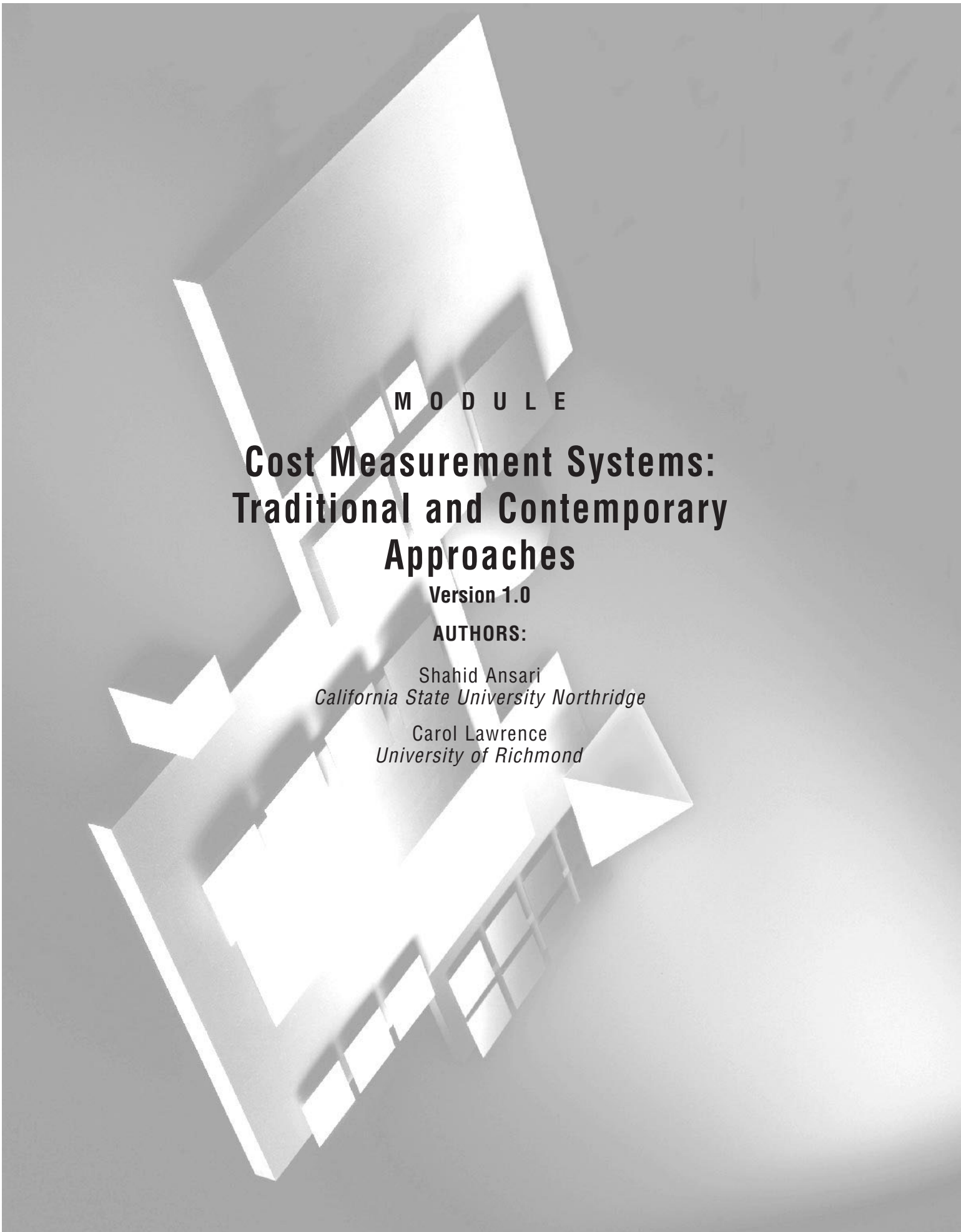
Required:

1. Prepare a flowchart of the company's value chain starting with suppliers and ending with the customer. Put as much factual detail in the flow chart as you can.
2. Prepare a statement that lists the costs by whether they are part of the company's internal value chain or external value chain.
3. Assume that the company is trying to set margins and prices. What is the product cost per unit? (For this question, you can assume they only sell one product so you can sum the units for the three models.)
4. For the previous question, what is the product cost that the company will report on its external balance sheet?
5. What does this product cost a customer from the time he or she purchases it to the time that he or she disposes of it (that is, the life cycle or cost of ownership)?
6. Assume that this next year, production and sales are expected to increase by 20 percent. List all costs that will change. Also state whether the change will be less than, greater than, or equal to 20 percent and the basis for your answer. If production and sales decreased by 20 percent would all costs that you identified as increasing by 20 percent also decrease by 20 percent? Why or why not?
7. Review your answers to questions 2–6 above. What conclusions can you draw about the cost structure of the company from this analysis of its costs? What insights have you gained about cost management?

Exhibit 17
Kaleidoscope Inc.
Income Statement
For the year ended December 31, 1995

Net sales revenue:	$6,542,760
Cost of Sales	
Purchased Parts	2,563,331
Recycled Parts	456,873
Direct Labor	560,800
Design Charges	87,135
Depreciation	23,564
Equipment Rental	25,645
Insurance—Medical, etc.	124,789
Payroll Taxes	75,680
Rent on Plant	135,000
Repairs & Maintenance	36,621
Warranty Repairs	168,554
Supplies & Tools	18,264
Supervisory Salaries	354,658
Utilities	34,689
Total cost of sales	4,665,603
Gross Margin	1,877,157
Operating Expenses:	
Sales Commission & Salaries	121,844
Salesmen Salaries	60,863
Shipments & Delivery	43,813
Depreciation—Office Equipment	18,900
Accounting & Legal Fees	45,324
Insurance	35,650
Miscellaneous Expenses	27,294
Office Supplies	9,446
Administrative Salaries	542,980
Payroll Taxes, etc.	18,600
Pension Plan	98,745
Operating Taxes & License	32,396
Telephone	33,484
Total operating expenses	1,089,339
Operating Income	$787,818

NOTES



M O D U L E

Cost Measurement Systems: Traditional and Contemporary Approaches

Version 1.0

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Module Contents
Cost Measurement Systems: Traditional and Contemporary Approaches

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TWO PERSPECTIVES ON COSTING

"It's really not fair to compare the cost of the job we're working on now for a wastewater treatment plant in Sweden with the job we just finished for a sugar mill in Zimbabwe. The Sweden job requires heavy-duty surface finishes to withstand the exposure to severe winter weather. We've had real problems with the new weatherproof paint we're trying." The production manager of **Alfa Laval** offered this explanation at the monthly staff meeting as managers reviewed the latest cost reports. The company's plant in Richmond, Virginia, makes equipment for industrial processes that require heating and cooling of liquids during processing.

Meanwhile, across town at the **A.H. Robins** plant that produces over-the-counter and prescription cold and flu medicines sold under the brand names Robitussin and Dimetapp, managers were also reviewing cost reports. Costs in the mixing department were slowly inching upwards. The plant manager protested, "But the cost increase is only *2 cents*!" The controller responded, "With the huge quantities we produce, 2 cents per bottle adds up in a hurry. That 2 cents a bottle will increase our total cost by $360,000 this quarter, and if this keeps up, total cost for the year will be $1,440,000 more than last year!"

Everyone agreed with the plant manager when he commented, "You know, it seems we get lots of information from our accounting system, but it doesn't really tell us what we need to know. I want to know how to manage our costs proactively, not just find out after the fact they were too high!" The controller spoke up, "I know our accounting system has to change. Perhaps we can incorporate some of the more contemporary approaches to cost measurement."

A cost measurement system records, tracks, and reports information about the resources consumed by an organization in providing its customers with the goods or services they want. The primary reasons for measuring costs are to make informed strategic choices and to manage costs. A cost measurement system is part of a **strategic management accounting system**. Other functions performed by a comprehensive strategic management accounting system include the following elements:

- ▲ *Competitor cost estimation* that estimates the cost at which competitors are providing similar goods and services.
- ▲ *Value chain* costing that helps management understand what each member of the value chain[1] contributes to the total cost of providing a product or service to a customer.
- ▲ *Strategic cost analysis* to help management estimate the impact of pursuing different customers or markets or of investing in different production technology.

[1] The value chain is the linked series of activities required to provide a service or product to a customer. A comprehensive view of the value chain would begin with the extraction of raw materials and include all steps through production, delivery, use by the customer, and recycling or final disposal.

▲ STRATEGIC IMPORTANCE OF COST MEASUREMENT SYSTEMS

Information provided by a cost measurement system helps managers achieve their major strategic objectives of providing customers with high-quality products or services, at a reasonable cost, and in a timely fashion.

- ▲ **Quality.** Providing customers the features and reliability they want at affordable prices can be a major challenge. A cost measurement system provides data that allows managers to understand the cost of providing customers with current levels of quality. In addition, a well-designed cost measurement system should provide information to estimate the cost of adding new features desired by customers.
- ▲ **Cost.** The purpose of measuring costs is to manage costs. A cost measurement system helps management to understand how each of the various cross-functional processes used to produce, deliver, and support products or services contributes to costs and what factors cause costs to change. This information helps managers to focus their cost management efforts on areas that produce the greatest benefit.
- ▲ **Time.** Both of the firms in the opening story face key strategic issues on the time dimension of the strategic triangle. Meeting a customer's deadline for installation is critical for Alfa Laval's heat-exchanger business. Late delivery of the heat exchangers can delay the completion of other aspects of construction, causing considerable ill will and expense for the customer.

For Robins, timely introduction of new drugs is vital to ensure an adequate return on their research spending. Because of seasonal fluctuations in demand, Robins must plan carefully to have adequate supplies of cold and flu medicines available for the winter flu season. The cost systems of both companies must help them understand how delays affect their costs and profits.

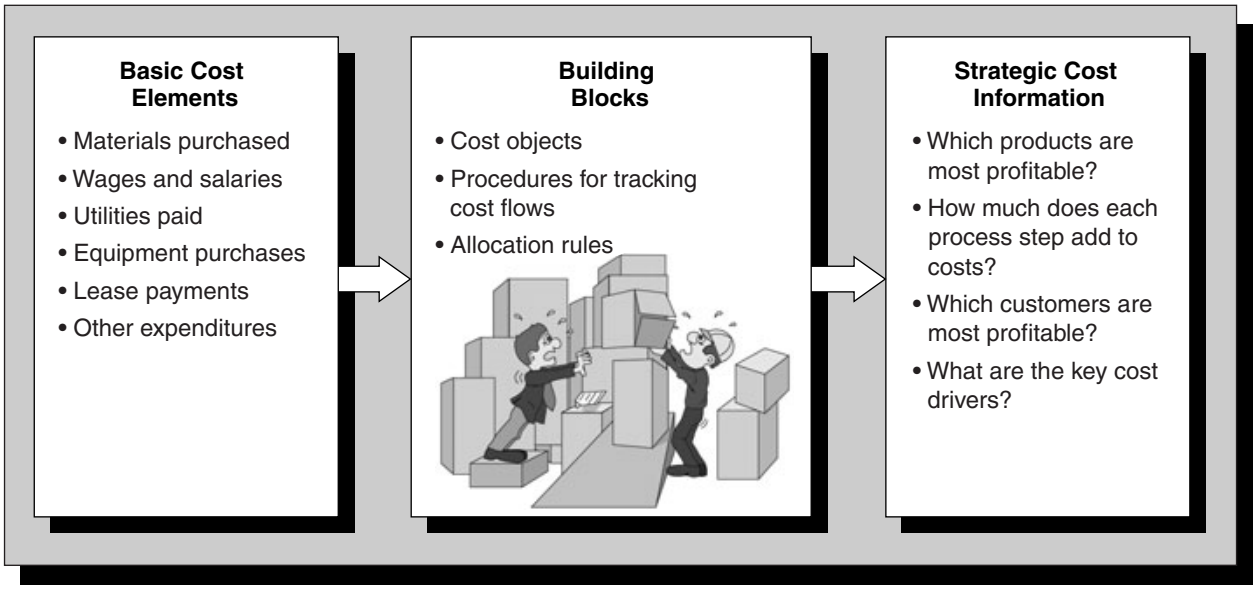
When you are finished with this module, you will

- ▲ Appreciate the strategic importance of cost measurement systems.
- ▲ Recognize that organizations use different cost measurement systems because they produce different types of outputs using different production methods.
- ▲ Learn about key design issues such as the selection of cost objects, accounts used to track cost flows, and allocation procedures used to trace costs to cost objects.
- ▲ Understand how a cost measurement system converts data on resources purchased into information on resources consumed by the cost objects (customers, activities, operations, products, processes) of interest to management.
- ▲ Understand how traditional department-focused cost measurement systems such as job order costing and process costing differ from contemporary cost measurement systems that focus on all activities and operations required to design, produce, and deliver a product or service to a customer.
- ▲ Understand the technical, behavioral, and cultural attributes of traditional and contemporary cost measurement systems.

▲ NATURE OF A COST MEASUREMENT SYSTEM

The process of cost measurement is like a building process. The basic raw material is data on purchases of resources such as materials, equipment, or labor. A cost measurement system uses these data as basic building blocks, arranging them into a structure that provides managers with cost information for making strategic decisions and managing costs. Exhibit 1 depicts this view of a cost measurement system.

Exhibit 1
Cost Measurement System as a Building Process



The reason we need to go through this building process is that most accounting systems initially capture data on resources *purchased*, whereas managers need to know how resources are *used* to meet strategic objectives. For example, the accounting system records events such as the purchase of $100,000 worth of materials; payment of $300,000 in salary and wages (recorded in the payroll account); and purchase of $50,000 worth of new equipment. However, managers want to know how much of the $100,000 in materials; $300,000 in salaries; and $50,000 in equipment was used to produce products, how much to deliver them, and how much to support them. More important is the question: Were the revenues generated greater than the resources used in generating these revenues? This type of information is critical in determining whether a firm is producing outputs that meet or exceed customer expectations and generate profits.

The cost measurement system provides this type of managerially relevant information by creating a structure whose primary building blocks are

- ▲ *A set of cost objects*, processes, products, activities, customers, and so on that serve as the focus of cost accumulation and analysis.
- ▲ *Procedures for tracking the flow of costs* through various accounts.
- ▲ *Methods of allocating resources* shared by more than one cost object.

Cost Object Selection.

Most organizations use many different types of cost objects. Products, services, departments, activities, product lines and customer groups are some examples of commonly used cost objects. In a well-designed cost measurement system, cost objects correspond to management's strategic decision needs. For example, to decide which market segment to focus on, Alfa Laval's management must know which of its customers are most profitable. This factor explains why individual customer jobs are an important cost object for Alfa Laval.

Cost objects must be selected with care. Inappropriate selection of cost objects can seriously impair the usefulness of a cost measurement system. For example, until recently most organizations did not use activities as cost objects and, therefore, did not have cost data that could be used for managing critical business processes. Even today many companies use cost objects that are relevant for external financial reporting and irrelevant or misleading for internal management decision making. Measuring inventory at "full product cost" is one example of this tendency.[2]

Selecting the right cost object is particularly difficult in service industries because their output is hard to define. For example, the output of a hospital can be measured in a variety of ways. The cost measurement system might report cost per patient, per patient day, or per bed. In the early 1980s the Medicare system implemented a new reimbursement plan, based on diagnosis-related groups (DRG). The DRG system classifies each patient into one of 470 DRGs based on the nature and severity of the patient's ailment. Medicare reimburses hospitals a standard amount for each patient treated in each DRG, regardless of the actual costs the hospital incurs to treat a patient. Today many hospitals use DRGs as a major cost object for accumulating and reporting costs.[3]

Think Along

What is the cost object your university or college uses to measure the cost of educating students?[4]

Procedures for Tracking Cost Flows.

A cost measurement system provides the means of tracking costs through various accounts and intermediate cost objects to the final cost objects of interest to management. Traditional cost systems use functional areas or departments to flow and track costs to cost objects. Contemporary cost systems use activities and operations to accumulate the cost and then charge these costs to final cost objects.

Cost Allocation.

The allocation of costs that are common or shared is a critical part of the design of any cost system. Allocation rules can be quite complex. In a well-designed system the allocation scheme will reflect how costs are caused by or incurred to benefit the selected cost objects.

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[2] The *Theory of Constraints and Throughput Accounting* module in this series develops in greater detail the difference between inventory measures for external financial reporting versus managing operations.

[3] For additional detail on hospital cost measurement systems, see Carol M. Lawrence, "The Effect of Ownership Structure and Accounting System Type on Hospital Costs," *Research in Governmental and Nonprofit Accounting*, Vol. 6, 1990, pp. 35–60.

[4] Colleges use full-time equivalent student hours. See discussion on page CMS–15.

An Example.

Let us consider a simple example to illustrate the three steps in measuring costs. Assume a hospital uses a traditional department-based cost system and wants to know the cost of treating patients who are classified in disease group 215 (i.e., the cost object is DRG 215). The first step, if the hospital uses a traditional system, is to track costs to departments. Assume we have three departments: clinic, laboratory, and administration. Further assume that for this period the total materials, supplies, salaries, and other costs traced to the three departments and their other selected statistics are as follows:

Department	*Costs*	*Other Statistics*
Clinic	$1,000,000	16,000 physician hours
Laboratory	300,000	10,000 tests
Administration	700,000	
Total	$2,000,000	

The next step is to reallocate the administration cost to the clinic and the laboratory. Let us assume that, based on a predetermined formula, these costs are split $600,000 to the clinic and $100,000 to the laboratory. The new totals are clinic $1,600,000 and laboratory $400,000. Assume that physicians spent 100 hours treating 50 patients in DRG 215 and that these patients received 150 tests. Then the cost per patient in DRG 215 can be calculated as follows:

Exam cost:	[($1,600,000 ÷ 16,000 physician hours) × 100 hours]	= $10,000
Lab cost:	[($400,000 ÷ 10,000 tests) × 150 tests]	= $ 6,000
Total cost for DRG 215		= $16,000
Cost per patient in DRG 215 (divided by 50 patients)		= $ 320

Think Along

How would the hospital determine the cost of this DRG if it used activities rather than departments to collect cost?

An activity-based system would trace the $2,000,000 costs to specific activities that support treating a patient in DRG 215. The hospital in our example would have to compute the cost of admitting patients, keeping records, conducting a physical exam, performing each type of test (blood, EKG, etc.), filling prescriptions, and so on. The cost would be assigned to DRG 215 based on activities consumed by patients in this DRG. Later in the module we describe this process in greater detail.

▲ INFLUENCES ON COST MEASUREMENT SYSTEMS

Before we look at the different methods organizations use in practice to track and flow costs to final cost objects, we need to consider the reasons behind these differences. This diversity of cost systems reflects the differences in the *type of output* organizations produce and the *production methods* they use.

Type of Outputs.

Cost systems differ because each type of output requires different cost elements and a different cost management strategy. For example, in the construction industry a single major building can be a cost object and costs can be traced to it. In rice farming it does not make sense to trace costs to each grain. In automobiles the cost of purchased parts and assembling them is critical. In oil exploration the product does not require any assembled parts.

In general, organizations provide one of five types of outputs:

Extracted products are removed or drawn out of the earth by special effort or force. Oil refining, natural gas production, and coal mining are examples of extractive industries.

Processed goods are obtained by converting raw materials through substantial additional processing. Agricultural products, such as milk, cheese, butter, and ice cream, are good examples. Other examples include chemicals, paint, and cement. Robins's output (bottles of Robitussin cough syrup) fits into this category.

Assembled products are those in which numerous parts and subcomponents are put together to form a final product. Examples include cars, televisions, radios, computers, airplanes, and ships.

Fabricated products are a hybrid between processed and assembled goods. A major raw material is typically processed and then a few parts are assembled to create the final product. Examples of this group include semiconductors; machine tools and dyes; plastic toys; and paper products such as cups, stationery, and packaging. The heat exchangers produced by Alfa Laval are fabricated products.

Personal services involve the performance of duties or work for another person. Services require skilled processing or work performed by professional or service specialists. The work product of accountants, lawyers, doctors, photographers, gardeners, insurance adjusters, and waiters falls in the personal services category.

Production Methods.

Cost systems also reflect the type of production environment in which they are used. Three types of production methods have dominated the 20th century.

Craft production, universally observed prior to the Industrial Revolution, is still used for one-of-kind products produced in very small quantities. Examples are artistic works such as paintings, sculpture, and animated movies. In craft production, analysis of past costs is of limited usefulness as a guide to predicting future costs because each unit produced may be unique.

Mass production techniques have been the dominant method of manufacturing products during the 20th century. Mass production firms produce large volumes of products with little product variety. They typically use inflexible equipment and specialized labor, have long manufacturing cycles, and rely on inventories to buffer their systems from uncertainty.

Lean and **"agile"** production, developed by Japanese firms such as Toyota, is fast becoming a popular method of production in the last part of this century.[5] A lean or agile manufacturing system emphasizes flexibility and quick response. Such a system produces

[5] For a detailed discussion of differences between craft, mass, and lean production, see James P. Womack, Daniel T. Jones, and Daniel Roos, *The Machine That Changed the World*. Accounting implications of lean production methods are described in detail in the module *Management Accounting in the Age of Lean Production* in this series.

small volumes of products quickly and can provide a great deal of product variety. These systems typically rely on computer-aided manufacturing and use just-in-time manufacturing.

Some service industries, such as banks or insurance companies, handle large volumes of similar transactions and have characteristics of mass production. Other service industries, such as consulting, auditing, or legal services, more closely resemble a custom-order situation.

Think Along

How do the type of output produced and the production methods used influence the design of a cost system?

Influence on Cost Measurement Systems.

While the nature of output often dictates the choice of production methods, it is not a universally fixed relationship. For example, many products today, such as automobiles, machine parts, and electronic goods, are produced using both mass and lean manufacturing methods. The choice influences the design of a cost measurement system in three major ways.

First, companies that use mass production systems have substantial inventories of raw materials, work-in-process, and finished goods. Cost measurement systems in such environments focus heavily on *inventory measurement*. In addition, because historically financial-reporting standards have dominated management reporting, manufacturing costs are often equated with product cost; only costs that can be "matched" with revenues.[6]

Second, mass production systems use unskilled labor and emphasize functional specialization. The use of unskilled labor vests all authority and responsibility with functional area managers. Managerial accounting systems reflect this orientation by using *responsibility accounting* systems. In a responsibility accounting system, managers are held responsible for managing costs within the administrative department or organizational subunit under their control. The cost centers typically are organized functionally and are referred to as *responsibility centers*. Responsibility accounting systems track costs by the person or entity responsible for costs rather than the work that gives rise to a cost. For example, assume that the warehouse in a retail department receives goods and stocks the goods on shelves. A responsibility accounting system will track all costs incurred in the warehouse—the responsibility center. However, this system will not routinely report the cost of the activities "receiving goods" and "stocking goods."

Finally, mass production systems have low product variety (few products) and large volume. Lean production systems are the opposite. They have large variety and low volumes. Mass production systems, therefore, tend to use a simple single allocation base such as labor hours and machine hours to allocate common costs to products. Lean production systems tend to use systems that use multiple allocation bases, one for each major cost pool, to allocate common costs.

▲ TRADITIONAL COST MEASUREMENT SYSTEMS

Traditional cost measurement systems reflect the influence of mass production and are characterized by excessive focus on inventory measurement, use of responsibility centers

[6] This is called the "matching principle." It has long governed financial reporting, and it asserts that inventory or product costs should include only costs that can be matched with revenues generated. In practice, therefore, only production costs are part of product costs, since they are easy to match with revenues.

for cost tracking, and a single base for allocating indirect or common costs. Many organizations use some variant of two popular forms of traditional cost measurement systems: job-order costing and process costing. In practice most cost systems are hybrid and combine features of both job-order and process costing. To understand their differences, however, we will illustrate job-order and process costing in their pure forms.

Increasingly, organizations are modifying or redesigning their systems to match changes in their production systems or to meet the changing needs of their competitive environment. We will use the two firms from our opening story (Alfa Laval and A.H. Robins) to describe traditional cost measurement systems and their operation and then show how these firms might design contemporary cost measurement systems.

Job-Order Costing—Alfa Laval.

In a job cost system, the primary cost object is a customer job. Job costs provide the information necessary to compute unit product costs.

Alfa Laval is a classic example of a firm that would use job-order costing.[7] One of its products is a heat exchanger used in industrial processes that must change the temperature of liquids during processing.[8] Each customer job is unique and starts with the development of detailed product specifications based on a customer's special requirements. The *engineering* department performs this function.

The production of a heat exchanger involves three manufacturing processes. First, sheet metal is stamped into plates. These plates are then moved from the *stamping* department to the *assembly* department where the plates, frames, and cover are assembled. Next, the *testing* department runs reliability tests on the assembled units. Alfa Laval's *customer support* department installs the units at the customer's site and trains customer personnel in the operation and maintenance of the units. We will illustrate a traditional cost measurement system for Alfa Laval by discussing two orders: eight units for a waste-water-treatment plant in Sweden and six units for a sugar mill in Zimbabwe. The Zimbabwe job is complete, but the heat exchangers for the Sweden job are still in process.

As stated earlier, traditional job-order costing defines *product costs* as costs that can be carried on the balance sheet as the asset inventory. Therefore, *only manufacturing costs are considered part of the product cost* for valuing inventory and calculating the cost of goods sold. All other costs are referred to as "period costs." Also, all costs are traced to functions and departments and from there to customer jobs and units produced. Exhibit 2 graphically depicts the cost tracking that occurs in a traditional job cost system.

Think Along

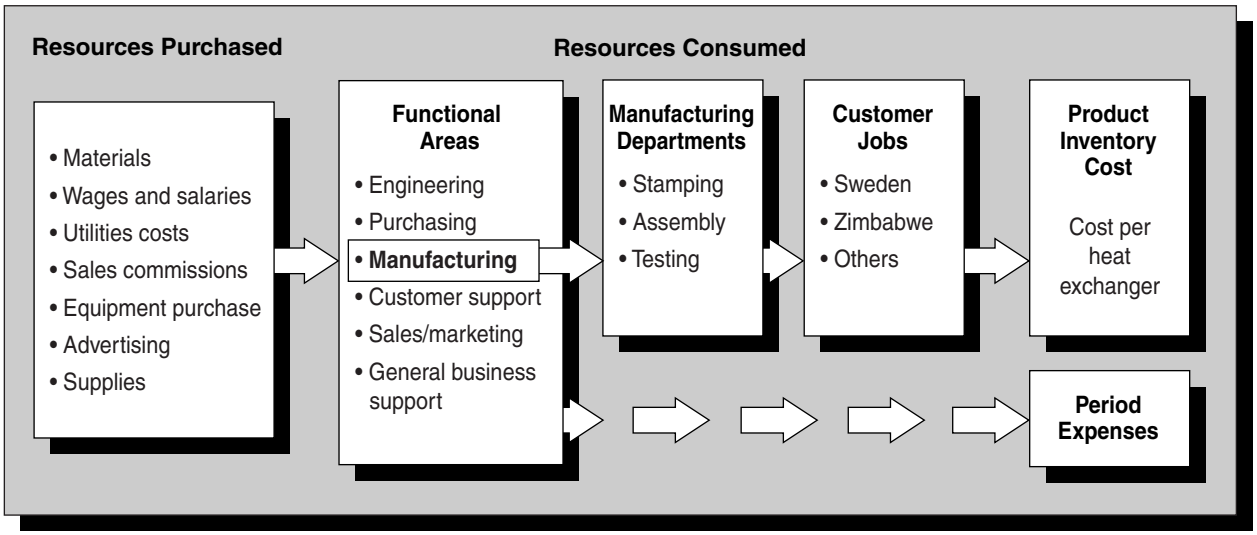
How can Alfa Laval determine the manufacturing cost of the heat exchangers for the two jobs?

As the box at the far left of Exhibit 2 shows, cost tracking starts when resources (materials, labor, machinery, buildings, etc.) are acquired by an organization. Resources purchased are originally recorded in the accounting records by cost elements (materials, wages, etc.).

[7] We use Alfa Laval and Robins for illustrative purposes only. All numbers are fictitious. The description here has been adapted for pedagogical purposes. We do not claim, nor are we attempting, to provide a detailed and accurate description of their cost systems. No criticism of their systems is implied by this illustration.

[8] To see a picture of a plate heat exchanger, visit Alfa Laval's website at http://www.alfalaval.com/alfalaval/therm/thhome1.htm.

Exhibit 2
Cost Flows in Traditional Job-Order Costing



The cost system then traces these costs to the intermediate building blocks of functional areas, departments, and jobs. In traditional systems only resources consumed in manufacturing a heat exchanger are part of the job cost and unit product cost. Other cost elements, such as sales and marketing and general business support, are called period costs and are not traced to jobs or products. Instead, they are treated as expenses on the income statement.

The first step, therefore, is to identify those resources that are used by the manufacturing function. In addition, the logic of responsibility accounting requires that resources consumed within manufacturing be traced to the specific responsibility unit that uses these resources. The responsibility units are often called cost centers. Often a cost center also represents an organizational department headed by a manager who is responsible for managing costs in that cost center. As Exhibit 3 shows, Alfa Laval's manufacturing function has three cost centers: stamping, assembly, and testing. All resources consumed by these cost centers are broken into those that can be uniquely traced to particular customer jobs (direct materials and direct labor) and those that are common (manufacturing overhead costs) and must be allocated to jobs.

Exhibit 3
Analysis of Manufacturing Costs by Departments and Cost Categories.

	Stamping	*Assembly*	*Testing*	*Totals*
Direct materials issued	$3,200,000	$1,200,000	$300,000	$4,700,000
Direct labor	250,000	750,000	150,000	1,150,000
Manufacturing overhead	1,625,000	4,875,000	975,000	7,475,000
Total costs	**$5,075,000**	**$6,825,000**	**$1,425,000**	**$13,325,000**

From production departments Alfa Laval's system traces costs to individual customer jobs. This step requires the use of job numbers. Assume that the Sweden job is assigned the number WE-046-12-061-97 (WE signifies western Europe, 046 is the country code for Sweden, 12 is the sales territory within Sweden, 061 is the customer number, and 97 is the year the job started). The Zimbabwe job number is SA-263-15-026-97.

Job numbers serve both as authorization codes and as the means of tracing costs to jobs. When materials are requisitioned, the requisition slips indicate the department and the job that requested the materials. Engineers record the time they spend on each job on their time sheets. Machine operators and workers pass machine-readable bar codes on their identification badges through a bar code reader each time they change from one job to another.

Manufacturing overhead costs are indirect with respect to individual jobs. These costs are allocated to the two jobs using any one of several common allocation methods. For the example in Exhibit 4, we have assumed that manufacturing overhead is charged to jobs using machine hours in the stamping and testing departments and direct labor hours in the assembly department. A predetermined rate is used to charge overhead to jobs, and the difference between actual overhead incurred in a period and the amount charged to jobs is charged to the cost of good sold account. A full explanation of the allocation of common and shared costs is beyond the scope of this module. It is the subject of two separate modules in this series.[9] Exhibit 4 shows the results of this process.

Exhibit 4
Analysis of Manufacturing Costs by Jobs

	Sweden Job WE-046-12-061-97	*Zimbabwe Job SA-263-15-026-97*	*Other Jobs*	*Totals*
Direct materials				
Stamping	$384,000	$192,000	$2,624,000	$3,200,000
Assembly	108,000	72,000	1,020,000	1,200,000
Testing	54,000	18,000	228,000	300,000
Direct labor				
Stamping	5,000	3,000	242,000	250,000
Assembly	5,000	26,250	718,750	750,000
Testing	24,000	16,500	109,500	150,000
Manufacturing overhead*				
Stamping	48,750	32,500	1,543,750	1,625,000
Assembly	292,500	146,250	4,436,250	4,875,000
Testing	97,500	29,250	848,250	975,000
Total job cost	$1,018,750	$535,750	$11,770,500	$13,325,000
Number of units	8	6	86	
Current status	In process	Complete		
Cost per unit	$127,344	$89,292		

* Allocated on the basis of direct labor hours and machine hours used by each job.

Note that the total cost assigned to jobs in Exhibit 4 ($13,325,000) is the same as the total manufacturing cost shown in Exhibit 3. Also note that the cost per heat exchanger in Exhibit 4 is $127,344 for the Sweden job and $89,292 for Zimbabwe job. Finally, the cost per unit is different for the two jobs. Alfa Laval has already spent $127,344 per unit ($1,018,750/8) for Sweden's incomplete job as compared to $89,292 (535,750/6) for the fully completed units for the Zimbabwe job. This is because they use different materials and have different work specifications.

The basic mechanism for tracking costs is the *chart of accounts*. A chart of accounts is a list of accounts, each with a unique code to allow easy recording and tracking of costs in a computerized database. Account codes provide the capability to distinguish manufacturing

[9] See the modules *Measuring and Managing Indirect Costs* and *Manufacturing Overhead Allocation—Traditional and Activity Based* in this series.

costs from other functional costs (see box 2 in Exhibit 2). The chart of accounts and codes also allow costs to be traced to individual departments within the manufacturing function (box 3 of Exhibit 2) and to individual jobs and units produced (boxes 4 and 5 in Exhibit 2). The design of the chart of accounts is a key activity in the development of a cost measurement system. Appendix A discusses the logic of account codes and shows the flow of costs between accounts in greater detail.

Think Along

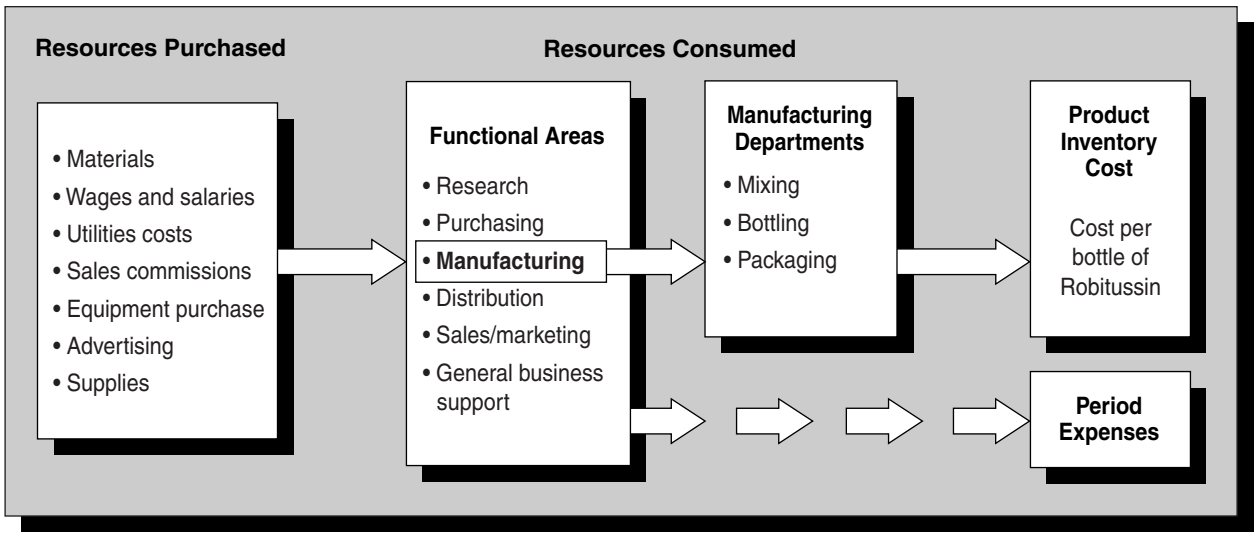
How would our costing approach change if the heat exchangers in all jobs had identical specifications?

Process Costing at Robins.

If all jobs had identical specifications, there would be no reason for Alfa Laval to separately track the costs of each individual job. The cost per unit could be computed simply by dividing the total cost in each department by the total number of units produced in that department. For example, the total cost in stamping is $5,075,000 (see Exhibit 3). The total number of units worked on in stamping is 100 (8 + 6 + 86 as shown in Exhibit 4). Because all 100 units are identical and assuming they have all been stamped and transferred to assembly, the stamping cost per unit for the heat exchanger is $50,750 ($5,075,000 ÷ 100 units). The total cost per heat exchanger would be the sum of the cost expended in all three operations.

This averaging of cost across processes is essentially what happens in our second example firm, A.H. Robins. Robins's production runs are much larger than Alfa Laval's and all units in a run are identical. A single production run may produce 2,500,000 tablets or 150,000,000 bottles of cough syrup, each exactly like the others in the batch. The processing time for various products ranges from two days to five months. The major processing steps are mixing, bottling, and packaging. Exhibit 5 below graphically represents the flow of costs in a traditional process costing system.

Exhibit 5
Cost Flows in Process Costing



Compare Exhibit 5 with Exhibit 2, which portrays Alfa Laval's job-order costing system. In both Alfa Laval's job costing system and Robins's process costing system, the first two steps are the same—costs are traced to functional areas of the firm and then to departments within these areas. Unlike Alfa Laval's customers, however, the individuals who purchase Robins's products expect no custom features, and Robins uses identical ingredients and processes for every bottle of cough syrup.[10] Therefore, the cost per unit does not vary from customer to customer, as was the case for Alfa Laval's heat exchangers, and Robins's cost measurement system can omit the step of tracing costs to individual customers or jobs. This situation greatly simplifies the design of the cost measurement system because fewer levels of building blocks are needed. Exhibit 6 shows the cost tracking for Robins. Note that Exhibit 6 is exactly the same as Exhibit 3 for Alfa Laval, except that for Robins the processing departments are mixing, bottling, and packaging.

Exhibit 6
Product Cost in Process Costing—Robitussin Cough Syrup

	Mixing	*Bottling*	*Packaging*	*Totals*
Direct materials	$1,200,000	$340,000	$700,000	$2,240,000
Direct labor	50,000	40,000	80,000	170,000
Manufacturing overhead	780,000	520,000	510,000	1,810,000
Total cost	**$2,030,000**	**$900,000**	**$1,290,000**	**$4,220,000**

Assume that the total processing costs of $4,220,000 is for producing 5,000,000 bottles of Robitussin cough syrup. Because all bottles are identical, we can obtain the cost per bottle of Robitussin by dividing $4,220,000 by 5,000,000 bottles to get $ 0.844 per bottle for this batch of the cough syrup. In addition, if we assume no spoilage or shrinkage, we can divide the cost of each processing center by 5,000,000 to obtain the processing cost per bottle in each processing center. You may recall from the opening story of the module that Robins's management was concerned that the cost per bottle was increasing in the mixing department. You can see that the computed cost of $0.406 per bottle in mixing ($2,030,000 ÷ 5,000,000) is the basis for this concern.

Inventory Issues in Traditional Cost Systems.

Product cost calculations in a traditional system rarely are as simple as those described for Robins, particularly in mass production environments. Long production cycle times and inventory buffers are two key characteristics of mass production systems. Accordingly, traditional systems have large amounts of raw materials, work-in-process, and finished-goods inventories. *Work-in-process* (WIP) means that there will always be some partially completed units in each process at the end of a period. That is, some cough syrup will be boiling, some will be bottled, and some will be packaged at the end of an accounting period.

Traditional job and process costing systems deal with this problem of work-in-process inventories by computing what are called **equivalent units of output**. An equivalent unit is a way of equating partially completed and fully completed units. Assume for example that Alfa Laval had four heat exchangers that were started at the beginning of the period and that no heat exchangers were in process at the beginning. At the end of the period, two exchangers are finished, and two are half finished. We can treat the two half-finished units as one finished unit

[10] In fact, once the Food and Drug Administration approves a product recipe, Robins *may not* alter the formulation.

and add them to the two fully completed units. Now we can say that Alfa Laval has three equivalent finished units. Because two out of three equivalent units are complete, two-thirds of the total cost for the period represents finished goods and one-third represents the cost of work-in-process.

Think Along

> What does *half finished* mean? How did we determine that the heat exchanger is half finished? How do we test whether the cost calculation makes sense?

The concept of equivalent units is based on costs to completion and not time or physical completion. A 50 percent complete unit means that one-half of the costs have been incurred. It does not mean that the unit is physically half complete or that 50 percent of the time to completion remains. These concepts of completion are important, but they are not the way accountants use the term *equivalent units*. Although these other concepts of completion may be related to cost, this is not always the case. For example, in home construction the most expensive items are finishing items (plumbing fixtures, electrical fixtures, appliances, doors, cabinets, etc.). They represent more than 35 percent of the cost but take up only 20 percent of the construction time.

To check the logic of equivalent units, let us return to the Alfa Laval example of the four heat exchangers. Assume that the total cost incurred on these heat exchangers is $450,000. Because we computed the output to be three equivalent units [2 + 2 (.5)], the cost per equivalent unit is $450,000 ÷ 3 = $150,000. Also, we know that two units are complete and have been transferred to the finished goods inventory. The transfer cost was $300,000 (2 × $150,000) and, therefore, work-in-process is $150,000. Because the $150,000 represents two (50 percent complete) units, each unit has a cost of $75,000. Completing these half-finished units, by definition, should require another $75,000 each. Thus when complete, all four heat exchangers will have the same per unit cost of $150,000.

In Robins's case, departments will have units in process from the last period (beginning work-in-process) and units in process at the end (ending work-in-process). Assume that during the current period, the mixing department started work on 5,300,000 bottles. In addition, it had 300,000 units in beginning work-in-process that were 40 percent completed last period. During the period, mixing transferred out 5,200,000 units to bottling. The remaining 400,000 units (300,000 + 5,300,000 − 5,200,000) in ending work-in-process are 70 percent complete. Exhibit 7 summarizes this data for the mixing department at Robins.

> Compute the cost per bottle transferred from mixing to bottling.

Exhibit 7
Equivalent Units Processed by Mixing Department

	Units Produced	*Completion Stage*
Bottles in process at beginning of period	300,000	40% complete
Bottles started this period	5,300,000	
Number of bottles transferred to next department	5,200,000	
Bottles in process at end of period	400,000	70% complete

Exhibit 8
Equivalent Units of Output for the Mixing Department

Bottles	*Equivalent Units—FIFO*		*Equivalent Units—Weighted Average*	
Beginning WIP	180,000	(300,000 × (1−.6)	300,000	
Started and finished (5,300,000 − 400,000)	4,900,000		4,900,000	
Ending WIP	280,000	(400,000 × .7)	280,000	(400,000 × .7)
Total	**5,360,000**		**5,480,000**	

The mixing department had 300,000 bottles on which 40 percent of the cost had been incurred. This period, to complete these bottles, they incurred the other 60 percent or the equivalent of 180,000 bottles. The department started another 5,300,000 bottles, bringing the total to 5,600,000. At the end mixing has 400,000 bottles still in process that are 70 percent complete. Therefore, 4,900,000 were started and completed during the period (5,200,000 − 300,000), and the equivalent of another 280,000 complete bottles (400,000 × .70) are still in process. The mixing department, therefore, completed work on 5,360,000 equivalent bottles this period. This procedure, which separates the percentage of completion of both beginning and ending work-in-process, is called the *first-in-first-out (FIFO)* method.

A more common method for dealing with percentage of completion is called the *weighted-average method*. This method ignores the percentage of completion of the beginning work-in-process. These units are combined with the units started and completed this period. The 70 percent completed ending work is added to the 5,200,000 units transferred to yield 5,480,000 equivalent units. Exhibit 8 shows the computation of equivalent units of output for the mixing department under the two methods.[11]

Assuming the use of the weighted-average method, the information on equivalent units can be combined with the cost information from Exhibit 6 to determine the cost per equivalent unit for each cost element, as shown in Exhibit 9.

Exhibit 9
Calculation of Cost per Equivalent Unit

Cost Element	*Amount*	*Equivalent Units Produced*	*Cost per Equivalent Unit*
Direct materials	$1,200,000	5,480,000	$0.219
Direct labor	50,000	5,480,000	0.009
Manufacturing overhead	780,000	5,480,000	0.142
Total	**$2,030,000**		**$0.370**

Test your understanding of the concept of equivalent units of production by calculating the equivalent units for the bottling department. Assume the following: Beginning work-in-process inventory is 245,000 units, 30 percent complete; and ending work-in-process inventory is 240,000 units, 60 percent complete. During the current period bottling started work on another 5,200,000 units and completed and transferred 5,205,000 to packaging. (The answer is provided at the end of the module.)

[11] A full discussion of these methods is contained in the forthcoming advanced module on *Process Costing* in this series.

The concept of equivalent units has wide applicability. In addition to manufacturing, equivalent unit computation is relevant to service industries that have long production cycles. As college students you have may have completed two out of your four years toward a bachelor's degree at this point. From a cost perspective you are now a 50 percent equivalent finished student. Similarly, some students in your class may be full-time students, and others may be part-time students. Colleges compute their student load by adding these students through a unit called the "full-time equivalent" (FTE). Since 15 credit hours is a full-time load, two students, one with 9 credit hours and the other with 6 credit hours, will be counted as one full-time-equivalent student. In a class, however, the one equivalent student occupies two physical seats. Similarly, two students starting their junior year do not add up to one college degree. Ten half-completed planes, with only one wing attached, may be equal to five equivalent planes, but none of the planes can fly!

Key Point

An equivalent unit is simply a way to account for two physically dissimilar units by adding together their common denominator, costs. It should not be confused with physical completion.

Weaknesses in Traditional Job Cost Systems.

Think Along

Do the job and process cost calculations provide the information that managers at Alfa Laval and Robins need to better manage resources and to service their customers?

The costs traced to the two jobs in Exhibits 2, 3, and 4, and the cost per bottle in Exhibit 9 provide limited management insight for two main reasons.

First, total job cost and the per unit product cost of $1,018,750 and $127,344 respectively, for the Sweden job and $535,750 and $89,292 for the Zimbabwe job are neither the total cost of serving these customers nor do they represent total product cost. They are only manufacturing costs. Substantial costs incurred in other areas, such as marketing, distribution, and business support, are not included as part of the job cost. Hence the job cost calculated in this way is not the total cost of servicing a customer. The same is true for the cost per bottle of $0.37 for Robins.

Second, indirect costs account for a significant portion of the production costs in the two companies. For Alfa Laval manufacturing overhead costs account for 56 percent of total manufacturing costs (manufacturing overhead of $7,475,000/13,325,000 = .56). Single-driver allocation systems (direct labor or machine hours) used by many traditional systems to allocate indirect costs can provide a very misleading view of product cost and profitability. In addition, such single allocation systems do not provide any information about cost drivers—that is, those factors that explain what causes costs to change. Thus management has very little information to assess whether the amount of resources consumed by a customer is excessive and how to better manage these costs.

Remember how the managers in our opening story lamented the lack of information to manage costs proactively and strategically. You can begin to see why.

▲ CONTEMPORARY COST MEASUREMENT SYSTEMS

Traditional cost systems are not suited to the needs of today's competitive business environment. In particular, the advent of lean manufacturing systems, the use of Total Quality Management (TQM) techniques, and increasingly intense competition has greatly reduced the usefulness of traditional cost measurement systems.

Lean manufacturing systems use just-in-time systems and have little or no inventory. This system diminishes the usefulness of inventory valuation as a function of the cost measurement system and greatly simplifies the accounting part of the costing function because there are no work-in-process inventories and equivalent units to track.

TQM emphasizes cross-functional management of processes rather than department-based management systems. It reduces the need for responsibility accounting by departments and emphasizes instead cost management through redesign of products and processes. Cost tracking by departments does not help process management.

Finally, the competitive environment requires managers to think more strategically about how cost measurement systems can help an organization to compete effectively and to achieve its strategic goals.[12] This environment requires understanding cost drivers so costs can be managed proactively rather than reactively.

Contemporary cost measurement systems, therefore, emphasize the measurement of all costs and not just manufacturing (inventory) costs. Consistent with the process focus, contemporary cost systems use activities and operations as critical cost objects in building a cost measurement system. They also provide better information to help managers understand what drives the costs of each step in the process of developing, producing, and delivering products to customers. By analyzing costs at the detailed level of activities and operations involved in the cross-functional flow of work, these newer systems make visible how activities in one processing step may affect costs at other processing steps, thus enhancing the visibility of cost-driver relationships.

There are four important differences between traditional and contemporary approaches to cost measurement. A contemporary system:

- ▲ Provides comprehensive product cost information by including in product cost not only manufacturing costs but the costs of all activities and operations that create, produce, deliver, and support the product or service. This includes both preproduction (upstream) costs and postproduction (downstream) costs.
- ▲ Emphasizes management of the activities and operations that make up the process rather than the department that performs the work.
- ▲ Allocates indirect costs to activities/operations and from there to products rather than from responsibility centers to products.
- ▲ Supports strategic cost management by making cost driver relationships visible as opposed to emphasizing external financial reporting.

One of the more important types of contemporary cost measurement systems is an activity/operations costing system. The focus of this system is on the total product cost (not just manufacturing costs). Its key building blocks are activities and operations that constitute the major cross-functional processes.[13]

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[12] This is one of the fourteen principles Total Quality enunciated by Edwards Deming, the leader of the quality movement.

[13] An *activity* is a series of related tasks performed by a person. An *operation* is a series of tasks performed by a piece of machinery. The distinction is not always clear, and the boundary between the two is somewhat fuzzy.

Think Along

How will Alfa Laval or Robins need to modify its cost measurement systems to adopt this new approach?

Alfa Laval—An Activity and Operations Costing View.

To convert Alfa Laval's traditional job costing system into an activity/operations costing system, we must start by developing a *process map*, which is a graphic representation of the sequence of activities/operations that must be performed to produce a heat exchanger. The heat exchangers in the two customer jobs examined earlier go through many activities and manufacturing operations. These activities involve all functional areas of the organization. Exhibit 10 is an abbreviated process map of some of the major activities/operations required by the two customer jobs.

Exhibit 11 identifies the functional area that has primary responsibility for each activity. Note that the various activities and operations involve all the functional areas and departments at Alfa Laval. Although we have kept this example simple, in practice many of the activities also cut across functional boundaries and involve several functions. A good example is drafting a contract. The legal, sales, engineering, and manufacturing departments all participate in this activity.

Each activity/operation consumes resources. The cost differences across jobs result from the fact that the various jobs require different activities and therefore consume different amounts of resources. To compute the cost of the two customer jobs, we must perform the following steps:

1. Identify activities and operations used by each job.[14]
2. Compute the costs of these activities and operations (including both direct and indirect costs).
3. Determine the cost drivers for each activity/operation.
4. Combine costs of activities that have common drivers into cost pools.
5. Assign costs to jobs based on the drivers each job consumes.
6. Determine unit product cost.

We can illustrate this six-step process using a sample of the activities identified in Exhibits 10 and 11.

1. Identify activities/operations used by jobs.

Notice that the completion of this job requires activities and operations in many areas of the organization. Substantial resources are required to support the activities performed by marketing personnel in visiting the prospective customer, by engineering personnel in developing product specifications, and by customer support personnel in the installation at the customer site. These activities are essential to complete the process of providing a heat exchanger to a customer, but traditional job-order costing systems do not treat these as part of the cost of heat exchangers. Costs of these activities must be included, however, to understand the full cost of the job. To understand why the cost of the Sweden job differs from the cost of other jobs, management needs to analyze which activities are unique to this job.

[14] Methods of documenting activities and computing their costs are discussed in detail in the modules *Activity-Based Management* and *Manufacturing Overhead Allocations—Traditional and Activity Based* in this series.

Exhibit 10
Abbreviated Process Map for Alfa Laval's Customer Jobs

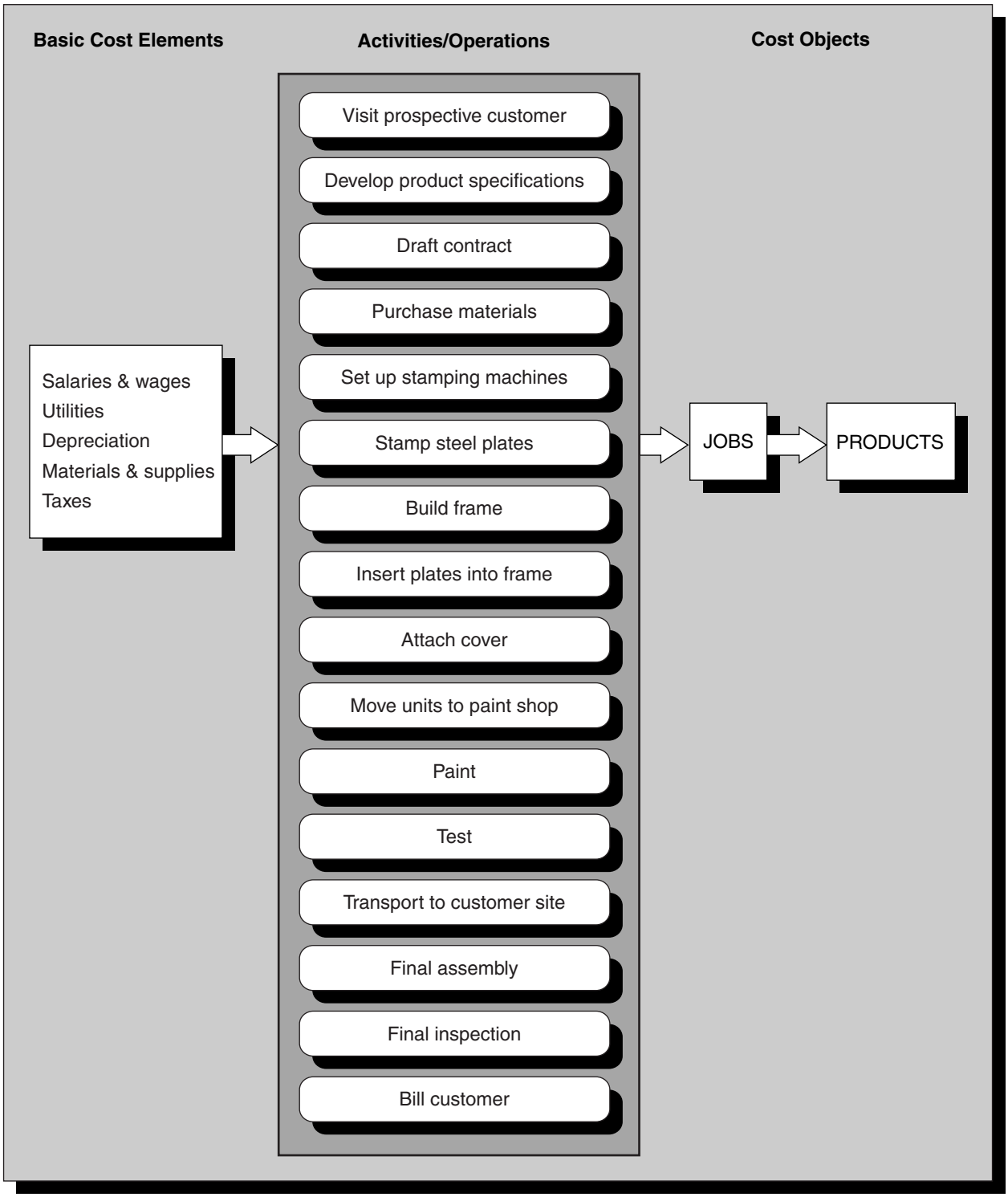

Exhibit 11
Activities/Operations for Alfa Laval's Customer Jobs

Activity or Operation in the Process	*Functional Area with Primary Responsibility*
Visit prospective customer	Sales and marketing
Develop product specifications	Engineering
Draft contract	Legal
Purchase materials	Purchasing
Set up stamping machines	Stamping
Stamp steel plates	Stamping
Build frame	Assembly
Insert plates into frames	Assembly
Attach cover	Assembly
Move units to paint shop	Assembly
Paint	Assembly
Test	Testing
Transport to customer site	Customer support
Final assembly	Customer support
Final inspection	Customer support
Bill customer	General administration
Other activities	Various

2. Compute the costs of the activities and operations.

Each activity uses resources such as people, materials, factory space, and other cost items. Some cost items, such as operator salaries and supplies, are traceable to particular activities and operations. Other costs, such as property taxes on buildings, are indirect and have to be allocated to activities/operations based on *resource-usage drivers* such as square feet of space required by an activity. Exhibit 12 shows the results of this analysis for Alfa Laval.[15]

Exhibit 12
Activity Costs for Heat Exchangers

Activity or Operation	*Cost*
Visit prospective customer	$83,600
Develop product specifications	608,000
Draft contract	270,000
Purchase materials	288,000
Set up stamping machines	1,176,000
Stamp steel plates	3,952,000
Build frame	756,000
Insert plates into frames	5,040,000
Attach cover	126,000
Move unit to paint shop	9,000
Paint	480,000
Test	770,000
Transport to customer site	910,000
Final assembly	702,000
Final inspection	504,000
Bill customer	8,400
Other activities	87,000
Total activities cost	**$15,770,000**

[15] How to document and obtain the cost of activities is discussed in detail in the *Activity-Based Management* module in this series.

Exhibit 13
Activity Cost per Unit of Cost Driver

Activity or Operation	*Cost*	*Driver*	*Units of Driver*	*Cost per Unit of Driver*
Visit prospective customer	$ 83,600	Number of trips	22	$3,800
Develop product specifications	608,000	Engineering hours	3,800	160
Draft contract	270,000	Legal staff hours	1,800	150
Purchase materials	288,000	Per purchase order	2,400	120
Set up stamping machines	1,176,000	Per production run	120	9,800
Stamp steel plates	3,952,000	Per machine hour	520	7,600
Build frame	756,000	Per component	420	1,800
Insert plates in frames	5,040,000	Per plate	6,300	800
Attach cover	126,000	Attachment points	2,100	60
Move to paint shop	9,000	Per unit	120	75
Paint	480,000	Surface area, sq. ft.	32,000	15
Test	770,000	Per test	275	2,800
Transport to customer site	910,000	Per trip	140	6,500
Final assembly	702,000	Per unit	120	5,850
Final inspection	504,000	Per unit	120	4,200
Bill customer	8,400	Per bill	28	300
Other activities	87,000			
Total activities cost	**$15,770,000**			

3. Determine cost drivers for each activity and operation.

The accountant must work closely with personnel in other areas of the organization to determine what causal factors increase or decrease the cost of an activity. These causal factors are referred to as "cost drivers." Identifying the cost driver for the activity "developing product specifications," for example, may require talking to design engineers, sales people, manufacturing engineers, machine operators, quality assurance, installers, service engineers, and cost analysts. The analysis may reveal that the number of engineering hours consumed is the cost driver for this activity. The next step is to divide the cost of the activity by the number of engineering hours consumed to determine the activity/operation cost per unit of the driver. This analysis is shown in Exhibit 13.

Although this type of first-level cost driver is sufficient for assigning activity costs to heat exchangers, Alfa Laval may find it useful to conduct additional levels of analysis for cost management purposes. Exhibit 13 shows that using one more engineering hour for developing product specifications increases cost by $160. To manage engineering costs, however, they need to know what causes engineering hours to go up. For example, the heat exchangers being produced for Sweden must withstand severe winter weather and operate under various climatic conditions in the plant. Accordingly, engineering personnel have to spend additional time researching how to make existing components operate under different environmental conditions. Engineering hours, therefore, are being driven by the "variety of operating conditions" under which the heat exchanger must perform.

To manage the cost of engineering hours consumed, Alfa Laval must go beyond the obvious cost drivers and understand the deeper levels of cost drivers.

4. Create cost pools for common cost drivers.

Some cost drivers may be common to several activities. Consider, for example, the activities "final assembly" and "final inspection." The cost driver for both activities is "number

Exhibit 14
Alfa Laval—Costs Assigned to Jobs

Activity	Sweden Job WE-046-12-061-97		Zimbabwe Job SA-263-15-026-97	
	Units of Cost Driver	*Cost Assigned*	*Units of Cost Driver*	*Cost Assigned*
Visit prospective customer	4	$15,200	1	$3,800
Develop product specifications	1,400	224,000	300	48,000
Draft contract	18	2,700	4	600
Purchase materials	240	28,800	90	10,800
Set up stamping machines	11	107,800	3	29,400
Stamp steel plates	22	167,200	8	60,800
Build frame	38	68,400	25	45,000
Insert plates into frames	280	224,000	95	76,000
Attach cover	122	7,320	90	5,400
Move unit to paint shop	14	1,050	6	450
Paint	3,800	57,000	825	12,375
Test	18	50,400	6	16,800
Transport to customer site	0	0	2	13,000
Final assembly	0	0	6	35,100
Final inspection	0	0	6	25,200
Bill customer	0	0	1	300
Total activities cost		**$953,870**		**$383,025**

of units." To simplify calculations, the costs associated with these two activities can be combined and treated as a single cost pool for allocation purposes. Aggregating costs by common cost drivers highlight those cost drivers that account for a significant portion of costs and thus helps to focus cost management efforts on the correct variables.

5. Assign costs based on drivers.

The next step is to assign costs to jobs based on the drivers consumed. Exhibit 14 shows this analysis as well as the calculation of cost per unit for each job.

6. Determine unit product cost.

The determination of unit product cost requires adding the cost of specific materials issued for each job to the cost of each activity or operation consumed by that job and dividing by the number of equivalent completed units in that job. Exhibit 15 shows this analysis and compares it to the traditional cost analysis for these same jobs.

Exhibit 15
Comparison of Job Cost

	Sweden		Zimbabwe	
	Total Job Cost	*Cost per Unit*	*Total Job Cost*	*Cost per Unit*
Activity/operations view				
Materials cost	$546,000	$68,250	$282,000	$47,000
Activities cost	953,870	119,234	383,025	63,838
Total cost	$1,499,870	$187,484	$665,025	$110,838
Traditional view				
Direct materials	$546,000	$68,250	$282,000	$47,000
Direct labor	34,000	4,250	45,750	7,625
Manufacturing overhead	438,750	54,844	208,000	34,667
Total cost	**$1,018,750**	**$127,344**	**$535,750**	**$89,292**

Notice that the activity/operations costs for the two jobs ($1,499,870 for Sweden; $665,025 for Zimbabwe) is substantially greater than that derived by Alfa Laval's traditional job order system ($1,018,750 for Sweden; $535,750 for Zimbabwe).

Think Along

> Why is the cost per unit from the contemporary cost measurement system shown here different from the cost per unit determined by the traditional job-order costing system?

You may recall that the traditional cost measurement system described in Exhibits 3 and 4 includes only manufacturing costs. A contemporary activity/operations cost system traces all costs from other functional areas, such as engineering and customer support, and assigns these costs to jobs based on the usage of these activities.

Robins—An Activity and Operations Costing View.

Like Alfa Laval, Robins can use the six steps described above to make their cost system more consistent with the contemporary activity/operations-based approach. Because all the steps, with the exception of tracing costs to jobs, are the same as for Alfa Laval, we will not illustrate them again in detail. Exhibit 16 provides an example of the final numbers that Robins's contemporary cost system might produce.[16]

Think Along

> The mixing cost of a bottle of Robitussin as calculated by the activity-based analysis is $0.28. Why is this value different from the mixing cost per bottle of $0.37 shown in Exhibit

The main difference between the costs shown in Exhibit 9 and those shown below (Exhibit 16) is due to the allocation of manufacturing overhead costs. In a traditional system all manufacturing overhead is first charged to the three processing centers and then to products. In an activity-based system, the overhead costs are charged first to activities and then to products.[17]

Also note that Robins's new cost system shown in Exhibit 16, provides an analysis of costs by traditional categories as well as by activities/operations and by cost drivers. This "kaleidoscopic view" of costs allows Robins to see the $2.05 cost per bottle of Robitussin cough syrup in many ways. The first is by type of resources consumed—that is, materials, wages, supplies, utilities, equipment, and so on. Next it also shows cost by activities. Finally, Robins can also see costs by drivers.

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[16] Exhibit 16 has been adapted from an article on Teva Pharmaceutical Industries Ltd., which describes its experience in developing an activity-based cost system. The article supports our hypothetical example by showing how in the real world a company in the same business as Robins can use an activity/operations costing system. See Robert Kaplan, Dan Weiss and Eyal Dinesh, "Transfer Pricing with ABC," *Management Accounting*, May 1997, pp. 20–28.

[17] For a detailed discussion of why differences in allocation systems result in different cost assignments, see the module *Manufacturing Overhead Allocation: Traditional and Activity Based* in this series.

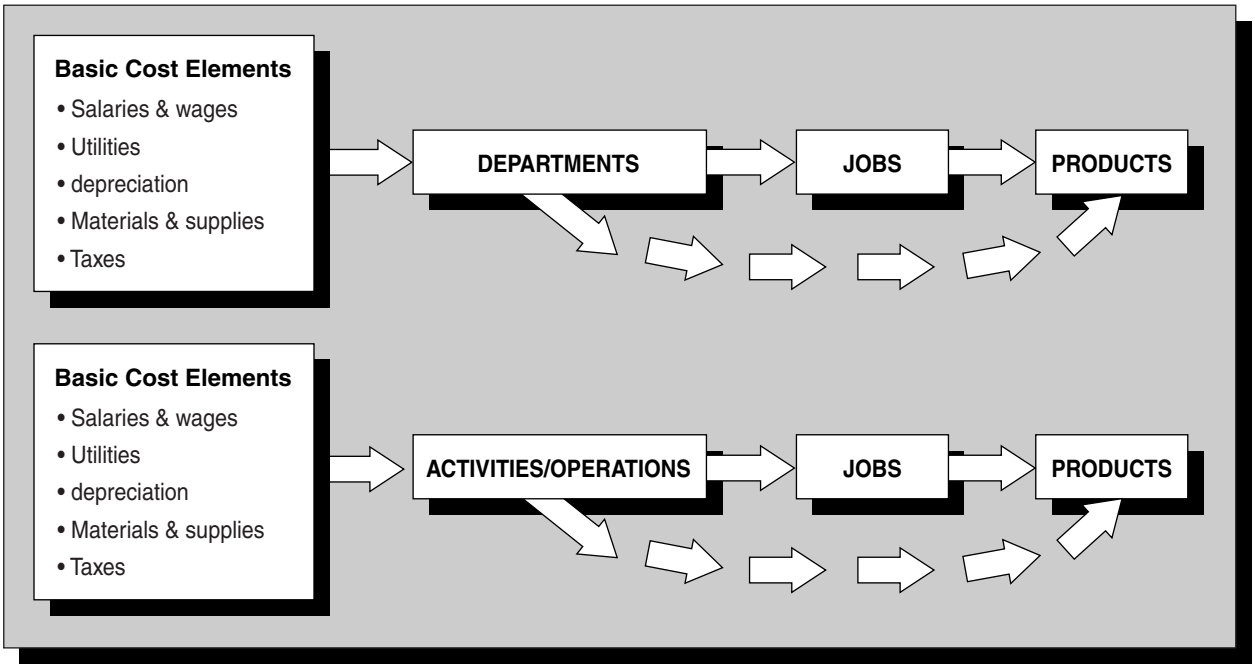
Exhibit 16
Sample Cost Breakdown for Robitussin Using a Contemporary Cost System

Classification	*Cost*	*Classification*	*Cost*
By Resources:		**By Activities:**	
Materials	$0.42	Develop customer relations	$.04
Labor	0.03	Process orders	.02
Manufacturing overhead		New product development	.34
Supplies	0.02	Purchase chemicals	.06
Utilities	0.06	Secure storage	.04
Wages	0.14	Issue chemicals to production	.02
Equipment	0.10	Print cartons	.09
Other	0.02	Mixing	.28
Subtotal	0.34	Bottling	.23
Other costs		Packaging	.35
Shipping supplies	0.04	Quality assurance	.06
Utilities	0.05	Equipment maintenance	.25
Salaries	0.90	Move to storage	.02
Equipment	0.07	Distribution	.03
Other	0.20	Billing	.22
Subtotal	1.26	**Total**	**$2.05**
Total	**$2.05**		
By Cost Drivers:			
Customer calls	$.07		
Purchase orders	.03		
Engineering hours	.31		
Material moves, secured	.11		
Material moves, unsecured	.02		
Production runs	.35		
Number of colors	.13		
Machine hours	.67		
Number of bottles	.33		
Number of bills	.03		
Total	**$2.05**		

Comparison of Traditional and Contemporary Cost Systems.

Traditional and contemporary cost measurement systems are built on fundamentally different conceptual foundations. A traditional cost system uses responsibility centers (commonly defined as departments or functional areas of the firm) as a key cost object in tracking cost flows. A contemporary cost system uses activities/operations as intermediate cost objects to trace costs to final cost objects. It assigns costs to final cost objects based on cost drivers and provides multiple views of costs—by resources consumed, by activities consumed, and by drivers consumed. The contemporary approach facilitates

Exhibit 17
Cost Flow Differences between Traditional (top) and Contemporary (bottom) Cost Systems



cost management by making these various causal relationships visible to managers. Exhibit 17 shows the differences in cost flows between these two approaches.

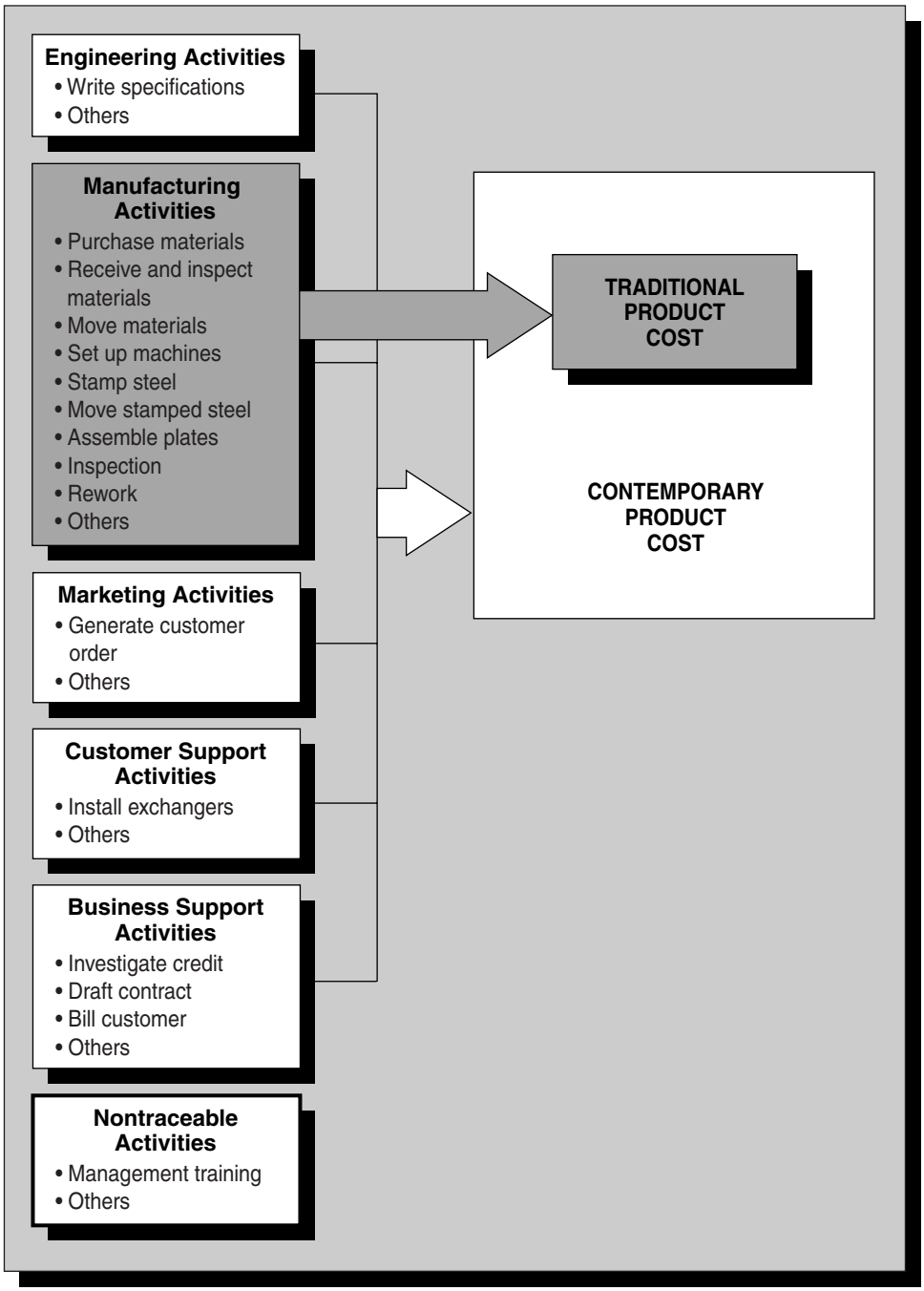
Another important difference is that the two systems define product costs differently. Exhibit 18 below shows this difference. A traditional system, the shaded portion of Exhibit 18, includes only manufacturing and manufacturing support costs in product costs. A contemporary system includes, in addition, the cost of all traceable activities in computing per unit product cost. Some costs, such as management training or the costs of operating corporate headquarters, are so distant from any specific product that both types of systems may choose not to trace them to products. However, by including these other costs, a contemporary cost system enhances the visibility of nonmanufacturing costs and provides a more comprehensive view of a job's profitability.

This difference between the two approaches represents the difference between generally accepted accounting principles (GAAP) and managerial use of accounting data. GAAP has a more restrictive definition of what can be included in product cost. An activity-based system allows many more costs to be directly identified with products. It is interesting to see whether GAAP rules will change to allow more costs to be part of product cost.[18]

A third difference between the two systems is that activity-based systems focus attention on the process of work rather than on who does the work. The contemporary system tells Alfa Laval's management that the most expensive activities are inserting plates in frames, and stamping steel plates.

[18] It is interesting to note that the income tax treatment is also different from GAAP. Many other costs, such as interest, treated as an expense by GAAP must be capitalized in determining product costs for tax reporting.

Exhibit 18
Product Cost Buildup—Traditional and Contemporary



Finally, the contemporary system provides comprehensive product cost information by functions, resources, activities, and cost drivers. The information on cost drivers is particularly useful in managing and redesigning work processes. For example, the data in

Exhibit 16 facilitates effective cost management in several ways. The resource breakdown shows Robins that its single largest cost category is general and administrative salaries, which total roughly 44 percent of the total product cost of $2.05. The activity analysis shows packaging and new-product development are the two costliest activities. Finally, analysis of costs by drivers shows machine hours and production runs are the most significant cost drivers for Robins, accounting for 65% of the product cost for Robitussin. The cost management strategy for Robins should be to reduce materials price and usage, search for ways to better perform new product development and packaging activities, and reduce the number of machine hours used if possible.

Although the contemporary cost measurement system expands the definition of costs, it is still not a complete picture of all costs incurred to serve a customer. What a customer pays for Robitussin includes costs incurred by firms that provide or receive services from Robins. They are part of the value chain of suppliers and dealers that enable the cough syrup to get to the final consumer. Few cost measurement systems in use today track such costs, partly because of the practical problems associated with analyzing costs incurred by different organizations. However, a large part of the reason is a lack of trust that makes organizations reluctant to share cost information with others.

Key Point

Although many costs are traceable to products, under current GAAP many such costs cannot be included as inventory cost on the balance sheet. In an activity/operations costing system, each discrete *activity* and each *manufacturing operation* become cost objects. The product cost includes many activities and operations that are traceable to products.

▲ ATTRIBUTES OF A COST MEASUREMENT SYSTEM

A well-designed cost measurement system must have desirable technical, behavioral, and cultural attributes.

Technical Attributes.

A cost measurement system should improve the quality of management decisions and enhance their process understanding to facilitate process management.

Decision relevance.

For a cost system to provide information relevant to management's decisions, cost objects must be related to the strategic objectives of quality, cost, and time. For example, cost measurement systems must help managers understand the costs associated with providing existing levels of quality and estimate costs of adding features desired by their customers. The following quote from a manager at Hewlett-Packard's circuit board assembly plant in Palo Alto, California, reflects the expectations of managers with regard to their cost measurement systems.

> We expect our cost system to do more than just allocate costs and produce reports. We need to know what drives these costs. We want the cost system to talk to our design engineers so they can carry their understanding of costs into product designs that are cost-effective to produce.

Note that at Hewlett-Packard the test of a good system is its ability to improve product design decisions. The cost system aids engineers in designing better products by showing them how design decisions drive product costs. We have seen in this module that traditional systems are of little help in proactively managing costs, since they focus on departments and not on cost drivers. The contemporary approach's focus on cost drivers improves decisions about where to spend managerial time and what areas to focus on.

Process understanding.
A good cost measurement system must help managers to understand their work processes and the economic impact of activities or operations that reduce quality, increase cost, or cause delays. This feature is a major strength of the contemporary cost systems. Their primary focus is work operations and activities. As we have seen, their starting point is a process map (Exhibit 10). Contemporary systems can readily extend the analysis to include all value chain activities, thereby providing a more comprehensive process view than a system constrained by the departmental boundaries of a single organization. Finally, the cost impact of manufacturing and innovation cycle time are not made visible by traditional systems. By emphasizing costs across all steps in a process, a contemporary cost measurement system can reveal which activities or operations cause delays and thus cause cost increases.

Behavioral Attributes.

Cost measurement systems can affect behavior of people in organizations in many ways. The selection of cost objects can be a particularly important means of changing behavior in organizations because a cost object makes the selected variable *visible*, *focuses attention*, and *communicates* managerial intent. When selected carelessly, the cost system can lead to dysfunctional behaviors.

Consider the use of DRGs as cost objects by hospitals. Many industry observers claim that this shift has made hospitals play games to provide proper health care to patients. Hospitals sometimes discharge and then readmit patients under a different DRG to complete the treatment for a single episode or ailment when a patient's length of stays exceeds that permitted by a DRG. Similarly, state colleges measure costs based on equivalent full-time students. Some critics charge that this method of measuring and funding state colleges has led to overcrowding in the classroom.

Another way in which cost measurement systems can change behaviors is through highlighting cost drivers. Cost driver analysis can focus attention on managing the right variables and can also help to communicate efficient and better design rules and practices. As the Hewlett-Packard quote points out, many world-class organizations use their cost measurement system to communicate with design engineers about how to develop better and more cost-effective product and process designs.[19] They do this by penalizing designs that consume more of critical cost drivers. This approach forces designers to explicitly consider cost as an important variable in putting features and functions into products and in choosing the processes to produce and deliver these products.[20]

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[19] For example, see D. Berlant, R. Browning, and G. Foster, "How Hewlett-Packard Gets Numbers It Can Trust," *Harvard Business Review*, Jan-Feb 1990, pp. 178–183 and T. Hiromoto, " Another Hidden Edge—Japanese Management Accounting," *Harvard Business Review*, July-Aug 1988, pp. 22–26.

[20] The *Target Costing* module in this series discusses cost management in the product design phase in greater detail.

A well-designed cost measurement system uses the selection of cost objects and cost measurement rules as an opportunity to reinforce behaviors that lead to the accomplishment of strategic objectives. When properly selected, that cost object will make visible customer requirements throughout the organization, reduce product costs, and decrease cycle time for manufacturing, innovation, or delivery.

Cultural Attributes.

A cost measurement system both reflects and reinforces an organization's culture. In an organization where finding fault and laying blaming are a pervasive *mind-set*, the cost measurement system becomes a tool toward that end. Traditional systems, in general, are more susceptible to this because they are responsibility-focused, and therefore encourage the tendency to assign blame. They reinforce the role of the accountant as a corporate cop. On the other hand, activity systems have a process focus. They encourage improving processes by looking for underlying causes of changes in costs. By focusing on cost drivers and cross-functional processes, activity-based cost measurement systems transform the role of an accountant from a cop to a business advisor.[21] Management accountants become symbols and actors that help to create and foster a healthy organization culture.

The selection of cost objects can send symbolic messages in an organization. An organization that uses cost objects related solely to profitability and efficiency sends a message that it cares only for its own well-being. A corporation that measures costs for cost objects such as the environment, social activities, and human resource development can use these cost objects as powerful symbols to say that it is socially responsible and cares about its people and the environment.

▲ LESSONS LEARNED

- ▲ A cost measurement system is part of a strategic management accounting system that helps an organization to meet its strategic objectives of quality, cost, and time.
- ▲ A cost measurement system is like a building process that transforms raw data about resource purchases into useful information about resources consumed.
- ▲ The design of a cost measurement system involves selecting the right cost objects, establishing a chart of accounts and codes to track cost flows, and establishing rules for allocating the cost of shared resources.
- ▲ The type of cost measurement system an organization uses typically reflects the nature of products or services it produces and the production methods it uses.
- ▲ Firms that fabricate, assemble products from parts, or provide personal services using mass production techniques typically use job-order or batch costing. Firms using mass production methods in extractive and process industries typically use process costing.
- ▲ Traditional job and process cost systems trace costs first to departments (responsibility units) and from there to units produced.

[21] For an extended discussion of these two roles of accountants, see *The Organizational Role of the Management Accountants* module in this series.

- ▲ Firms using lean production methods typically use activity/operations costing systems. These contemporary cost systems trace costs first to activities and operations and then to units produced.
- ▲ An activity/operations costing system provides more comprehensive product cost data and makes cost drivers visible to managers.
- ▲ A well-designed cost measurement system improves decisions and facilitates process management by providing data on the cost of outputs produced, the cost of the processes (activities) used, and the underlying causal relationships (drivers) that cause costs to change. A good cost system encourages behaviors consistent with strategic objectives and creates mindsets and values that create a healthy and positive organizational culture.

Solution to Notepad p. CMS–15.
Equivalent Units in Bottling

Bottles	***Equivalent Units—Weighted Average***		***Equivalent Units—FIFO***	
Beginning WIP	245,000		171,500	(245,000 × (1−.3)
Started and finished (5,205,000 − 245,000)	4,960,000		4,960,000	
Ending WIP	144,000	(240,000 × .6)	144,000	(240,000 × .6)
Total	**5,349,000**		**5,275,500**	

APPENDIX

▲ COST TRACKING—TECHNICAL ISSUES

This appendix explains how a *chart of accounts* and *account codes* allow Alfa Laval to generate the job cost data shown in Exhibits 3 and 4. Before you read on, it may be useful for you to review once more the job costs identified in these exhibits.

Cost Flows and the Chart of Accounts.

A *chart of accounts* is a series of general ledger accounts that record the resources acquired and the resources used by an organization. Consider the information in Exhibits 3 and 4. We know that during the current period, Alfa Laval used materials, labor, machinery, utilities, supplies, and so on to produce heat exchangers. We also know that some of the work was complete and was transferred to customers and some work is still in process. The resources used during the current period were acquired in prior periods (materials) or during the current period (employee wages).

To understand the flow of costs during the current period, we must gather and record data pertaining to resource acquisition and use. Exhibit 19 summarizes this data for Alfa Laval.

The data for Exhibit 19 comes from various source documents. For example, purchase orders, receipts, and invoices paid are documents generated when materials are purchased. A material requisition slip is the source document that identifies the type of material requested, who requested it, and for what job.

Exhibit 20 below uses T-accounts to show how Alfa Laval records the information from source documents into various accounts. The letters a to l correspond to the items listed in Exhibit 19.

Can you reconcile these numbers with the numbers shown in Exhibits 3 and 4 of the module?

The top part of Exhibit 20 shows the source documents. We know from looking at invoices that we purchased $12,800,000 of materials this period. The material requisition slips tell us that $4,700,000 worth of materials were issued to departments for specific jobs. The departmental amounts are the same as those in Exhibit 3. In addition, another $1,600,000 in materials was issued but could not be identified with specific jobs and is initially charged to the manufacturing overhead account. Alfa Laval started the period with a beginning materials inventory of $3,000,000; after the new purchases and uses, it has an ending inventory balance of $9,500,000.

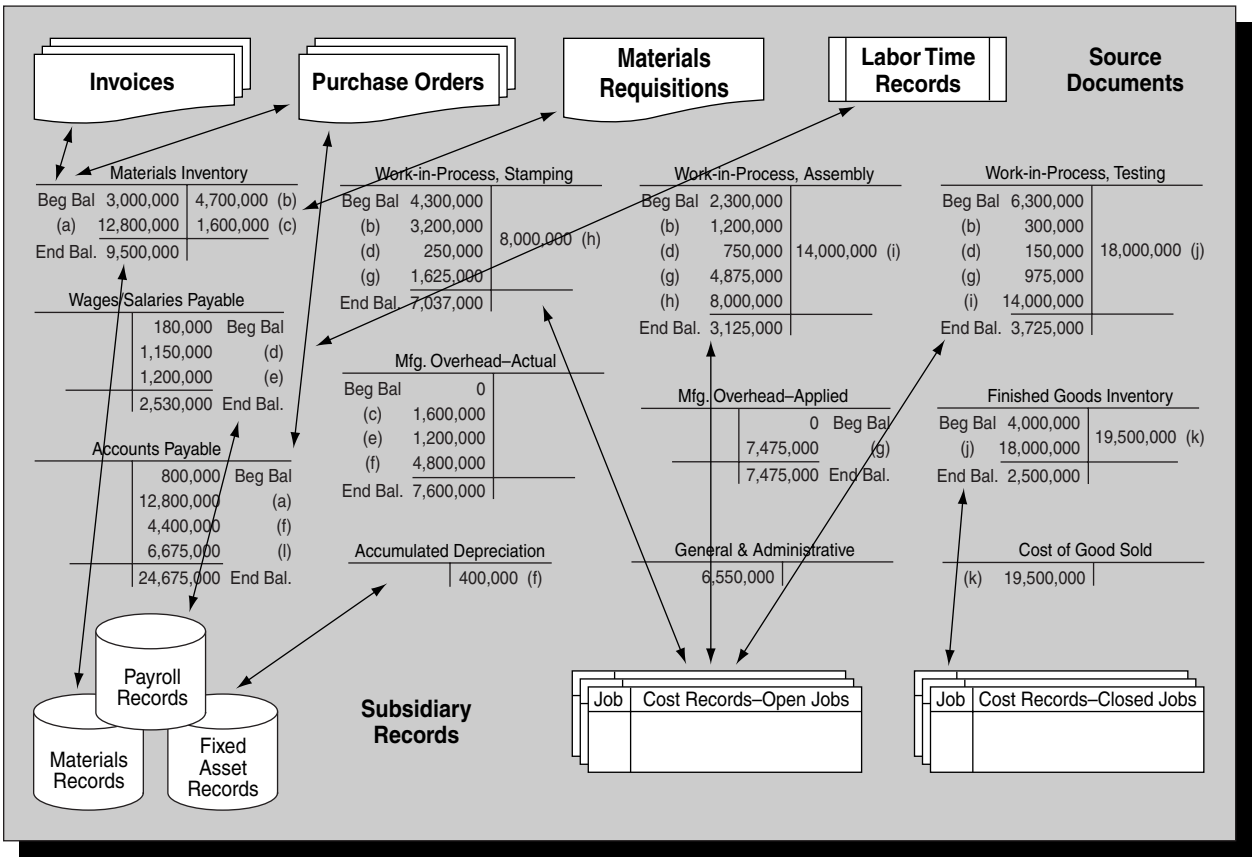
In each department a work-in-process account combines the materials, labor, and other manufacturing costs for production during a period. Because not all work is completed within the accounting period, the work-in-process accounts also start with a beginning and ending balance. As work is completed, the cost of completed jobs is transferred from work-in-process of a preceding department to the work-in-process of the succeeding department. The last department, assembly, transfers its completed items to the Finished Goods Inventory account.[22] Finally, when goods are shipped to customers, we record the sales revenue and move the cost of that job from the Finished Goods Inventory account to

[22] Realistically, Alfa Laval will have little or no finished goods inventory, due to the nature of its product. The heat exchangers are all done to order, and final assembly occurs at the customer's location.

Exhibit 19
Alfa Laval—Data on Resources Purchased and Used

Item	*Description*
a.	Purchase of materials, $12,800,000.
b.	Direct materials requisitioned by production departments: stamping $3,200,000; assembly $1,200,000; testing $300,000.
c.	Indirect materials consumed, $1,600,000.
d.	Direct labor recorded: stamping $250,000; assembly $750,000; testing $150,000.
e.	Indirect labor recorded, $1,200,000.
f.	Actual manufacturing overhead costs incurred, including $400,000 in depreciation on manufacturing equipment and $4,400,000 in other items.
g.	Overhead applied to production departments at rate of $6.50 per direct labor dollar.
h.	Movement of jobs from stamping to assembly, $8,000,000.
i.	Movement of jobs from assembly to testing, $14,000,000.
j.	Completion of jobs, $18,000,000.
k.	Delivery of completed units to customer sites, cost of goods sold recorded.
l.	$19,500,000. Sales revenue and accounts receivable recorded, $28,000,000; general and administrative expenses recorded, $6,550,000.

Exhibit 20
Alfa Laval—Cost Flows and Source Documents



Cost of Goods Sold. General & Administrative expenses of $6,550,000 are not treated as part of product cost and are expensed at the end of the period when financial statements are prepared.

Before any department transfers out a job, it must allocate a portion of the indirect manufacturing costs to that job. In a traditional job-order costing system, the actual overhead costs are first traced to departments and then assigned to jobs using predetermined departmental or plantwide overhead rates. A predetermined rate is an estimate based on the total budgeted dollars of overhead for the year divided by a budgeted allocation base such as machine hours, labor hours, or labor dollars. Because a detailed discussion of overhead allocation is beyond the scope of this module, we will simply use a plantwide rate to illustrate the cost flows.

Assume that Alfa Laval's budget calls for total labor cost of $1,170,000 and estimated overhead costs of $7,600,000. At the beginning of the accounting period, the company would calculate an overhead application rate as follows:

$$\text{Overhead Rate} = \frac{7{,}600{,}000}{1{,}170{,}000} = \$6.50 \text{ (rounded) per direct labor dollar}$$

Notice in Exhibit 20 that the overhead cost assigned to each department is 6.5 times the direct labor cost for that department. At the end of any given period, there is a difference between overhead costs incurred and overhead costs charged to jobs. This difference is called *under-* or *overapplied overhead* and is charged to the Cost of Goods Sold account at the end of the period.

Finally, note that the bottom part of Exhibit 20 shows the subsidiary records that support the cost tracking. For instance, payroll records for employees support labor cost tracking. Individual job cost sheets allow separation of material, labor, and overhead costs by jobs.

Think Along

How would the accounts used be different in a contemporary cost measurement system?

Account Codes.

For a firm to benefit from an activity-based approach, the accounting system must capture costs not just by departments and jobs but also by activities and operations. These systems require a new set of accounts and account codes.

Account codes are the technical mechanism that permits organizations to track costs in a variety of ways. An account code is a number assigned to an account. Each number codes a particular field of data that is of interest to the users of the system. For example, Exhibit 3 tells us that during the current period the three manufacturing departments used $4,700,000 in direct manufacturing materials. Also, we know that of this amount $3,200,000 went to the stamping department. Exhibit 4 tells us that the stamping department used $384,000 out of the $3,200,000 in materials on the Swedish job.

Clearly, Alfa Laval's accounting system must be capable of tracking all expenditures by type, function, cost center, and job. In addition, because materials purchased exceed materials used, any remaining materials have to be shown on the balance sheet as an asset. Therefore, the system must also distinguish between expenditures that create assets and categorize the asset as current or noncurrent. In database terminology the five items of interest about the expenditure for materials (type, function, cost center, job, and balance sheet classification) are called "fields." In an accounting database, the fields are coded with

a single- or double-digit number. For example, direct materials may be account number 1152137. The explanation for each digit is as follows: 1 = asset, 1 = current asset, 5 = materials, 2 = manufacturing, 1 = stamping department, and 37 = Swedish job. If we want to know the total cost in stamping, the database needs to add all expenditures charged to accounts that have 21 as the fourth and fifth digit. Similarly, to get the cost of the Sweden job, we must sort all expenditures that have a 37 as their sixth and seventh digits.

In practice, account codes and the database programs that handle cost tracking are quite complex. The account codes must be flexible enough to allow for both future expansion and any special analysis management may request. Many organizations do not think far enough ahead when they establish their chart of accounts and find that their computer systems cannot code data by certain cost objects because they "have run out of digits." This problem is not trivial if you consider that the so-called millennium bug (the inability of computer programs to handle the two-digit year change from year 1999 to 2000) has cost billions of dollars to fix.

Because most traditional accounting systems track costs by responsibility centers or departments, these systems do not easily provide activity/operations costs. Firms seeking to obtain activity costs often resort to one-time special cost studies to obtain this data. We believe that in the long run, this approach is costly. If possible, the system should be modified to provide an additional field for activity/operations coding of raw data.

One solution, for organizations that can afford it, is to use software packages called enterprise resource planning (ERP) programs to track cost flows.[23] These packages can track resources in various ways. For example, sorting all employees by a certain field will tell us the salary cost for a functional area such as manufacturing or engineering. Most of these software packages are adding modules that allow organizations to organize and sort data by activities and operations. This feature will make it easier for organizations to move from traditional to contemporary cost systems in the future.

[23] Some major ERP software packages/providers are BANYAN, PEOPLESOFT, ORACLE, and SAP.

▲ COMMON TERMS*

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See Process diagram.)

Activity-Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

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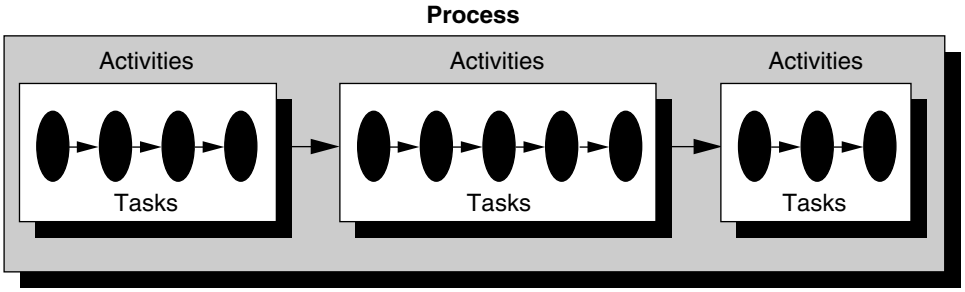
* The list of common terms for all modules is available online at www.mhhe.com/modules.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Value Chain (See Extended Enterprise.)

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self-test Questions.

a. What are the four components of a strategic management accounting system?
b. What are the three primary building blocks of a cost measurement system?
c. How should an organization determine what cost objects it needs?
d. What is cost allocation?
e. How does responsibility accounting differ from more modern cost measurement systems?
f. How is *product cost* defined for financial-reporting purposes?
g. Give examples of some cost items that are not part of product cost using the financial-reporting definition, but which would be included in product cost in a modern cost measurement system.
h. Give several examples of cost items that would be classified as period costs in a traditional cost measurement system.
i. Give several examples of firms that would use job-order costing.
j. What level of building blocks does a job-order costing system use that would not be found in a process costing system?
k. Describe the journal entries that are used to record manufacturing costs in a traditional job-order costing system.
l. Give several examples of firms that would use process costing.
m. What is an equivalent unit of production?
n. Why is inventory valuation less important in the cost measurement systems of firms that use modern manufacturing techniques?
o. Explain in your own words the three major differences between modern and traditional cost measurement systems.
p. What is a process map?
q. Name and explain the six steps involved in determining product cost in a modern cost measurement system.
r. What is a cost driver?
s. Exhibit 17 of the module shows some activity costs that are not traced to products. Why is this?
t. Explain why a modern cost measurement system provides superior process understanding.
u. Give an example of the behavioral impact of different definitions of cost objects.
v. What mindset does traditional responsibility accounting foster?

Exercises, Problems, and Cases.

2. For each of the firms described below, identify a strategic decision related to each leg of the strategic triangle (quality, cost, time). For each decision identified, what cost objects should be defined in the firm's CMS?

a. Heartthrob, Inc., which manufactures two kinds of heart monitors, including one for fitness enthusiasts to wear while working out and another for people at risk for heart attacks.

b. Mug Shots, Inc., produces insulated coffee mugs for Starbucks Coffee and Barnes & Noble Bookstores, and also produces a line of mugs with company logos on special order for organizations to use for promotional purposes.
c. TrashMasters, Inc., makes plastic trash bags using a process that includes the steps of mixing the plastic compounds, extruding sheets of plastic, and forming the sheets into bags.
d. Provident Beneficial Insurance Co. sells life insurance, homeowners' insurance, and car insurance to individuals and corporations.

3. You are conducting a continuing education course for financial managers. At the first session you presented the diagrams shown in Exhibits 2, 5, and 17 of the module, and described the basic differences between traditional job order and process costing and contemporary cost measurement systems. Two financial managers from a local hospital are debating whether the hospital should use job-order costing or process costing. A third individual comments that because hospitals are labor-intensive service organizations, the only kind of cost measurement system they should consider is an activity-based system. How will you (diplomatically) resolve this issue? (Hint: Consider the technical, behavioral, and cultural attributes of the cost measurement systems.)

4. Consider the following list of cost items:

- ▲ Production workers' wages.
- ▲ Salaries of product design engineers.
- ▲ The salary of an accountant at corporate headquarters.
- ▲ The president's salary.
- ▲ Salaries of customer sales representatives.
- ▲ Utilities for the factory.
- ▲ Commissions paid to sales staff.
- ▲ Supplies and salaries related to maintaining records for a major customer who orders parts just-in-time and is billed monthly.

Required:

a. For each item, indicate whether it would be considered part of product cost by a traditional cost measurement system.
b. For each item, indicate whether it would be considered part of product cost by a contemporary cost measurement system.

5. Fragonard Perfume Company in Paris produces two lines of perfumes. One is a generic brand sold to tourists. The other product line is sold to exclusive name-brand retail outlets at a high markup. The resources consumed by the firm include space in Paris for a production facility and sales room, employees and equipment there, and farming costs for fields of flowers and other ingredients grown in the south of France. Among the Paris employees is a blender, referred to in the trade as a "nose," who custom blends the ingredients at a large pigeonhole desk called the "organ." A major cost item is insurance on the "nose," since only 30 individuals in the world are qualified to perform this function.

Required:

a. Prepare a listing of the main cost elements Fragonard will record and indicate how each would be classified in a traditional cost measurement system (direct materials, direct labor, indirect manufacturing costs [overhead], or nonmanufacturing costs).

b. Develop a set of account codes that Fragonard could use to record these costs. Design your codes to allow the firm to analyze costs by the nature of the resources consumed and by activities performed.
c. Of the cost elements your account codes will track, which might differ across the two types of perfume?

6. The University of Southern Iowa encourages faculty to submit proposals for research grants to various external foundations and government agencies. The university's Office of Grants and Research assists faculty in preparing and submitting proposals, and Campus Computing Services provides data entry and analysis support. Some faculty members in the chemistry department are preparing a proposal for a research project. They estimate that the direct costs associated with the project will be as follows:

Cost Item	***Amount***
Faculty summer support	$8,000
Graduate student stipend	4,500
Travel	1,500
Total	**$14,000**

The university requires that researchers include in their grant budgets a request for funding to recover the cost of operating the Office of Grants and Research. Each year the university calculates an indirect cost rate based on budgeted expenses for the department and the total dollar of grants it expects faculty will receive during the year. For this year the total departmental budget is $3,600,000. This amount includes $2,400,000 in general operating expenses and $1,200,000 for data entry services. Faculty members are expected to receive grants totaling $8,000,000 during the year. The university uses a traditional job-order costing system that charges indirect costs to jobs based on a predetermined rate.

Required:

a. Based on this year's budget, what will be the indirect cost rate?
b. What amount of indirect costs will be charged to the research proposal? What is the total amount the researchers must request?
c. The researchers have learned that the agency to which they plan to submit the grant proposal will reimburse indirect costs only in amounts up to 35 percent of a project's direct costs. Assume you are the university's finance director, and the chemistry professors have come to you for help. How can you help them?
d. If the researchers are not able to recover all of the indirect costs from the grant, how will these costs be covered? What cultural values are relevant to this situation?

7. A small print shop currently has two jobs in process—an elementary school textbook and a children's craft book. Both books sell for $9 per unit, and both jobs are for 2,000 books. The production of a book involves several steps. After the material is received from the author, the design department performs the preliminary activities of copyediting and typesetting. Next the book goes to printing and finally to the assembly department, which completes the process of assembling the book and attaching the binding. The two books are similar in the resources they require for design and printing. Assembly is considerably more complex for the craft book because of special design features and the need to withstand hard use. Materials requisitions and payroll records provide the following information about costs incurred on the two jobs.

	Text	Craft
Design		
Materials	800	800
Labor	144	144
Printing		
Materials	440	440
Labor	80	80
Assembly		
Materials	275	280
Labor	1,440	1,680

Labor time cards indicate that the more highly skilled workers who assembled the craft book were paid, on average, $12 per hour rather than the normal wage of $8 per hour paid to all other workers. The company applies manufacturing overhead to jobs based on a predetermined overhead rate, calculated at the beginning of the year based on budgeted spending for labor and overhead. This year's budget called for 20,000 direct labor hours, at a total cost of $180,000. Budgeted spending for overhead items was $450,000.

Required:

a. Assume the firm uses direct labor hours to apply overhead. Calculate the overhead rate and the amount of overhead applied to each job.
b. Assume the firm uses direct labor dollars as the basis for assigning overhead. Calculate the overhead rate and the amount of overhead applied to each job.
c. For each job, calculate the cost per book and the total cost for the job using each of the two overhead allocations you calculated in questions (a) and (b). Which job is more profitable?
d. Based on your calculations, what behavioral problems might arise due to the choice of an overhead allocation basis?
e. How can the choice of an overhead allocation rate affect the firm's pursuit of its strategic goals?

8. Gloria Lauren, Inc., is a couture dress company. It has three production departments—design, cutting, and sewing. The accounting system provides the following balances in the company's general ledger as of May 1.

Account No.	Description	Beginning Balance
18000	Fabric	$6,000
12000	Supplies Inventory	380
14300	Work-in-Process—Design	8,500
14500	Work-in-Process—Cutting	7,200
14700	Work-in-Process—Sewing	9,400
15000	Overhead—Applied	0
16000	Overhead—Actual	0
18000	Finished Goods Inventory	11,500
42000	Cost of Goods Sold	0
45000	General and Administrative Expenses	0
50000	Sales Revenue	0
19000	Accounts Receivable	6,500
21000	Wages and Salaries Payable	3,500
24000	Accounts Payable	8,000

Required:

a. Set up T-accounts and show how Gloria would record the following transactions/events for the month of May. Be sure to show the beginning and ending balance for each T-account.
   i. Fabric was purchased at a cost of $1,300.
   ii. The cutting department began work on job number 98-5-761 and requisitioned fabric costing $450.
   iii. Payroll records show the following amounts were paid to employees during the month: designers, $15,000; cutters, $4,200; sewers, $6,500. The production supervisor was paid $3,000. Marketing department salaries for the month totaled $8,200; the president was paid $12,000; and the bookkeeper was paid $2,300
   iv. Supplies consumed during May, $220.
   v. Other expenses during the month were miscellaneous overhead items, $13,500, and various general and administrative expenses of $5,500.
   vi. Overhead was applied to each department at a rate of $.60 per direct labor dollar.
   vii. Jobs with $2,800 in costs were transferred from the cutting department to the sewing department.
   viii. The sewing department completed jobs with costs of $3,800. These were moved to the finished goods storage area.
   ix. Jobs with costs of $9,000 were shipped to customers. The customers were billed $23,000.

b. Determine the amount of costs that Gloria should classify as direct materials, direct labor, indirect materials, overhead, and nonmanufacturing costs.

c. A student from a local college has been hired as a summer intern. As you are explaining the account codes, the intern suggests that, since all account numbers have zeros in the last two places, it would make sense to shorten the codes, to speed up data entry and reduce the potential for errors. How do you respond to this suggestion?

9. Jack Biddle and Jeff Greene have started a business assembling disk drives. During their first month of operation, they incurred costs of $4,365 and completely assembled 85 units. In addition, they had 40 units partially assembled at the end of the month.

Required:

Assuming the ending inventory is 30 percent assembled, what is the cost per equivalent unit for the month?

10. Jen and Mary's is a small firm that produces flavored ice tea and similar drinks using only environmentally friendly ingredients and processes. The production process has two departments, processing and bottling. Tea is bottled after it is completely processed. There was no beginning or ending inventory in the bottling activity this year.

At the beginning of 1997, Jen and Mary had 22,000 gallons of kiwi-pomegranate tea in processing. Jen estimates this beginning inventory was 60 percent complete at that time for this activity. During the year processing started on 148,500 additional gallons. By the end of the year, 152,000 gallons were completely through processing. Jen believes the tea in the processing activity at the end of the year was 30 percent complete.

Jen and Mary incurred the following production costs during the year:

Cost Item	*Amount*
Juices and teas	$7,500
Purified water	5,000
Bottles and cases	15,200
Processing labor	24,000
Bottling labor	18,000
Depreciation and other equipment costs—processing	27,000
Depreciation and other equipment costs—bottling	10,000
Occupancy cost of plant	15,000

Processing uses 3,000 square feet of the plant space; bottling uses 1,500 square feet. In addition to these costs, Jen and Mary also incurred marketing expenses of $30,400 and administrative expenses of $45,000.

Required:

a. How many equivalent units of product were processed this year?
b. What was the cost per equivalent gallon of tea processed this year?
c. Bottling incurred how much total cost this period?
d. How many equivalent units of product did bottling produce this period?
e. What is the cost per equivalent unit for bottling this period?
f. Based on the definition of product cost used by traditional cost measurement systems (direct materials, direct labor, manufacturing overhead) what is the cost per equivalent unit of tea completed this period?
g. Based on the broader definition of product cost used by contemporary cost measurement systems, what is the full cost of a gallon of tea this period considering production, administrative, and marketing costs?
h. What are the behavioral implications of the two different product cost calculations you have done in parts (f) and (g) of this problem?

11. The American Association of University Women (AAUW) provides college scholarships for economically disadvantaged high school graduates. The AAUW grants scholarships based on applications filed by students. The following table shows the activities involved in evaluating an application and the approximate percentage of total processing effort consumed by each activity.

Activity	*Percent of Total Processing*
Receive and log application	10%
Enter into computer evaluation template	10
Send letters of verification	20
Update file and print evaluation score	10
Rank applicants and grant scholarships	40
Notify and disburse funds	10

In the first year of the program, the scholarship committee received 800 applications. Of these the committee completely processed 650 during the first year. The remaining applications had been received and logged, but no additional processing steps had been performed at the end of year 1. In the second year the committee received 900 additional applications. At the end of year 2, one hundred applications were partially processed. One-half of these had been received and logged; the other half had letters of verification sent.

Required:

a. On an equivalent units basis, how many scholarship applications did the committee process during year 1?
b. On an equivalent units basis, how many scholarship applications did the committee process during year 2?
c. From the perspective of the scholarship applicant, what constitutes quality in the process of granting scholarships?
d. What quality measures might you suggest that the committee track?
e. What is the time required for the scholarship application process? (Think in terms of the customer's perspective of time.)

12. Refer to the previous problem. Assume you work for University of the South. One of your jobs is to prepare advertising materials and supervise application processing for AAUW. You are also responsible for managing the costs of its operations. The work you do for AAUW uses about 20 percent of your time, and AAUW reimburses your university for 20 percent of your salary. AAUW receives free space for this operation from University of the South, and faculty members donated old computers, file cabinets, desks, and other office equipment. Your major cost item is payroll. You don't have any permanent employees, but students serve as temporary employees when processing has to be performed. In addition, you have supplies, telephone, and advertising expenses. The costs incurred in years 1 and 2 are as follows:

Expenditure Item	*Year 1*	*Year 2*	*Comments*
Salaries	$7,000	$10,275	Part time wages of college students.
Telephone	600	750	Monthly charge of $50 levied by the university plus extra service features installed.
Supplies	875	1,283	Used on each application.
Advertising	1,500	2,000	The AAUW committee approved a higher budget in year 2.
Manager's salary	7,000	7,210	Twenty percent of manager's salary and benefits.

Required:

a. What was the cost per application processed in year 1?
b. What was the cost per application processed in year 2?
c. How well is the manager managing the cost of the operation? (Hint: Think about how costs would behave as the volume of applications change.)
d. The industry norm for processing applications is about $15 per application. Given the cost structure that exists for this operation, how many applications must AAUW process to achieve the industry norm?

Writing Assignments

13. You have been hired as project manager for financial systems at an old-line *Fortune* 500 manufacturing firm and want to get approval for an activity/operation costing project. However, your boss, who has been with the firm for 37 years, argues that the firm has been profitable for 50 years without this "new-fangled accounting" and there is no need for a new system. Write a memo to persuade the boss. Remember, she does your performance evaluation, so you must be very tactful.

14. Explain two ways in which financial reporting principles have influenced the focus of traditional cost measurement systems.

Team Projects

15. Visit a local business. Determine what its key strategic decisions are, define relevant cost objects for each, and design a set of account codes for its cost measurement system.

16. Identify a *Fortune* 500 firm that you would expect to use job order costing. Visit its website or obtain a copy of its annual report to see whether you can deduce what kinds of jobs it would need to account for. What cost items should it trace to jobs? Are there any costs the firm should not trace to jobs?

17. Visit a local firm and draw a process map of its production process similar to that shown in Exhibit 10 of the module. Describe activities and operations the firm must perform to produce its product or provide its service to customers and define a set of account codes to track costs to each.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

18. The Boys Club of Boone County operates two programs designed to keep at-risk teenagers out of trouble—an after-school program and a summer camp. In addition, staff members conduct numerous fund-raising events during the year, such as open houses at the club and a family day of activities for children of donors. For financial reporting purposes, the Boys Club is classified as a voluntary health and welfare organization (VHWO) and is subject to the standards of the Governmental Accounting Standards Board (GASB). The GASB requires all VHWOs to prepare an annual Statement of Functional Expenses that shows spending separately by the broad categories of program spending and supporting services. Supporting services expenditures are further subdivided into management/general and fund-raising. The club's cost measurement system is designed to facilitate compliance with this reporting requirement as well as to provide information to help manage costs in these areas. Accordingly, the cost measurement system uses these four cost objects:

Program spending, after-school program
Program spending, summer camp
Supporting services, management and general
Supporting services, fund-raising

You have recently been hired as a part-time student intern to help with the club's accounting. From the club's records you have obtained the following information about resources consumed during the past year of operation.

Cost Elements	*Amount*
Direct labor	
Sports director	8,800
Art teacher	7,200
Camp counselors	9,000
Bus driver	14,000
Custodian	22,000
Other operating expenses	
Manager's salary	44,000
Travel	7,600
Van operating expenses	9,500
Printing and publicity	18,000
Rent	16,000
Utilities	3,500
Insurance	7,400
Phone	3,800
Supplies	4,200

The club's existing cost measurement system traces labor costs to cost objects on the basis of information provided by time sheets indicating the time spent on each program. For last year, the employee salaries traced to each program are as shown below.

Employee	*After School*	*Camp*	*Management/ General*	*Fund-raising*
Sports director	5,250	1,600	700	1,250
Art teacher	4,520	1,464	678	538
Camp counselors	0	9,000	0	0
Bus driver	8,400	4,900	0	700
Custodian	15,400	3,300	0	3,300

The club's existing cost measurement system assigns operating expenses (including the manager's salary) to the programs on the basis of direct labor costs. However, you have convinced the club manager to let you experiment with activity analysis and design a contemporary cost measurement system for the club. After much coaxing, you induce the manager to review his calendar and estimate how he spends his time. He determines that during the 42 weeks of the year when the after-school program is operating, he spends, on average, 15 hours per week in supervisory activities related to that program, 4 hours on developing programs for the summer camp, 11 hours on general management tasks, and 10 hours meeting with donors and other activities related to fund-raising. During the eight weeks when the summer camp is operating, he spends, on average, 6 hours per week in

various activities related to the after-school program, 20 hours on the summer camp, 10 hours on general management tasks, and 4 hours in activities related to fund-raising. The remaining two weeks of the year the club is closed.

You determine that travel expenses, van operating expenses, and printing and publicity costs can be traced directly to cost objects. Analysis of travel reimbursement records reveals that the travel costs are distributed as follows: after-school program, $750; camp, $800; management and general, $3,500; and fund-raising, $2,550. In discussions with the driver, you estimate that the van drove 15,000 miles for the after-school program; 9,000 miles for the camp; 600 miles on miscellaneous errands for management; and 400 miles for fund-raising events. Invoices show charges for printing and publicity of $4,500 for the after-school program; $3,600 for the camp; $2,700 for management; and $7,200 for fund-raising.

All other indirect costs will be combined into a single cost pool and assigned on the basis of square feet occupied. You and the manager estimate that roughly 50 percent of the space is used by the after-school program, 20 percent for camp-related activities and storage, and 25 percent by general and administrative activities. The rest is used for records storage related to fund-raising .

A local corporation has offered to provide a major grant to help the club cover operating expenses. The company's bylaws stipulate that it may donate only to nonprofit organizations whose expenditures for items other than program services are less than 20 percent of their total budget.

Required:

a. Based on the club's existing cost measurement system, determine the cost of the after-school program, the summer camp, management/general expenditures, and fund-raising. Calculate the total cost for the two categories of program spending and supporting services. Calculate the percentage of the club's total expenditures in each category.

b. Determine the total cost of the after-school program, the summer camp, management/general expenditures, and fund-raising as defined by the contemporary cost measurement system suggested earlier. Calculate the total cost for the two categories of program spending and supporting services. Calculate the percentage of the club's total expenditures in each category.

c. Which system better helps management understand the resources consumed by the various programs?

d. The club's bookkeeper has suggested that rather than combine facilities costs (rent, utilities, insurance) with supplies and phone in a single cost pool, the system should use two cost pools, with the facilities cost allocated on the basis of square feet and the phone and supplies allocated on the basis of salaries. What is your response to this suggestion?

e. The manager rejects the new system because the new cost assignment means that the club will not qualify for the gift. The manager justifies this action by saying. "Allocations are all arbitrary, and there's no way to prove that one is any better than another." Write a memo to the club director, who has no accounting background, explaining your position on which system the club should use.

f. Comment on the behavioral and cultural issues raised by this situation.

19. A.P. Brown Industries (APB) is a small firm that produces five-speed transmissions for sale to specialty automakers such as Porsche and Lamborghini. The accountant is preparing a cost of production report for 1997. During 1997 the firm incurred $301,000 in materials costs and $129,000 in conversion costs. At the beginning of the year, it was working on 65 transmissions that were approximately 20 percent completed at that time. During the year work began on 180 transmissions. At the end of the year, the firm had 80 partly completed transmissions on the shop floor. The production supervisor believes these units are 30 percent complete.

Last year's cost per equivalent unit for transmissions was $2,400. The production manager receives a year-end bonus based on cost control. If this year's cost per equivalent unit is higher than last year's, he will receive no bonus. He is pressuring the supervisor to report a higher percentage of completion for the ending inventory in order to reduce the calculated cost per equivalent unit.

Required:

a. What is this year's cost per equivalent unit?

b. What must the percentage of completion of the year-end work-in-process be for the manager to qualify for a bonus?

c. How could the manager's performance be evaluated to avoid this adverse behavioral impact?

20. Reider Processing, Inc. manufactures food products, primarily vegetable oils. Its main customers are restaurant chains and grocery stores. Various crude oils (corn, soybean, palm) are purchased on long-term contracts. Because of the fluctuating prices in commodities markets, speculative buying of raw materials is key to maintaining profitability. Trading specialists monitor commodities markets continually, locking in long-term contracts when prices are favorable. Contracts specify price and delivery date, but Reider does not actually take delivery until the oils are needed.

All oils go through four processing steps: refining, bleaching, deodorizing, and hydrogenization. Oils for industrial customers such as Frito Lay are piped directly into tank trucks for delivery. Oils for restaurant chains such as Arby's and McDonald's are packaged in 35-gallon barrels.

Reider uses a traditional process costing system for its main production. At the beginning of the year, 125,000,000 gallons of vegetable oil were in process. These were approximately 40 percent processed. Costs incurred in the prior period on the oil in beginning work-in-process include $24,375,000 in materials and $5,900,000 in conversion costs. During the year, 400,000,000 gallons of oil were placed into production. At the end of the year, the firm had 90,000,000 gallons in work-in-process. These were about 55 percent processed. Accounting records show that Reider spent $88,000,000 for materials and $55,890,000 for conversion costs during the year.

Required:

a. Assume that all materials are added at the beginning of the process. Determine the cost per equivalent unit (gallon) for materials using the FIFO cost flow assumption. (Round your answers to four decimal places.)

b. Assume that conversion costs are incurred evenly throughout the process. Determine the cost per equivalent unit (gallon) for conversion costs using the FIFO cost flow assumption. (Round your answers to four decimal places.)

21. Although Reider (refer to previous question) is tiny, it has been able to compete successfully with such giant food processors as Cargill and Archer Daniels Midland by providing quick turnaround on special orders. For pricing special orders Reider uses a job-order costing system with costs assigned to jobs on the basis of activities performed to complete the job. Records provide the following information about activity costs, cost drivers, and units of the cost drivers.

Activities	*Cost*	*Cost Driver*	*Units of Cost Driver*
Commodities trades	$988,000	Time, hours	3,800
Receiving	1,128,000	Incoming shipments	1,200
Materials management	23,760,000	Materials cost	88,000,000
Refining	12,960,000	Batch	180
Bleaching	11,700,000	Batch	180
Deodorizing	19,800,000	Batch	180
Hydrogenization	6,300,000	Batch	180
Lab tests	3,510,000	No. of tests	3,600
Finished goods storage	15,229,000	No. of barrels	2,600,000
Delivery	10,625,000	Truckloads	3,400

During a recent flood in the Midwest, Cargill asked Reider for 15,000,000 gallons of oil because Cargill's plants were flooded and it was unable to meet commitments to its customers. Michelle Reider, the president of the firm, estimates that traders will need about four hours to locate and purchase the necessary oils on the spot market. The crude oil can be shipped to Reider in three shipments. Production personnel indicate the order will be processed in five batches. Because of Cargill's strict quality requirements eight lab tests will be needed to ensure adequate quality control. Because the oil will be piped directly from the production vats to the delivery truck, no finished goods storage is needed. The order will be delivered to Cargill in two truckloads. The cost of ingredients for the order is estimated to be $3,300,000.

Required:

a. Determine the total cost of all activities necessary to fill the Cargill order.
b. Use the activity cost analysis and estimated materials cost to determine the total cost per gallon of the oil produced for Cargill.
c. Why is the cost per gallon for the Cargill order different from the cost per gallon you calculated in (b)?
d. What factors other than cost should Reider use in deciding whether to accept the Cargill order?
e. Based on your answers to these two problems, should Reider accept the Cargill order? Why or why not?

Case 1: Yamazoo Waverunner Manufacturers.

Yamazoo manufactures two models of waverunners in its Kalamazoo, Michigan, plant: the Stingray and the Shark. The Shark has a larger engine and is generally more costly than the Stingray. Yamazoo's income statement for the year 1997 is shown in Exhibit 1. In 1997 it sold 2,000 Stingrays and 975 Sharks to waverunner dealers. These units were sold to dealers at approximately 200 percent of Yamazoo's manufacturing or product cost.

Dealers sell the waverunners to customers and perform warranty repairs for Yamazoo, during the one-year warranty period, using parts obtained from Yamazoo. Yamazoo pays dealers for labor and overhead at standard rates established for each type of repair performed. During the warranty period, an average of $75 is paid to dealers for warranty repairs for Stingrays and an average of $90 is paid for Sharks.

Internally, Yamazoo is divided into three production areas: engine assembly, final assembly, and special finishing. Each engine assembly cell is staffed by three highly trained, flexible employees who fully assemble and inspect engines. Shark engines spend approximately twice the time in engine assembly as Stingrays. Final assembly is a production line operation with lesser skilled employees who routinely perform the same assembly step on each waverunner. Both waverunner models receive the same processing and parts in this area. Stingrays are complete after final assembly; they do not receive special finishing. Sharks go through both assembly areas and also through special finishing. Stingrays and Sharks have different direct materials as well. The costing system captured the following information about production during 1997:

Description	*Job Order 101*	*Job Order 102*
Number and model of waverunner	1,000 sharks	2,000 Stingrays
Direct materials:		
Engine parts	$300,000	$220,000
Waverunner parts other than engines	200,000	300,000

In addition, engine assembly, final assembly, and special finishing incurred $300,000; $450,000; and $50,000; respectively, in other costs. During this period, special finishing was the only area with work-in-process inventory. It started the period with no inventory, and it completed only 975 units. The other remaining waverunners were 50 percent complete with respect to special finishing.

In addition to the manufacturing process, Yamazoo has an internal administrative office that performs normal personnel, accounting, and other administrative functions. Auditing, tax planning and preparation, and legal services are handled by outside contractors. The president of Yamazoo also contracts all product design and marketing services to outside agencies.

During this past year an external product design firm worked extensively with the Shark. It had engine problems that were corrected in the 1997 model. The design firm estimated that 80 percent of its effort was devoted to Sharks and that the remaining 20 percent went to developing the 1997 Stingray.

About 50 percent of all marketing costs were for the benefit of both products last year. Of the remaining 50 percent, the marketing firm spent 300 hours developing new manuals for the redesigned 1997 Shark and 150 hours reviewing and refreshing literature for the 1997 Stingray model.

Exhibit 21
Yamazoo Manufacturers

Income Statement For the fiscal year ended 12/31/97			
Sales Revenue			$3,599,450
Cost of Goods Sold			
Materials	$1,007,500		
Indirect Labor	259,864		
Factory Depreciation	232,500		
Rent & Utilities	150,000		
Tools & Supplies	99,500		
Insurance	50,000		1,799,364
Gross Profit			1,800,086
Warranty Expenses		$237,750	
Marketing		150,000	
Design Charges		100,000	
Outside Accounting		50,000	
Legal Services		25,000	
Common Carrier (delivery charges)		150,000	
Administrative Office Costs:			
Office Rent	48,000		
Salaries	250,000		
Depreciation, Office Equipment	16,000		
Utilities	16,000		
Insurance	30,000		
Supplies	50,000		
Telephone	40,000	450,000	$1,162,750
			637,336
Taxes			254,934
Profit after tax			$382,402

Required:

a. What is the conversion cost in engine assembly for a Shark engine? What is the cost for a Stingray engine?

b. What is the conversion cost per unit in final assembly if both Sharks and Stingrays require the same time, effort, and cost factors?

c. How many equivalent units of Sharks are complete with respect to special finishing?

d. What is the cost per unit in special finishing?

e. What is the product cost of a Shark and a Stingray?

f. How much marketing cost would you allocate to each product line? Why?

g. How would you suggest that common carrier cost should be allocated to each product? Why?

h. Using units of production to allocate all indirect costs that do not have a clear allocation base suggested in the problem, determine the full cost of a Shark and a Stingray. Considering this cost, what is the return on sales from selling one of each?

Case 2: Logic Conductors.©

> The semiconductor business is extremely competitive and rapidly changing. We need to choose our products and processes carefully. We are under extreme cost pressures and always welcome opportunities to reduce or manage our costs better. If we are not cost competitive, we will not last very long in this business. We need a good operations cost system not only to tell us what our products cost, but also to help us understand how each step in our production process contributes to that cost.

This is how the chief manufacturing engineer of Logic Conductors, Bangkok, Thailand, described the nature of the firm's business. Logic Conductors is an international manufacturer of electronic components such as circuit boards, semiconductors, cables, and connectors. It has manufacturing facilities throughout the United States, Asia, and Europe. Its Asian manufacturing operations are in Thailand, Malaysia, Hong Kong, and Singapore. Corporate offices are located in the United States. Regional headquarters make the sales and then assign production to plants based on their location and manufacturing capability. The company's current sales exceed $5,000,000,000 and it employs more than 30,000 people. Half of its sales are from North America. The other half is split evenly between Europe and Asia.

Products.

Semiconductors, or chips in common parlance, are integrated circuits usually made out of silicon. High-precision chips, though, use other materials such as gallium arsenide. Semiconductor chips vary in sophistication from simple "merchant" semiconductors to sophisticated application-specific integrated circuits (ASICs). Merchant semiconductors are integrated circuits used in simple electronic applications such as telephones, kitchen appliances, and sophisticated children's toys. They are typically mass produced in large batches. Next in terms of complexity and sophistication are dynamic random access memory (DRAM) chips used in personal computers and peripherals. ASICs are dedicated to specific applications and, therefore, are produced in smaller lot sizes. Logic produces mostly sophisticated DRAM memory chips and ASICs in its wafer-fabrication facility in Bangkok.

Fabrication Process.

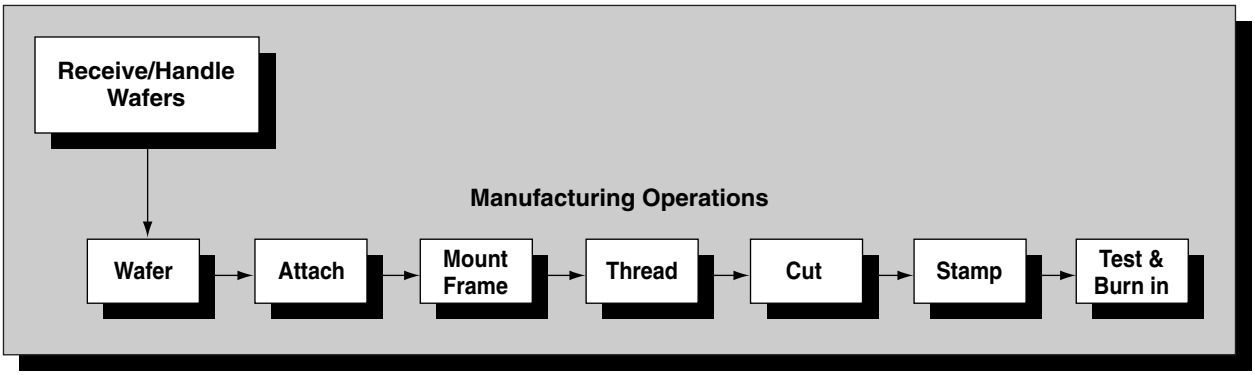
The fabrication process for the various types of chips reflects their level of sophistication. Typically, the fabrication process is defined by the distance between the number of transistors packed on a chip. For example, Intel's Pentium II chip introduced in 1997 has several million more transistors than the Pentium introduced in 1995. The distance between each transistor on the Pentium was .35 microns. The Pentium II has been fabricated on a new process that packs the chips at .25 microns or much closer together.

 This case is based on fieldwork done in connection with a CAM-I supported project titled *Strategy Deployment*. We have disguised the name of the organization at its request.

Given the nature of its product line, the company produces a large variety of integrated circuits in small lot sizes. Its design facility in California does the basic design and litho-graphy of the chips. In the lithography process a blank wafer coated with light-sensitive material is exposed to the circuit pattern. A laser-etching machine transfers the circuit design onto a "wafer," which is then doped with solvents and stripped away until the circuit design is etched on the wafer. The etched wafer, which contains several dies, is the basic raw material for the Bangkok plant whose process starts with the receipt and storage of wafers. Exhibit 22 shows a simplified schematic diagram of the most important manufacturing operations.

The first step in the manufacturing process is to cut each die on the wafers with a diamond saw. A resin bonds the good dies to a backing in the cavity of the ceramic package. The dies are then mounted on a frame and a threading machine attaches metal wires (aluminum, silver, or gold) that act as the inserts that connect the chip to the external electrical connection in the end product. The cutting operation, which is next, cuts the wires to the exact size called out in the product specification. The stamping operation puts an ink stamp on each chip that identifies the type of chip and its manufacturing location. The last step is a test to ensure that all connections are functioning; this step also burns in the chips in electronic ovens to ensure stability in the operating environment for that application. The special ovens typically take batches of 200 chips at any one time.

Exhibit 22
Manufacturing Layout for Bangkok Plant



Each manufacturing operation has one machine operator. One supervisor and one manufacturing engineer oversee the entire manufacturing operation.

At each stage of the manufacturing process, the yields are different. Of the wafers introduced in the production process, only 90 to 92 percent reach the resin-attachment operation. Another 5 to 6 percent of the chips are lost between resin attachment and stamping. Finally, the test stage usually uncovers another 1 percent defective so that the final yield is typically much lower than the number of wafers put into process during any given period.

Cost Data.

In the early 1990s, responding to increased competition on both price and quality in the electronics industry, Logic Conductors instituted a TQM program. The program was well received and cascaded training was used to get the message to every level in the organization. Within two years a quality focus had emerged, but costs were still not under control.

The company's cost system was typical of most traditional job-order costing systems. It identified materials cost based on requisitions. Labor time tickets were used to assign labor costs. For manufacturing overhead costs the system traced them first to departments and then assigned them to customer jobs using predetermined rates. While all manufacturing operations were in one department, the manufacturing overhead was divided into two cost pools. The first pool included materials handling and supervision. These costs were allocated to jobs based on direct labor hours. The other pool included the remaining costs, and machine hours were the base for allocating these costs. There was a growing feeling that the system was not providing the type of cost data needed for cost management.

To solve this problem the company began to implement an activity-based cost system to determine cost of the products and cost of each manufacturing operation (activity). The new system traced all resources to activities and manufacturing operations. Next the system identified a resource and cost driver for each activity and operation. The cost drivers were used to assign costs to products. The last step was to create cost pools based on common drivers.

This last year the total manufacturing cost was $540,500 broken down as follows:

Cost Item	*Total*
Machine operator salaries	$88,000
Supervisor salaries—material handling	12,000
Supervisor salaries—manufacturing	35,000
Machine depreciation	370,000
Occupancy	28,000
Supplies	4,800
Furniture/fixtures	2,700
Total cost	**$540,500**

The following additional information is also available.

1. Operator salaries and machine depreciation for each operation are as follows:

	Material Handling	*Saw*	*Resin*	*Frame*	*Wire*	*Cut*	*Stamp*	*Test*	*Total*
Salaries	$10,500	12,500	10,500	12,500	13,000	11,400	9,600	8,000	88,000
Machine depreciation		55,000	65,000	35,000	50,000	24,000	16,000	125,000	370,000

2. The manufacturing supervisors spend equal time on all operations.
3. Space occupied by the equipment in each operation is as follows:

	Material Handling	*Saw*	*Resin*	*Frame*	*Wire*	*Cut*	*Stamp*	*Test*	*Total*
Percentage of total space	14%	11	11	10	15	11	9	19	100

4. All activities and operations have roughly the same use of supplies.
5. Each employee is provided with furniture and fixtures. The cost is approximately 2 percent of their salary.
6. The following table provides cost drivers for each activity and operation. Also available are total amount of each driver consumed and the amount consumed by two of the many jobs done this last year. Job 1 produced video dynamic random access memory (VDRAM) chips for a manufacturer of PC video cards. Job 2 is a digital signal processor (DSP) chip for use in a cellular telephone/beeper combination device.

Activity/Manufacturing Operation	Cost Driver	Drivers Consumed by All Jobs	Drivers Consumed By	
			Job 1 VDRAM	***Job 2 DSP***
Material handling	# of units	300,000	20,000	28,000
Saw cut	# of saw cuts	1,750,000	2	3
Resin	# of wafers	250,000	18,000	26,000
Frame	# of framing hours	6,750	1 minute	2 minutes
Wire	# of inserts	5,000,000	12	8
Cut	# of wire cuts	750,000	4	2
Stamp	# of items stamped	230,000	17,000	25,000
Test	# of hours	7,245	75 min	120 min

7. The raw material cost of the wafer for the two jobs was

Chip job 1	$11.45 per wafer
Chip job 2	14.56 per wafer

8. Both jobs were complete at the end of the period.

Required:

a. Compute the total cost of each manufacturing operation at Logic Conductors. Do you think there might be better ways of tracing resources to operations?
b. Do you think it is appropriate for the new system to lump labor with the other manufacturing support costs and assign it to products as a single number?
c. Which management insight does this calculation provide? How might you use this information for cost management?
d. For each manufacturing operation, compute a cost per driver.
e. Which management insight does this calculation provide? How might you use this information for cost management?
f. Compute the unit product cost for the two jobs. What is the impact of "yield" rate on unit product cost?

NOTES

M O D U L E

Activity-Based Management (ABM)

Version 1.0

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Module Contents
Activity-Based Management (ABM)

Activity-Based Management (ABM)

MIDDLE RIVER'S BUDGET WOES

"I need another $300,000 over my budget from last year if we are to provide the services students, faculty, and the taxpayers of the state are demanding of us. I need to invest in new technology and software. It is essential for our functioning." These words were spoken by Vikram Yarmel, Director of Student Services for Middle River State University.[1] His unit was responsible for processing applications, doing graduation status checks, issuing transcripts, and checking for prerequisites when registering students in courses. Yarmel was addressing the University Budget Committee which faced the difficult task of recommending budget allocations during a time of decreasing resources for education. Throughout the day, the committee had heard from various unit heads who were there to justify their budget requests.

When the committee started to deliberate the budget request, several members expressed reservations about the quality of data available to them for making decisions. The university budget was typically stated in traditional cost categories (personnel salaries [80%] and operating expenses [20%]). As the committee wrestled with how to make their choices, a frustrated Professor Miriam Hazleton, a member of the committee, finally verbalized the sentiments of many on the committee:

"We cannot continue to make serious budgetary and other resource allocation decisions on this type of data. Our decisions have serious implications for students; we already know that tuition has increased 103 percent in the past three years. How can we make an informed recommendation about budget allocations when we do not know how the spending relates to what we do as a university? We don't know how our recommendations impact the university's ability to perform its basic mission of providing quality education to all qualified students, at an affordable tuition, and graduate them in a timely manner. For instance, I do not know how Vikram's unit currently spends their funding on the various things that they do, nor how well they do them relative to other universities. It would be useful to know what it costs them to admit a student. Provide a class roster. Issue a transcript. We need to know what ***activities*** Vikram's department performs, how much they cost, how well his unit performs these ***activities***, and whether these ***activities*** need to be performed at all!"

▲ STRATEGIC IMPLICATIONS OF ACTIVITY-BASED INFORMATION

For students of management accounting this story about the need for activity information in budget decisions raises several important strategic issues.

▲ **Quality.** Work performed by employees constitutes an organization's activities. To provide customers and constituents with quality products and services requires

[1] We have used an assumed name to preserve the anonymity of the real university. The story, however, is based on real data and events.

performing the proper activities in an efficient and cost effective manner. An activity-based management (ABM) system documents which activities are undertaken, for what purpose, and how they are performed. This allows a comparison of what personnel are doing to the stated goals and objectives of the organization. For example, one mission of Middle River State University is to provide quality education. If a good student does not get his/her admission letter on a timely basis because of poor admissions processing, then that good student may decide to accept admission elsewhere. Losing a good student lowers the quality of the student body and hence the quality of education for all students. Similarly, inadequate checking of prerequisites may fill a class with unqualified students, decreasing educational quality for all. Quality of education can be improved only by understanding the nature and cost of activities undertaken to admit a student or to check prerequisites and then focusing continuous improvement efforts on these activities.

- ▲ **Cost.** Activities use resources such as labor, technology, capital equipment, materials, supplies, and utilities. Those resources have a cost. By knowing what these activities cost, we can either redesign them so they cost less or eliminate them completely if they are not essential to an organization's mission. Redesigning the way in which we process student applications can decrease the cost of admissions. Better advisement may eliminate the need for checking prerequisites. ABM orients managers to think about the cost of what they do and how they can do it for less by eliminating wasted action and resources.
- ▲ **Time.** The way activities are performed, the resources devoted to them, and the synchronization of activities across the organization affects the timeliness of service to customers. For example, processing applications, checking prerequisites, or doing graduation checks affects the timeliness of admission decisions and the ability of students to graduate on time. Students can start their studies at the right time and graduate within a reasonable period if they take the right classes at the proper time. ABM documents activities and their linkages across an organization. It identifies duplicate, unsynchronized, or poorly designed activities.

▲ PURPOSE OF THIS MODULE

ABM refers to analysis and costing of activities in order to improve work processes in an organization.[2] This module explains how to use ABM to improve organizational performance and manage costs. In ABM analysis, *the cost object is an activity*. The costing of activities is the first step in managing activities and in costing secondary cost objects such as products, services, or customers. When you complete study of this module you should understand:

- ▲ The history of ABM.
- ▲ The nature and purpose of ABM.
- ▲ The steps in performing ABM.

[2] Some authors refer to this as activity-based costing (ABC). Others use the term ABC to refer to the use of activity analysis for product costing.

- How to identify inputs, outputs, resources consumed, and performance measures for activities.
- How to use ABM information to recommend improvements in activities.
- How to collect detailed information from employees about activities.
- The technical, behavioral, and cultural attributes of ABM.
- Relationship of ABM to other management accounting issues.

A BRIEF HISTORY OF ACTIVITY-BASED MANAGEMENT

ABM is an idea that has been around for quite a long time. In the last thirty years, many writers have pointed out that we do not pay enough attention to understanding the horizontal work relationships in an organization. Yet the interest in understanding, analyzing, and costing activities in organizations is fairly recent. It has arisen from the increase in global competition. The highly competitive environment has caused management to look at their management and accounting practices more critically. They have begun to recognize the importance of *process management*, a management approach that focuses on work relationships across rather than within organizational units. *ABM is at the heart of process management.* As managers have shifted focus, they have asked accountants to provide information that helps the organization to better understand the cost of their work processes. This is why management accountants have gotten more interested in learning about and using ABM.

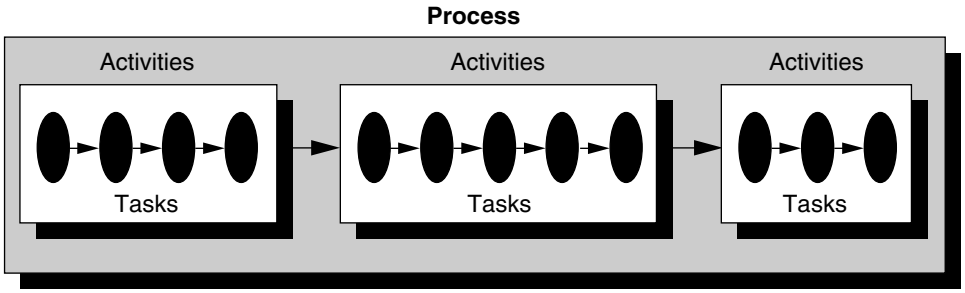
It is surprising that ABM has not been widely used in the past in the U.S. since one of the earliest applications of activity accounting was at General Electric (GE).[3] GE developed "activity cost analysis" in the 1960s as a way to manage indirect costs. They standardized lists of activities in "activity dictionaries" and perfected efficient interviewing techniques for collecting information on activities and their causes. GE understood that "upstream" decisions, such as engineering changes, created "downstream costs" such as quality assurance, storage, and packaging costs. They collected information about the quantity of output from each activity and estimated activity costs by adding costs across all functional areas. This type of data was collected by GE because their traditional accounting systems never traced costs in a way that highlighted the cross-departmental impact of decisions on their costs.

Widespread applications of ABM in the U.S. started only in the late 1980s. Many U.S. companies such as Tektronix, John Deere, Schrader Bellows, and others adopted ABM in response to competitive pressures. They felt they did not have the type of cost management tools that they needed to compete in the global arena. ABM was recognized as a tool that had the potential for helping them understand and reduce costs. Today, most major U.S. corporations are using ABM in part or in whole. They include Chrysler, IBM, General Motors, and many others.

ABM is also consistent with the Total Quality Management (TQM) initiatives undertaken by these organizations. TQM is the quest for perfect quality in products and services. It contains two messages for workers: *do work right the first time and strive for continuous improvement.* TQM emphasizes the need to understand activities performed in order to improve them. ABM identifies and documents activities, their costs, and measures of

[3] The following discussion of GE is documented more fully in H.T. Johnson, "It's Time to Stop Overselling Activity-Based Concepts," *Management Accounting,* September, 1992.

Exhibit 1
Activities and the Work Hierarchy



performance. It provides a departure from accountants' traditional focus on functional areas and products. ABM provides the information needed for a TQM program to be successful and for an organization to achieve world class status.

▲ NATURE AND PURPOSE OF ABM

ABM is a cost management tool that improves organizational decisions by focusing attention on the *work* organizations do, *how* they do it, *why* they do it, and at what *cost* they do it. ABM employs activity analysis. *Activity analysis* is used to analyze the outputs, cost, and performance of organizational activities. It involves understanding the tasks that are done and searching for better ways of doing those tasks. Also, it identifies the resources that activities consume and what causes this resource consumption or cost to be incurred. The result is improved and more cost-efficient work processes.

In ABM, work is viewed as a progression from elementary tasks that combine to form activities that together constitute a process. Therefore, activities comprise the tasks performed within an organization, and processes comprise the activities performed within an organization. Each task, activity, or process has an input, a transformation, and an output. This hierarchy of work is shown above in Exhibit 1.

An example of such a work hierarchy is a university bookstore that must order books that students need. This may be called the bookstore's order process. The order process consists of several activities such as getting book requests from teachers, placing a purchase order with publishers, receiving books, cataloging books, stocking shelves, and so on. All these are activities within the order process. Each activity, for instance getting book orders from teachers, may have several discrete tasks such as getting a list of classes, receiving forms from departments, checking forms against class schedules, entering book requests into a computer, and so on.

There are two things that you should remember about this work hierarchy. First, the boundary between tasks, activities, and processes is somewhat imprecise. A *process* is typically described as a series of activities linked to perform a specific objective.[4] **A process has a beginning, an end, and clearly identified inputs and outputs.** A *task* is too small

[4] Thomas Davenport, *Process Innovation,* HBS Press, 1993. Davenport defines a process at a much higher level than we do. Again, we believe that the boundary between activities and process depends on an analyst's purpose and whether or not standard activities and processes exist across an industry.

to have a clearly identifiable objective. For example, data entry into a computer is a task that has no purpose apart from its related activity or process. Second, processes often do not have a departmental boundary as they may cut across several departments. The same may be true of activities. Some processes even cut across organizational boundaries. For example, product design may involve suppliers and is a process that spans several departments inside and outside an organization.

Key Point

> Whether you draw the line neatly between tasks, processes, and activities is not critical. Collecting information on processes and activities focuses management's attention on how work is done rather than what output is produced. Focusing on work flows is what is important.

▲ STEPS IN ACTIVITY-BASED ANALYSIS

A typical ABM analysis involves a series of steps. It starts within a department and is expanded to other departments when activities and processes cut across them. Using departments as a starting point is convenient because that is how most organizations work and how most traditional accounting systems typically accumulate costs. Once a department is selected, a typical ABM project unfolds in *ten major steps*:

1. Obtain the *existing cost* information and reports on the focal department.
2. Determine the major *processes* that occur within the department.
3. Identify the *inputs* that start each process and the *outputs* or results that the process produces.
4. Determine the *activities* involved in the various processes. Document the current activity flow in detail and list all *tasks* that are part of each activity.
5. Identify all *resources* used (people, machinery, supplies, space, etc.) by each activity.
6. For each major activity, define an *output measure*. This measure may be financial or nonfinancial.
7. For each major activity, define a *performance measure*. These measures may be financial or nonfinancial.
8. Record the *actual performance*, on the selected performance measures. The measures may be quality, cost, or time.
9. Use the performance to *determine how well you are performing* the activity.
10. Brainstorm *improvement* ideas.

▲ PERFORMING ACTIVITY-BASED ANALYSIS— AN ILLUSTRATION

We can illustrate the ten steps in the ABM process using the Student Services Department of Middle River State University discussed in the story at the beginning of this module. Assume that Student Services Department spent $1,055,000 this last year. The University

Exhibit 2
Student Services Department–
Costs of Major Activities
and Processes

Processes	*Cost*
Process 1	?
Activity 1	?
Activity 2	?
Activity	?
Process 2	?
Activity 1	?
Activity 2	?
$Activity_i$	?
$Process_n$	?
Activity 1	?
Activity 2	?
$Activity_k$	?
Total Cost	**$1,055,000**

Budget Committee, you will recall, wants to understand how this amount was spent relative to the work activities of this department. Exhibit 2 summarizes the information they want to know about Student Services' use of their funding but were unable to get from the existing accounting system.

In the following pages we will explain how the ten steps in activity analysis can be used to fill in the unknown numbers in Exhibit 2 and how these numbers can answer the concerns raised by the University Budget Committee.

1. Obtain Financial Information.

The first step is to ask for the financial information available for the department to determine their current operating costs. Exhibit 3 contains the information currently available from the Student Services Department. It is the information that was provided to the Budget Committee. Notice that the accounting system tracks the costs incurred by object of expenditure, such as wages, operating expenses, occupancy, and so forth. Since we need cost information on activities performed, we must collect more information about the activities of the Student Services Department.

Exhibit 3
Student Services Department
Costs by Account Categories

Account Category	*Total Cost*
Labor & Benefits	$696,000
Operating Expenses	124,000
Occupancy Cost	235,000
Total	**$1,055,000**

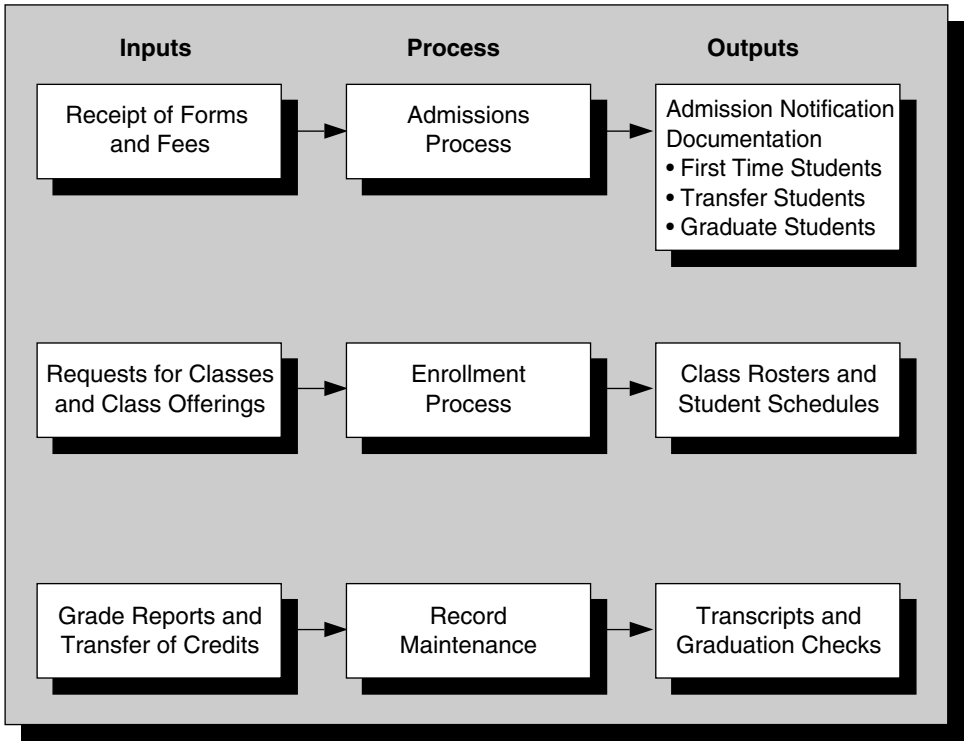
2. Determine Major Processes.

The next step is to interview the managers in the Student Services Department. This will enable us to identify the processes that occur in the department. The interviews will probably tell us that this department admits students, enrolls students in classes, prepares class rosters for teachers, and maintains student records and transcripts. We can tentatively accept these three as the major processes in the Student Services Department: We will refer to them as the *admissions* process, *enrollment* process, and *records maintenance* process. As we will see, each process requires several activities and tasks.

3. Identify Process Inputs and Outputs.

The third step is to determine the inputs and outputs of each process. Inputs are the acts or events that cause the tasks and activities in a process to start. These acts or events are sometimes called drivers. A *driver* is any event, circumstance or condition that causes activities within a process to commence. Receipt of a student's application form and fees starts the various activities that are part of the admissions process. Outputs refers to the outcomes or results of the process. One output of the admissions process is a notification of admission mailed to students. Exhibit 4 summarizes the major inputs and outputs for the three processes in the Student Services Department.

Exhibit 4
Major Processes in the Student Services Department



Each process can have more than one input that starts the process. For example, the Admissions process starts with the receipt of an application and a fee. The enrollment process starts with students' requests for classes listed in a schedule of classes. However, the record maintenance process can begin when grades earned are submitted by faculty at the semester's end or when there is a transfer of credits from another university or college.

4. Determine Activities and Tasks in Each Process.

We know now that the admissions process starts with the receipt of a student application and ends when an admission notification is mailed to a student. We now need to determine the various activities and tasks that occur within this process. This is essential if we are to know how well the admissions process works and what it costs the university. There are several data collection methods that are used in practice. They are discussed more fully in the next section.

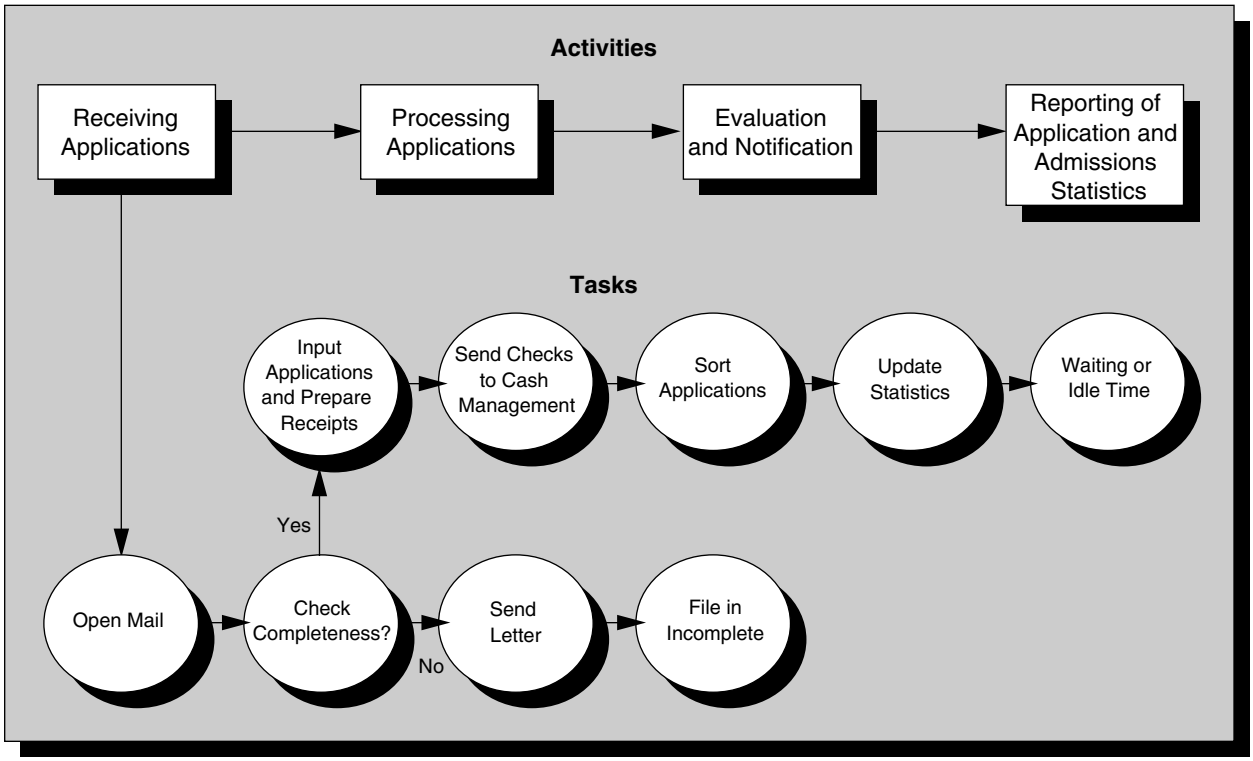
Assume that using these data collection methods we find that there are four major activities in the admissions process. These activities are:

1. *Receiving applications*, which involves collecting the application fee and notifying students that the competed package has been received by the university.
2. *Processing applications*, which involves creating an application file and a computer record for each student.
3. *Evaluating and notifying*, which involves the decision of whether to accept or reject an applicant as well as how much credit to grant for prior course work.
4. Compiling *reports and statistics*, which involves maintaining statistics on the number, types, and prior educational experience of applicants accepted and rejected.

We must next determine the basic tasks that are performed as part of each activity. Exhibit 5 shows eight basic tasks that form the first activity, *receiving applications*. These tasks are:

1. Delivering mail applications to the admissions staff in the Student Services Department where two employees open and date stamp the mail.
2. Checking applications to see if all forms are intact and the application fee has been submitted.
3. Separating incomplete forms and sending the applicants a letter informing them of the missing items. These applications are filed in an incomplete or pending applications file.
4. Inputting information from completed applications into a software program that prepares a fee receipt and a form letter notifying each applicant of his or her application status.
5. Endorsing all checks on the back and batching, running a tape total on, and sending them to Cash Management.
6. Sorting applications alphabetically and by applicant's status (first time freshman, transfer student, graduate, etc.).
7. Inputting information on the day's applications into a statistics file maintained on a computer.
8. Stopping the input activity several times because sorted applications are not available.

Exhibit 5
Major Activities and Tasks in the Admissions Process



Notice the level of detail used to describe each task in this activity. Each step could have been further subdivided. For instance, to open the mail could be described as pick up letter opener, pick up application, slit envelope, discard envelope, place application on desk, and so on. The appropriate level of detail to use in describing tasks is ultimately a matter of judgment.

> In the analysis process, it is important to get enough detail of what is being done so inefficient methods can be discovered. Yet it is equally important not to get bogged down in so many details that an activity map becomes cumbersome.

The last task is not really a task. It is a record of the time spent waiting for the next task to start or for inputs from a prior task to be available. This is shown as waiting and idle time. In this particular activity, it resulted from waiting for sorted applications. The waiting time is a measure of available idle resources that are currently unused.

5. Identify Resources Used by Activities.

All the tasks and activities described in Exhibit 5 require resources. They use people, computer time, furniture, supplies, physical space, and other costs. The resources consumed by these activities are the costs of performing these activities. Our next task is to determine

Exhibit 6a
Resources Used by Receiving Applications Activity

Resources	*Resouce Driver*	*Cost/Resource Driver*	*Usage Statistics*
Labor & Benefits	Actual Employees	Actual Salary	1.75 clerical .25 supervisor
Materials	Actual Usage	Actual Cost	0%
Occupancy Costs	Number of Desks	$180/month	2
	Square Feet	$3.75/sq. ft.	620
Computer Equipment	Number of Machines	$2,500/machine	1

the resources used by each major task and combine them to determine the cost of each activity and the cost of each process. We know from Exhibit 3 that the total cost of these resources is $1,055,000. Our next step is to assign this total cost of $1,055,000 to the activities. To do this we need to collect data on how each activity draws on these resources.

Consider the activity *receiving applications*. This activity, you will recall, has eight major tasks. We must determine the resources used by these tasks. Assume that our analysis indicates that the resources consumed by these eight tasks are labor and benefits, occupancy costs, and computer equipment. There is an immaterial amount of supplies used in this activity (one piece of computer paper per applicant), but its cost is included in the processing applications activity.

Exhibits 6a and 6b show how the costs of resources are assigned to *receiving applications*. The first column of Exhibit 6a shows the resources consumed. Note that this represents **all resources** used by an activity. Also note that some of these resources can be **directly traced** to the activity (e.g., wages of the personnel performing the activity) while others are **indirect** and have to be assigned on some reasonable basis (e.g., occupancy costs include a charge for the building, furniture, fixtures, telephone, janitorial services, and utilities).

Key Point

There is no such thing as a unique or true cost of an activity because different methods of assigning costs to activities will result in different total costs. Regardless of these differences, we must measure the cost of an activity by assigning it a cost for each resource consumed.

Resources assigned to an activity should include all resources that could be saved or avoided if that activity were not performed. This includes resources that can be eliminated as soon as an activity ceases to exist as well as resources that can be eliminated through appropriate managerial cost planning. For example, at Middle River State University, if receiving applications was eliminated as an activity, there would be a savings not only on material and labor costs, but also on the floor space no longer needed for performing this activity. The space and equipment could be reassigned to other activities that are currently not performed due to lack of resources. If Middle River redesigned many activities so a significant amount of unused space existed, it could rent the space and generate revenue.

Exhibit 6b
Cost of Receiving Applications Activity

Resources	*Base Cost*	*Traceable portion*	*Cost Traced to Activity*
Labor & Benefits			
1 clerk full time	$20,000	100%	$ 20,000
1 clerk 75% time	20,000	75%	15,000
Supervisor 25% time	52,000	25%	13,000
Materials			
Occupancy Costs			
Furniture charges	$2,160/year	2 desks	4,320
Space use	$3.75/sq. ft.	620 sq. ft.	2,325
Computer Equipment	$2,500/yr.	1 machine	2,500
Total Cost			**$57,145**

The second column of Exhibit 6a shows the resource driver used to assign resource costs to the activity. A *resource driver* is the factor that best assigns the cost of resource use to an activity. Some resource drivers **cause** the costs of resources to change. For example, the resource, computer equipment, is driven (caused) by the number of computers used by people performing the activity. The third column shows the cost per resource driver. For computers, the cost has been determined to be $2,500 per machine. For occupancy costs such as utilities and building, the cost is $3.75 per square foot. For desks, $180 includes a charge for the desk, lamp, chair, telephone, and janitorial service. The last column shows the amount of resource drivers consumed by the activity under analysis, receiving applications.

Some of the unit costs shown in column three of Exhibit 6a are the result of a separate analysis not discussed here. They require investigating how the cost of a resource changes with its use. For example, total utilities cost may be the result of having separate meters for measuring electrical consumption or, more likely, dividing the total utilities bill for the university by the total square footage of all its buildings. Whenever possible, we must try and relate the consumption of resources to a resource driver that measures resources consumed by activities rather than to gross estimates such as square feet of space used.

The information about drivers can be used to compute the cost of the activity receiving applications. This is shown above in Exhibit 6b.

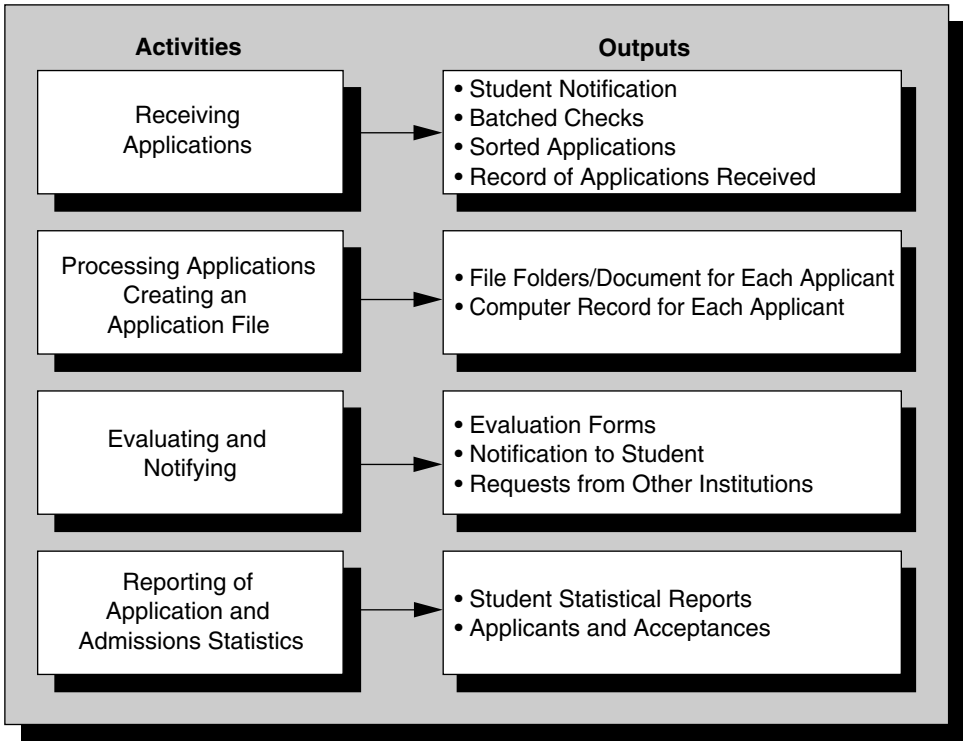
The amount of labor and benefits, $48,000, is the actual salary plus benefits of the three people who perform this activity. Occupancy cost incurred is $6,645 (two desks at $2,160/desk plus $3.75 per square foot of space × 620 square feet). The charge for computer equipment is derived from the fact that one computer is assigned to this function, and the department is charged $2,500 for each computer. This gives us a total cost of $57,145 for the activity receiving applications.

A similar analysis should be done for the other three activities within the admissions process. Assumed results from this type of analysis are summarized in Exhibit 6c below.

Exhibit 6c
Cost of Admissions Process

Receiving Applications	$ 57,145
Processing Applications	168,355
Evaluating and Notifying	220,900
Reporting and Statistics	33,600
Total	**$480,000**

Exhibit 7
Output Measures of Admission Activities



Note that the same five steps can be repeated to cost the activities in the *enrollment* and *records* processes. The total for all three of these activities will be $1,055,000, the total cost of the Student Services Department. It will complete the missing data in Exhibit 1 and will provide the information requested by the University Budget Committee.

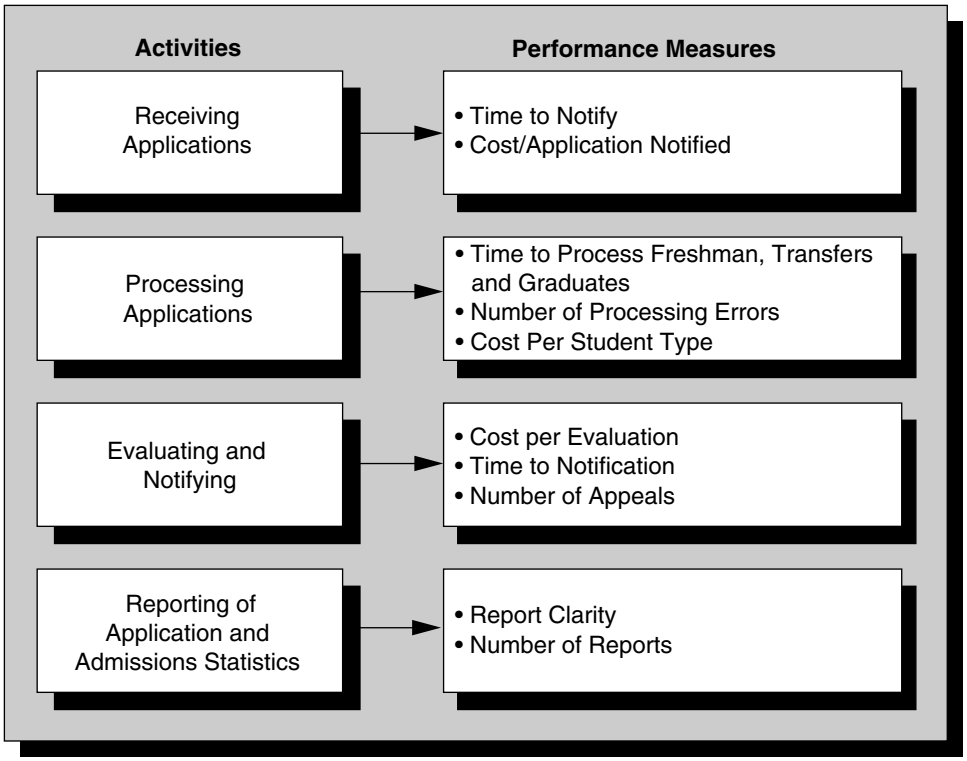
6. Define Output Measures for Activities.

We also need to identify and measure the outputs from each activity. An output is a tangible result or outcome of performing an activity. Outputs serve as inputs or cost drivers for other activities, and often link activities across departmental boundaries. They can be used to build performance measures as well. The activity, *receiving applications*, creates several outputs. These include student notifications that a complete (or incomplete) application has been received, batches of checks processed, applications sorted by status (first-time freshman, transfer and graduate students), and an updated record of applications received. Exhibit 7 lists some of the outputs for the activities in the admissions process.

7. Define Performance Measures for Activities.

To evaluate how well we are performing various activities, we need performance measures. Performance measures are metrics that monitor how well we perform an activity (our effectiveness) and what resource we use (our efficiency). These measures may be financial

Exhibit 8
Performance Measures of Admission Activities



or nonfinancial. Good performance measures lead to attaining strategic objectives of quality, cost or time. Exhibit 8 shows some sample performance measures for each of the four activities in the admissions process. For example, the activity, *evaluating and notifying*, has three performance measures: cost per applications evaluated, time from receipt of application to the letter of notification, and the quality of evaluation based on the number of student appeals filed.

8. Record Actual Performance on Each Activity.

The next step is to record the actual results on the performance measures for each activity. We will illustrate this by using the first activity, receiving applications. This activity has two performance measures: (1) time to notify a student about the receipt of their application; and (2) cost per application notified.

Time to notify a student that his or her application has been received can be measured by comparing the time from the date stamp on the application to the date the letter of notification was mailed. Assume that the average time is eight days. This can be compared to other similar operations in businesses or other universities.

The cost per application worked on by the receiving staff can be computed from the data in Exhibits 6b and 7. We know that the total cost of receiving applications activity is $57,145. We know the output is measured in terms of number of applications worked on.

Assume that during the current year we received and worked on 30,000 applications. The cost per application worked on is: $57,145/30,000 = $1.905 per application. This cost can be compared to the costs of other institutions, if that information is obtainable.

9. Determine How Well Activities Are Being Performed.

If data is available about how other organizations perform the activity (called *benchmarking data*), it should be obtained and used.[5] That data may show that other organizations achieve the same output by different activities, or perform the same activity at less cost, in less time, or with greater quality. For instance, Middle River may want to compare its eightday notification time with that of other universities or similar business operations. They can do the same for the unit cost of $1.905 for receiving applications. If this cost is higher than other comparable operations, then the activity should be analyzed further. The reason for each task must be documented, and a detailed analysis of its cost, time, and/or quality should be undertaken.

A more detailed costing of *each task* usually involves less direct tracing and more cost estimates. We can illustrate this by computing the cost of the task *opening mail*. Labor and benefits and occupancy cost could be assigned to this task by the amount of time spent on it by employees. Assume that 10 percent of the three employees' time is spent in opening mail. This would mean that $4,800 cost of labor is associated with this task. Similarly, 10 percent of occupancy cost, or $664.50, could be charged to mail opening since occupancy costs are incurred to provide work space, desks, telephone, and so forth for workers. No computer equipment cost would be charged since the computer is not used to open mail. The total cost of opening admission envelopes is $5,464.50.

How much does idle time cost the university?

This is an interesting question. If 25 percent of employees' time is spent waiting, then at least $12,000 of labor and benefits has to be assigned to waiting and idle time. There seems to be more cost as well related to capacity. The computer equipment is only used approximately 1,200 hours in the year. It certainly has the ability to be used more. Capacity-related costs are complex and are the subject of a separate module. If the efficiency of receiving applications is a problem within the university, perhaps employees could be assigned another task to perform during waiting and idle time, or the tasks could be reorganized to reduce the inefficiency. In addition, maybe the computer could be used for other tasks and not dedicated to receiving applications.

10. Brainstorm Improvement Ideas.

The prior analysis not only provides all of the information that the University Budget Committee wanted; it can be used also by the management of the Student Services Department to improve their activities. This requires generating ideas for improvement.

[5] Currently a major CPA firm is performing a benchmarking study for the California State University system to determine the costs of many administrative functions such as performing admissions, registration and permanent recordkeeping functions.

Brainstorming involves identifying how to eliminate a task or activity or how to make it more efficient. A team with some members familiar with the existing activity should be involved in brainstorming. Each suggestion about an alternate way to perform an activity should be documented and discussed.

For instance, the managers in the Student Services Department might use the questions listed below as a start for generating improvement ideas.

- ▲ Who is the "customer" of this activity, that is, who wants this done?
- ▲ Why do they want this activity or task performed?
- ▲ Is this task or activity being duplicated elsewhere in the university?
- ▲ How does this activity contribute to enhancing the quality of education?
- ▲ Is there a different way to generate the output of this activity?
- ▲ How does the activity help students graduate in a timely manner?
- ▲ Is this activity consistent with diversity and equal opportunity goals?
- ▲ What would happen if we did not perform this activity or task?

Notice that these questions are designed to probe why these activities exist, how they are tied to the strategic mission of the university, if there are alternative ways to perform them, and what would happen if they were not performed. *If the reason for an activity is strategic, then the activity should remain but may be improved*. Often you will discover that an activity is performed because it has always been done that way. These are sometime described as "non-value added" activities. These activities are prime candidates for elimination or redesign.

The language, "value-added" and "non-value added," is used to describe judgments about the usefulness of activities. Value-added activities are activities that are *essential to a customer*, like the activity of expediting the shipment of a perishable holiday gift (e.g., Harry and David fruit packages) so that it arrives at the designated time and in good condition. Value-added activities also include activities *essential to the functioning of the organization*, like performing the recordkeeping necessary to file quarterly payroll tax returns. Non-value activities can be eliminated without affecting price, quality, delivery, or service to customers or without violating any regulations affecting the organization. An example of this is the effort devoted to quality inspections after products are produced. The customer wants a quality product, not a product that has been through a post-production inspection process. He or she does not care if the firm provides quality products using TQM or a traditional inspection process.

In the admission process example, activities such as evaluating a correct applicant's record against existing admission's standards, notifying applicants of admission status, updating university records for those entitled to enroll, and maintaining statistics on applicants are value-added activities. All these activities are essential to the quality of the university's student body as well as to the timeliness of student notification. The activities should not be eliminated. Whether or not these activities could be redesigned to be more effective or cost less (efficient) is now the question.

Improving the process.

Brainstorming and checking with other universities about how they perform their admissions process typically leads to redesign of the process. Assume that one redesign idea generated by Student Services Department is to use computer technology. After determining

its feasibility, they invest in the new technology. This new technology will change three areas of the old admissions process.[6] These are:

1. Students now apply using a floppy disk that contains software that guides the application process. The student inputs his/her data directly into the software. At local high schools, counselors assist students. One disk can contain 50 applications. Transfer and graduate students can use a floppy disk or if they have dial in capability, place their application directly into Middle River University's computer.
2. Middle River sets up an "electronic data interchange" (EDI) between Middle River and the high schools from where it draws most of its students. This means that existing records are transferred electronically between the high schools and the university, eliminating errors, mailing and handling costs, and time.
3. They write a "bridging computer program" that takes data from the student records and inputs it into the records and statistics program. This eliminates the need to key punch the same information twice into separate computer programs.

These changes are expected to improve the admission process by providing a correct student record ready to evaluate against university standards. Students are notified in the traditional manner. All the data necessary for updating university records for those entitled to enroll and maintaining statistics on applicants are available. The redesigned process is expected to reduce by half the recurring cost of admitting a student as well as reduce notification time to two days. It will have a one-time cost of investing in the technology that is expected to pay for itself in three years.

▲ COLLECTING DATA ABOUT ACTIVITIES

In order to perform the ABM steps discussed above, you must obtain detailed information on activities. Most accountants are not well trained in how to gather this information. This section gives a brief overview of the commonly used methods.

There are three commonly used methods to gain information about activities. These are: personal observation, interview, and affinity diagramming, or storyboarding.[7] Typically observation is combined with one of the two other methods to obtain a thorough understanding of activities performed. The use of each of these methods is described below.

Observation.

This method requires that the person documenting activities spend time observing and recording what is occurring. Employees should be left to do their normal work. Record what inputs seem to start activities. Notes are made of which employees work on the activity and the sequencing of tasks performed. The relative amount of time each employee devotes to each task is recorded. Slack and time spent waiting are also noted. Other resources used to perform tasks are recorded. These include machinery, furniture, tools,

[6] We have not discussed the specific details of the technological solution because it is within the scope of Information Technology experts. However, the solution is based on actual applications being used by many universities today.

[7] Storyboarding is a term that has been developed by Peter Turney of ABC Technologies. It is a special version of affinity diagramming.

space, and materials and supplies. Output is documented. Occasionally, the work flow has to be interrupted to ask what is happening.

It is important to understand that when people are being observed, they may perform tasks as they think they should be performed rather than as they usually do. This is a normal phenomenon. It is helpful if employees understand that the purpose of the observation is not employee evaluation. An organizational culture of continuous improvement also helps. It is useful to return to the department after the initial observation period and unobtrusively observe small parts of activities that you have previously documented to see if things are occurring the way you understood. The results of an observation should be diagrammed to show tasks, work flow, resources, and output. These are discussed with key personnel involved in the activity and corrected as necessary.

Interviews.

This typically involves identifying a few key personnel who have a good understanding of the activity being studied. These people can be interviewed individually or in a group. It is helpful to start the process with standard questions. Document what causes the activity to start (its driver), what the purpose of the activity is and its outputs, what resources are consumed in the activity, and what causes more or less resources to be used. You can then ask questions about the tasks, their ordering, and the time each consumes. If a task seems to you to have subparts, you can ask for further clarification about how it occurs. If interviews are to be used, you, as an interviewer, should have some knowledge of the work flow and should have a list of standard questions to ask and a method to document responses.

Unless people are currently involved in an activity, they may not be knowledgeable of the exact tasks or their sequencing. For this reason, it is helpful to interview more than one person (for example, both workers and supervisors). Further, it is useful to combine interview information with information gained from personal observation. Sometimes additional tasks or activities will be uncovered. Often people are not aware of how much time they devote to various tasks they perform during their work day. It is helpful to ask them to document what they do on a log sheet for several days before your interview. A *warning* about this: some people, to justify what they do, will overload you with details and fail to mention any slack time in activities or their schedule.

Affinity diagramming or storyboarding.

This method involves bringing together people who work in a particular area and collecting information from them about what tasks they perform and why they perform them. Typically each employee will be given index cards and asked to spend a few minutes to write a description of each task performed using one card per task. A large board or paper should be available on a wall to display the index cards. Each person places his or her index cards on the wall in any order. Then the discussion starts concerning what tasks are performed and in what order. Index cards are moved into the final agreed upon activity flow. Additional questions about what drives the activity, why it is performed, what resources are consumed by tasks, and what outputs emerge are asked. Each person separately works on these on index cards and the group process tries to achieve agreement. At the end of the session, the agreed upon activity analysis is on the wall for all to see. It can be collected in order with the use of tape and then written up as documentation of the activity.

This process is fairly time consuming and requires employees who normally would be performing productive tasks to spend time in documenting them. It also requires a skilled person, called a facilitator, to run the session and keep the group on target with their task.

▲ EVALUATION OF ACTIVITY-BASED MANAGEMENT

Before embarking on activity-based management techniques, you should consider the technical, behavioral and cultural properties of an ABM system. To serve as a good cost management tool, it must have desirable properties in each of these three areas.

Technical Attributes.

ABM enhances accountants' and managers' understanding of work process and costs and provides information for improved decision making. This allows managers to improve product quality, reduce cost, and decrease time. ABM contributes to process understanding by pinpointing what activities are performed, how they are performed, what they cost, and how they are linked across the organization. It aids decision making by providing improved information for product design and for planning and control decisions.

ABM leads to a better *process understanding* in three ways:

1. Focus on work.
ABM leads to understanding what tasks are being performed and what they cost. This detailed knowledge facilitates an understanding of a complex organization by breaking it down into work activities rather than structurally by departments or authority lines. Activities can be mapped to strategic plans to understand how each activity contributes to the achievement of goals. ABM is useful in analyzing administrative, service, and support activities; few cost management tools are appropriate for these functions in an organization. ABM allows the accountant to communicate what activities cost throughout the organization. This concrete cost data and the linkage of activities to strategy, causes employees to question whether activities could be done more efficiently or whether they should be performed at all.

2. Cross-organizational impact.
Without ABM, the cost effect of an activity change cannot be readily appraised because those who perform work cannot see or understand how their actions impact costs across the organization. Operational personnel speak the language of operations they perform; they speak about processing accounts payable, soldering circuit boards, shipping products, ordering materials or responding to customer complaints. Accountants speak of product costs. They do not tell operating personnel how product costs are affected by *how* operating personnel process accounts payable, solder circuit boards, ship products, and so on. Operating personnel can communicate about the cost of activities to accountants, but they are hampered when accountants recast all that data around product cost. ABM refocuses the accountant's communications with others as well as his/her internal thought process, and makes accounting data an *operational tool* rather than a *recordkeeping tool*.

3. Interdependencies across the organization.
ABM also highlights interdependencies in organizations. Studying inputs and outputs of each activity pinpoints the linkage among activities in the organization. This analysis can facilitate finding the original reason that a follow on activity is performed, can help to identify redundant activities, or can highlight activities that are not synchronized. This analysis can result in lowered cost and less process time.

ABM leads to a improved *organizational decisions* in three major areas:

1. Product design.
Valuable decision making information is gained from collecting costs of activities, like knowing the total costs for a new part added to a product, the cost related to an engineering design change, the cost to setup a production process, or the costs of testing products. Such data can be useful to those whose decision and actions cause these costs to be incurred. Activity costing is a way of communicating to those personnel *before the costs are incurred* that certain actions or decisions they make drive costs. This information is very useful for designing new products or modifying existing ones.

2. Cost reductions.
ABM information also can be used to compare what activities cost us versus what others in the industry spend on them. This is a first step towards cost reductions and more efficient operations. Experience proves that cost reductions and efficiency don't come automatically. Constant management attention must be focused to achieve cost reductions. Traditional systems focus too much on costs such as material and labor that become a direct part of the product produced. In modern manufacturing environments and service organizations, other kinds of costs incurred to support and service customers and the organization are more important. In a manufacturing organization, service and support costs are at least 50 percent of the total costs.[8] These costs are important enough for an ABM system to exist which helps understand why the costs are incurred and how actions might be taken to reduce them.

Key Point

> Costs are not just incurred, they are *caused*. To reduce costs, reduce what *causes,* or drives activities to take place.

3. Budgeting.
Planning and budgeting become easier with ABM. Activities are the link between tasks performed, outputs achieved, and costs incurred. Budgets require operating personnel to think in terms of the tasks and activities they must perform for a certain level of output. It requires them to estimate the costs they will need to incur in order to perform. Capturing cost information about the activity cost actually incurred facilitates budgeting and cost control.

Behavioral Attributes.

ABM encourages good organizational behaviors. It reinforces the message that process knowledge is important and that continuous improvement is expected, and it empowers employees to participate in improving how things are done.

Communication that process knowledge matters.
ABM shifts an organization's focus from managing the costs of specific products or inventory totals to controlling the activities that create cost for the organization. It focuses attention on operations. ABM is a way of communicating that an in-depth understanding of

[8] Norm Raffish, "How Much Does That Product Really Cost?" *Management Accounting,* 1991. Reproduced in *Activity-Based Management in Action,* IMA, 1994, pp. 3–6.

how and why operations occur is important for managers and management accountants. Behaviorally, the old adage of what gets measured is important, applies here.

Reinforces TQM and continuous improvement.
ABM also encourages continuous improvement. Continuous improvement is an effort to achieve improvement in processes. Continuous improvement requires everyone involved in an activity to question why an activity takes place and to provide suggestions about how to improve. Cost measurement of activities provides benchmarks for those involved to see where they have improved. Behaviorally, ABM is an improvement over a one time study of activities and processes (like process value analysis) that does not have an associated costing mechanism. The costing of activities routinely provides a mechanism to sustain continuous improvement.[9]

Empowers employees.
Activity analysis empowers employees to participate. They know what they do and why they do it. An ABM system frees them to provide this input and provide suggestions to improve how things are done. It provides a link between organizational strategies and operations. It allows each employee to tie his/her work to how that work impacts the strategy of the organization. For empowerment to work, ABM must be introduced in an environment conducive to participation.

Negative impact.
A very negative behavioral impact of activity analysis is related to the use of "value" versus "non-value" terminology. The use of this language heightens people's natural tendency to resist change. The choice of value versus non-value language is unfortunate. It is deeply embedded in the literature now and is unlikely to disappear. It naturally causes discomfort and rejection of the idea of activity-based analysis. No one likes to hear that what they have done for years is non-value added. It makes people immediately suspicious that they are about to be fired, as well as demeans what they have spent a majority of their working lives doing. We strongly suggest that the language not be used. Another negative impact of activity analysis is that it can create a "fish bowl" effect. Observing people as they work can lead to a perception that ABM is a "disciplinary" mechanism rather than an improvement process. The purpose of ABM must be clearly communicated to the organization. Finally, sometimes ABM has resulted in the elimination of jobs. Employees have literally improved themselves out of a job! This can be avoided if those who contribute to improvement efforts know what personal outcomes to expect from such improvements.

Cultural Attributes.

ABM promotes a functional organizational culture but can also lead to cultural conflict. There are three ways it promotes a functional organizational culture:

1. It directs efforts towards managing processes and deemphasizes blaming people.
2. It challenges conventional wisdom.
3. It encourages cross-functional communication.

[9] Davenport, p. 145.

Organizations need to fix processes, not blame people.
ABM reorients the corporate mindset to think in terms of activities, their drivers, and costs. It is not a normal part of western culture to routinely study the activities we perform. Managers of units are simply held responsible for output. This has placed western organizations at a disadvantage relative to other cultures that reinforces routinely analyzing the way work is performed.

For example, a U.S. auto parts manufacturer, having difficulty competing with Japanese companies, realized that simply holding managers responsible for output was not working. The company divided its activities into three major activities based on their function. The three major activities were, core management, process improvement and problem solving. They compared their activities to similar classifications performed by their competitors. Japanese manufacturers had twice as many people devoted to process improvement. The U.S. company on the other hand dedicated four times as many people solving immediate, short-term problems.[10] Activity analysis showed the U.S. firm the differences in their management system. They began to manage their activities and processes and became more competitive.

ABM challenges conventional wisdom.
Activity costing prompts everyone to question the steps they perform and to know how their tasks and activities link to strategic objectives of the company. This may prove difficult to accept because the existing Western management paradigm views both improvement and innovation as lying outside routine management activities. Focusing on activities is an attempt to change this notion. Instead of accepting values such as *"if it ain't broke don't fix it,"* or *"this is the way it has always been done,"* ABM encourages critical self-examination and constant learning as organizational values.

ABM encourages cross-functional communication.
ABM provides a structure in which team work and cross-functional communication are both employed. Improvements require team work. While there is a growing recognition of the need for cross-functional team work, the culture of most organizations is still functional isolation and specialization. ABM is a good tool for breaking down functional silos and getting cross-functional communication going.

Cultural conflict.
While it can promote a healthy organizational culture, ABM can also cause conflict with some professional cultures. Defining work as a routine activity subject to ABM may be undesirable to some professionals. For example, senior bankers rejected activity analysis because they view their job as nonstructured "deal making." This problem usually arises when professionals don't want to admit that some process can be followed in their work, because it is in conflict with their self image.[11]

▲ OTHER RELATED ISSUES

Before we leave this topic, we need to consider how to select which activities and processes to analyze and the relationship of ABM to Activity Based Costing (ABC) and Business Process Reengineering (BPR).

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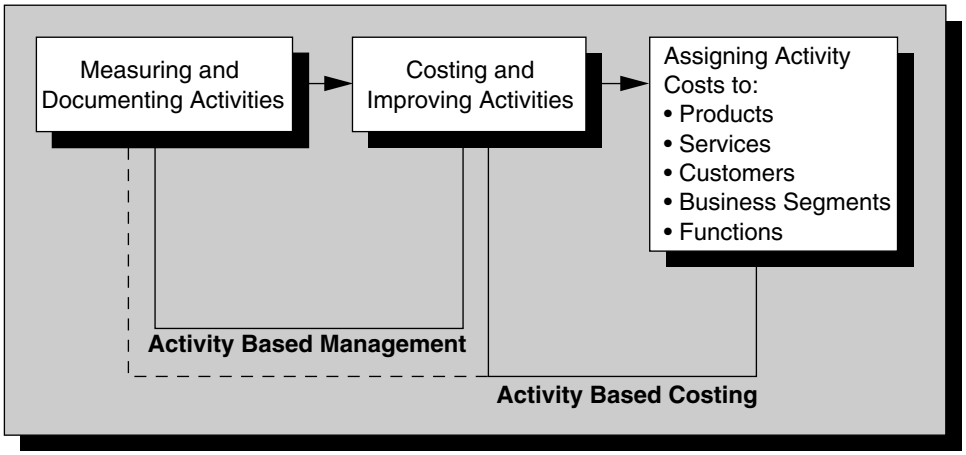
[10] M. Blaxill and T. Hout, "The Fallacy of The Overhead Quick Fix," *Harvard Business Review,* July-Aug. 1991, p. 98.
[11] Davenport, p. 138.

Exhibit 9
Relationship of ABM to ABC



Selecting activities to analyze.
Hundreds of activities exist in an organization. How do we decide which to subject to activity analysis? This is not an easy question. Again, judgment is required. It has been suggested that you take an approach which focuses on 20 percent of what the organization does that causes 80 percent of what you care about. Another way of thinking about this is that the analysis would start with those activities that cause 80 percent of the cost to be incurred, or 80 percent of the quality problems, or 80 percent of cycle time to occur. This type of analysis is called *Pareto analysis*.

Beyond deciding which activities to analyze, another crucial issue is how to get the savings that you are supposed to get from redesigning an activity. You cannot continue to keep the same equipment and space or employ the same people without any work for them to do. This simply creates excess capacity.

Key Point

After reengineering activities, it is essential to redeploy assets or reduce total spending to get true savings.

Relationship to other topics.
ABM is closely related to several additional topics such as Activity Based Costing, and Business Process Reengineering. While we briefly introduce each of these topics below, we cover each in detail in a separate module.

ABM is the first step toward *Activity Based Costing (ABC)*. It helps to provide better product cost data that enables an organization to make product or customer related decisions and to reduce product and process costs. Exhibit 9 shows that ABM is concerned with the activity as the object of interest, while ABC is concerned with secondary cost objects, such as products or customers. (The dotted line indicates that some authors define the entire chain as ABC while others define ABC as the part we call ABM.) While ABM is interested in asking how much an activity costs, ABC is interested in how other cost objects, such as products, consume activities. It uses consumption of *activities to trace and assign costs to these other cost objects*. For example, in a manufacturing environment,

the number of unique parts in a product may be used to assign the costs of procurement activities such as, purchasing and storing, to a product. This system of costing has advantages over traditional methods of product costing.

Business Process Reengineering is focused on making major changes to several of the most important processes a business performs; it makes significant changes in the way business is done. Process innovation results. Business Process Reengineering requires the use of benchmarking techniques and process analysis. It is a nonrepetitive, or "one time," special redesign effort. ABM is an ongoing system leading to continuous improvement in activities. It is a repetitive process and contains a costing mechanism to support it. Some of the steps of ABM involving activity analysis are useful to Business Process Reengineering.

▲ LESSONS LEARNED

ABM contains several important messages:

- ▲ Work is a process. Humans transform inputs they receive from suppliers into outputs they supply customers through the activities they perform. Which activities or processes are undertaken and how they are performed affect the quality, cost, and timeliness of an organization's products and services.
- ▲ Activities in a business form a system of interdependent processes that have an aim, which is to exceed customers' expectations profitably. Management's job is to ensure that its activities are customer focused, necessary, efficient, synchronized, and complementary.
- ▲ In the past, corporations have had a tradition of "managing by the numbers." This tradition encouraged employees and suppliers to manipulate processes in order to achieve accounting goals.[12] ABM is a process of collecting information on activities performed, their linkages, their costs, and their drivers. ABM reorients organizational participants toward understanding and managing work processes.
- ▲ Accountants are expected to act as business advisors to management. They cannot suggest how to be more efficient and effective without documenting what activities are done, how they are done, what they cost, why they are worth doing, and what ways exist to improve. Work activities must be managed, and accountants must focus on providing information about activities and their costs to facilitate management.

[12] Deming in T. Johnson, "It's Time to Stop Overselling Activity-Based Concepts," *Management Accounting,* September, 1992. p. 48.

▲ COMMON TERMS

Activity An activity is the work (series of tasks) performed in an organization. It represents what we do such as unload a truck, open a letter, or write a check. (See process diagram.)

Allocation An allocation is an apportionment or distribution of a common cost between two or more cost objects. In accounting allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost we want to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It refers to the price paid for acquiring a product or service.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object A cost object is any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Continuous Improvement A program to improve the strategic variables of quality, cost, or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is **subconsciously** used to interpret events and take action. It is often called the **collective programming** of the subconscious mind.

Driver A driver is any event, circumstance or condition that causes something to happen. For example, a cost driver is a factor(s) that causes costs to change.

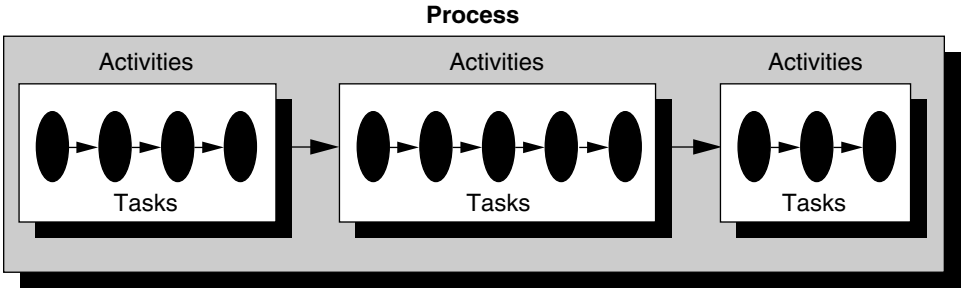
Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations.

Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on factory building is an example of a fixed production cost.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A process is a series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality Quality is a customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy Strategy is the way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. What is the relationship between activity information and budgeting decisions?
b. What is activity-based management (ABM)? How does it differ from activity-based costing (ABC)?
c. What factors contributed to the rise in interest in activity-based management?
d. What is activity analysis?
e. What is a task? An activity? A process?
f. What is the relationship between tasks, activities, and processes?
g. How is activity analysis used in finding better ways for an organization to perform?
h. What steps are required to complete an activity-based analysis?
i. What are resources? How are they related to the tasks and activities performed and the organization's processes?
j. What is the relationship between the inputs, outputs, and cost drivers of activities in a process and performance measures?
k. What is brainstorming and how does it relate to an activity analysis?
l. How are the terms "value-added" and "non-value-added" used in activity analysis?
m. What are the methods commonly used to gather information about activities? Briefly describe them.
n. What is storyboarding? How is it used in performing an activity analysis?
o. How does ABM enhance a manager's understanding of an organization's work process and costs?
p. How does ABM encourage good organizational behavior?
q. How does ABM lead to improved organizational decisions?
r. What are some of the negative impacts on employees that can lead to their rejecting activity-based analysis?
s. How does ABM promote a functional organizational culture?
t. How are the activities and processes to be analyzed selected?
u. What are the important messages provided by ABM?

2. Assume that one of the values displayed on bulletin boards and contained in employee manuals and other command media of your organization is ***"We believe in our people."*** This is reinforced in training programs. Managers remind employees that this means "We believe that our people will conduct themselves responsibly with a minimum of supervision."[13]

Required:

If this belief were widely held in your company, and an ABM initiative were scheduled for implementation, how might employees be expected to react? Include in your answer your

[13] This problem is based on a journal article written by Roger Beynon, "Change Management as a Platform for Activity-Based Management," *Journal of Cost Management,* Vol. 6, No. 2, Summer, 1992, pp. 24–30.

*Some material for this section was contributed by Paul D. Dierks, Wake Forest University—MBA and Paul E. Juras, Wake Forest University.

thoughts about the steps in activity-based management and their behavioral and cultural impacts. How might you lessen resistance to this new initiative?

3. Typically a cost accountant's self-image is based on his or her professional status. Many years were invested in learning ways of identifying, measuring, and reporting managerial accounting information. Within an organization, he or she is recognized for an ability to work with data from a complex, traditional accounting system. If an important problem needs solving, management requests the accountant to be assigned because of this knowledge and well-developed investigative skills. The cost accountant's value to the company is defined by the quality of his or her contribution to the company's conventional managerial accounting system.

Required:

How is this accountant likely to respond to the introduction of ABM?[14]

4. Katherine Mitchell, president of Salem Enterprises, has just returned from an executive education seminar dealing with managing costs. One of the topics that caught her attention related to the use of ABM. The instructor's quote that "Costs are not incurred, they are caused" is what really stuck in her mind. She learned some of the benefits of an activity-based system and thinks such a system might work in her company, but she has some concerns.

She has asked you to research the topic and write a memo addressing the following items:

Required:

1. Exactly what is meant by "Costs are not incurred, they are caused?"
2. How does ABM help uncover what causes cost?
3. What are the types and level of detail of activity information needed for ABM?
4. What pitfalls and/or organizational barriers may affect the success of an ABM system implementation?

5. An accounts payable department provides bill-paying services to several agencies of a state government. The department works two shifts, five days per week and has the capacity to process 40,000 payments, or checks, per week. Only the accounts payable department uses its space and computer equipment.

A time analysis of the work performed by the department revealed the following:

1. The department spends 45 percent of the time issuing 30,000 checks.
2. From paperwork arrival to check issuance normally takes 25 working days.
3. Five percent of the time, employees are waiting for paperwork or available computers so they can perform work.
4. Resolving problems with suppliers or with paperwork submitted by agencies takes 30 percent of the time.
5. Errors that require the clerks to rework 6,000 checks take 20 percent of the time.

The total budget for the department is $372,000. The budget detail is as follows:

1. $100,000 for space, utilities, and computers.
2. $200,000 for salaries and benefits for two shifts.
3. $72,000 for consumable supplies.

[14] Ibid.

Required:

1. Consider the results from the time analysis. Which of the activities would you consider productive uses of time? Why?
2. Which of the activities from the time analysis would you classify as nonproductive or as activities which do not contribute to the company's output? Why?
3. How much do nonproductive activities cost the department?
4. How much of workers' time would you classify as idle? What does idle time cost in this department?
5. What causes work to begin in this department? Who wants this work performed?
6. What are the outputs of the department?
7. What performance measures should be established for this activity?
8. What does it currently cost to issue a check?
9. Brainstorm. You have been asked to suggest improvements to this department's manager. About which activities would you like more detail? Would you like to redesign work so that any activities are eliminated? Which ones and why?

6. A packaging department services the catalog distribution operations of Favco, a major department store. The packaging department works three shifts, five days per week. The department has the capacity to package 90,000 customer orders per week. Only the packaging department uses its space and equipment.

An analysis of activities that are part of the overall process shows the following:

1. The department spends 55 percent of the time packaging 70,000 items.
2. Approximately 20 percent of workers' time is spent waiting for merchandise and for available packaging equipment and supplies.
3. Five percent of the time, workers search files for the manufacturer's packaging instructions for merchandise requiring special handling.
4. Resolving problems with packaging suppliers takes eight percent of the time.
5. Errors that require the associates to repackage 14,000 products take 12 percent of the time.
6. Eight percent of shipped merchandise is returned to Favco because of damage due to improper packaging or an incorrect address.
7. It takes five days on average from the time an order is placed to the time an item is shipped. Currently no express service is offered.

The total budget for the department is $576,000. The budget detail is as follows:

1. $150,000 for continually available space and packaging machines.
2. $300,000 for salaries and benefits for employees for three shifts.
3. $126,000 for consumable supplies.

Required:

1. What does it currently cost Favco to ship a package?
2. Who is the customer of Favco's packaging department? What do they want from the packaging department? Do you think that the customer's needs are being met? Why or why not?
3. What drives the activities in the packaging department to begin?
4. What are the outputs from the packaging department?
5. What performance measures are appropriate for this department?
6. Brainstorm. Study the analysis of activities provided above. Which of these activities are productive? Nonproductive? How is Favco's packaging department performing on

the performance measures you identified in requirement 5? What thoughts do you have about improving this packaging department?

7. Merchant tellers perform a variety of tasks at a bank. One of those is to handle merchants' daily deposits. When a customer enters the bank to make a commercial deposit, he or she enters the merchant teller line. The teller, who may be occupied with other business at the time, concludes what he or she is doing as promptly as possible, comes to the window, and signals the customer to approach the window. The customer opens a sealed compartment, inserts a completed deposit slip (typically in duplicate), cash, and batches of checks with adding machine tapes attached. When the customer closes the compartment, the teller opens the compartment and removes the items. First, the deposit slip is totaled by the cashier. The customer's account number is entered into the computer to begin the process of updating the account for the deposit. Next, currency is separated and counted. Ones are counted by machine. Ones are grouped by the teller into stacks of $25 and paper clipped. Groups of four stacks are banded and marked. Fives are grouped into stacks of $200s, tens $100, and so forth. An adding machine tape is then run of all currency amounts and compared with the amount indicated on the deposit slip. When the two agree, the teller initials the amount on the deposit slip. If the amounts do not agree, the process is repeated. Coins, wrapped, are inspected for size of package and for the customer's bank number. These are counted and compared to the deposit slip; again agreement results in initials placed on the slip. When the deposit slip and count of all cash items agree, the teller prepares a cash slip to place with the remaining paperwork and deposit and places the cash in a drawer. If the two do not agree, a recount is done. If agreement still does not occur, another clerk assists in the transaction. If the customer has made a mistake, the deposit slip is returned for correction and signature.

Checks are quickly inspected for endorsement, maker, and signature. The adding machine tape totals attached to check batches are compared to the listings on the face of the deposit slip. Assuming they agree, the deposit slip is receipted by amount and signature of the teller, if the total of the deposit is within the amount that he or she has the authority to accept. If the total exceeds the teller's authority, a supervisor reviews the deposit and paperwork and authorizes the transaction. The transaction amount is used to update the merchant's computer file. Then, one copy of the deposit slip, a cash slip, and the checks, bound together, are placed in the teller's drawer. The duplicate deposit slip with a bank receipt is given to the customer.

Required:

1. What drives this activity to begin?
2. Diagram the tasks that comprise the activity, merchant cash deposit.
3. What resources are consumed by these activities? (Identify each item that exists at the merchant teller's window, as well as space, workers or items shared with others.)
4. What resource driver would you use to assign each resource to the activity?
5. What performance measures would you establish for this activity? Why?

8. Refer to question 7. Assume that a competing bank offers merchants an opportunity to drop off their deposits in a sealed bag. The transactions are then processed by back-room employees and a telephone call is placed to merchants whose deposit slips disagree with amounts verified by bank employees.

Required:

1. Evaluate this merchant teller service from the perspective of the customer. Comment on how merchants would assess the service on quality, cost, and time dimensions.
2. Evaluate this service from the perspective of the bank. How would it impact internal assessments of quality, cost, and time? Why is an internal perspective not the same as a customer's perspective?
3. Are there any reasons why this service may not be acceptable to customers?

9. Waveco Electronics makes products for three different product lines. In recent years new products have been introduced in each of these lines. This has caused the number of products produced to increase greatly. Waveco's manufacturing facility, which manufacturers all products, has three production departments: machining, plating and assembly. It also contains several service departments that provide services within the manufacturing facility but do not manufacture or assemble products. These are purchasing, warehousing and inventory control, setup and scheduling, maintenance, and testing and quality control.

Waveco has a traditional responsibility reporting system with all costs first traced to a department. Since products are not worked on by the service departments, the costs of service departments are allocated to production departments, which include them in the costs assigned to each product produced. Under this system the costs of purchasing and warehousing and inventory control are assigned to the production departments based on the dollar amount of raw materials put into process by each. Setup and scheduling as well as maintenance are charged to departments based on the number of machine hours in each production department. Testing and quality control costs are assigned based on the direct labor costs incurred in each department.

Waveco has become concerned about its procedures. While allocation has always been done this way, marketing personnel are complaining about product prices. New products are always priced below competition and sell well, but established products' costs have increased over time. Marketing personnel believe that new products must cause costs to increase greatly, but that all products bear an average part of that increase because of the allocation methods used. Accounting confirms that this may occur. The marketing manager believes that this unfairly burdens the existing products in the line, making them uneconomical compared with those of overseas competitors.

To understand the nature of these complaints, management has formed a team comprised of a representative from marketing, accounting, engineering, and setup and scheduling to study the activities performed and costs incurred by setup and scheduling. The team first obtained the responsibility unit's cost report for the most recent year, as shown below:

Cost Element	***Amount***
Manager's Salary	$55,000
Employees' Wages	525,000
Occupancy Costs	18,000
Furniture & Fixtures	2,000
Computers & Software	10,000
Training & Travel	15,000
Total Costs	**$625,000**

Investigating further, the team obtained the following information:

Cost Element	*How the Cost Is Incurred*	*Use by Setup & Scheduling*
Manager's Salary	Supervises 15 workers	Time is split approximately 70–30 between supervision of setup and scheduling.
Employees' Wages	15 employees; production schedulers earn $40,000 on average. Setup employees earn $33,750 on average. These amounts include benefits.	3 workers do production scheduling; 12 perform setups
Occupancy Costs	Charged to each department based on the number of square feet in their area at a rate of $18 per square foot	Production scheduling occupies approximately 50% of the department's space.
Furniture & Fixtures	$400 per work station (desk, cabinets, chair and telephone); 5 stations exist	1 station used by Manager; 3 by scheduling. Remaining station is for setup personnel.
Computers & Software	5 computers; $2,000 each charged annually for software, hardware, and maintenance.	Each workstation in the department has a computer.
Training & Travel	Requested by Manager for specific purposes	40% is typically used by Manager for his or her attendance at industry meetings, 40% for training of production schedulers, and 20% for setup employees.

An interview with the manager revealed that the more difficult job is production scheduling. Different products require different amounts of time in the three production areas. Because of the expense of machinery, Waveco operates at 90 percent of its machine capacity. Effort has to be expended in scheduling to prevent bottlenecking in the machining department, while delivering products according to customers' demands. As new products are added to production, scheduling becomes much more difficult.

Setup is a simpler task. Setup is performed only for the machining department. The department manager checks the production schedule to see which products will be produced on which machines in which time period. Every time a different product is put into production, a person from setup is assigned to perform the required steps. The setup is the same for any size production run. No setup takes longer time than any other. In addition, all setups require approximately the same skill, so any setup employee can do the job.

The team decided that the two major activities of the department, setup and scheduling, should be analyzed and costed separately.

Required:

1. Cost the two major activities of the department separately. Explain why you used each resource driver to cost the activity.
2. How would you assign setup costs to products? Why? (The driver you would use to assign costs to products is called a "cost driver.")
3. If you were interested in determining if the setup activity was being performed efficiently and effectively, what additional steps would you perform? Why?
4. Write a memo responding to management about the concerns raised by marketing.

10. A typical claims adjuster has a very complex job. He or she is responsible for settling claims fairly, while protecting the insurance company's interest. Depending on the complexity of the assigned claims, work on an individual claim can range from several days to several years. Each adjuster has a mix of claims assigned. Except for payments to outside authorities and final settlements, costs of handling claims have not been determined. Operating expenses incurred by claims adjusters have typically been assigned to product lines (policy coverage offered) in an arbitrary fashion.

To determine if their policy premium structure is appropriate, management is interested in applying activity-based analysis. They have come to you for your assistance. Upon interviewing claims adjusters and their supervisors, you learn that the activities performed on a claim include: investigating the facts of the claim, evaluating the amount of damages incurred; managing outside authorities such as accident experts, attorneys, and medical authorities; documenting facts and damages; negotiating settlements with claimants; making court appearances; processing payments; and estimating amounts needed to cover future payments. The amount of time and resources devoted to each activity depends on the size and nature of the loss as well as on the legal jurisdiction for the claim.

Your job is to determine the cost and time required by the various activities for each type of policy coverage offered by the insurance company.

Required:

1. What drives resource use on a claim?
2. What are the potential resources consumed by a claim?
3. Prepare an assumed activity flow for a claim from the above description.
4. How would you analyze the time spent and resources consumed by claims adjusters on these activities? Remember that each adjuster has a mix of claims, with work on claims ranging from several days to several years.

11. Team project assignment.

You are to select an activity performed within an organizational process and analyze it. The activity you choose to analyze should be small enough for you to understand and document as illustrated in the Activity-Based Management Module. You can select an activity one of your group members performs at work—such as approving a customer order, selecting an item from a warehouse to fill a requisition, taking a customer order at a fast food restaurant, selling traveler's checks to a bank customer, or answering customer complaints or inquiries. If no one in your group works, select an activity all team members can observe. An example might be to observe workers in a fast food restaurant take an order, make the food, and deliver it to the customer. Another example might be to observe the steps involved in checking out reserved material at the library. There is no shortage of activities to observe, cost, and analyze. You should, however, seek permission to observe and ask questions before you start.

Identify what organizational process your activity belongs in. Document the purpose of the activity, what causes it to begin, what its outputs are, the time it takes, the tasks it involves, and your assessment of its performance quality. You are to determine what it currently costs to perform the activity. Indicate what resources the activity consumes, decide on resource drivers appropriate for each, and estimate the cost of performing the activity. The cost estimates should be reasonable and will involve asking questions of others about rates for space, telephones, computers, software, and so forth. Suggest various suitable performance measures for this activity and explain why they are suitable. Your report must also suggest ways of reducing costs, increasing quality, or improving on the time it takes to perform the activity.

Rules.

Be professional in the handling of information provided by others. Ask permission of the person from whom you obtain information to use it in your project. Disguise the company name and cost data if requested. Avoid asking about the salary paid to any specific person. Instead ask about salaries (or hourly pay) and benefits of different classifications of workers who might perform the job. Do not turn in the report until your group has discussed your findings with the person from whom you received information. Your group meeting minutes must indicate that you have gained permission to use information and have shared your findings with the organization studied.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

Mark Blaxill and Thomas Hout in "The Fallacy of the Overhead Quick Fix," *Harvard Business Review,* July–August, 1991, reported that a team from a competition-battered, auto parts manufacturer visited a Japanese affiliate to tour its manufacturing operations. Among their findings, the team reported that for the same production volume, the Japanese company's overhead was typically less than half that of the U.S. company.

When the team returned to their own organization, they realized that their organization did not capture information about the contributions of overhead employees. After debate, they decided that overhead workers fell into three categories: core management, process improvers, and problem fixers. Core management ran the plant and included the general manager, facilities maintenance people, and production control engineers. Process improvers searched for ways to make things better through continuous improvement. This group included process engineers, R&D engineers, materials engineers, and purchasing managers. Problem fixers kept production moving. They were the inspectors, expediters, extra materials handlers, and troubleshooters.

Required:

Can ABM be employed by this auto parts manufacturer to address its overhead problem? If so, how?

Case: Loan Analysis Department in a Southwestern State

Loan Analysis is a large department in a southwestern state that receives its funding from fees charged other state agencies for services rendered. There are currently 15 state agencies that provide loan funds to citizens meeting preset criteria such as income, student status, disaster relief, and business location. The Loan Analysis department processes all the loan documents generated by these lending agencies and charges them a fee for processing services based on the average cost of processing loans.

Background.
The Loan Analysis department is twenty years old and is an offshoot of the original student loan agency, which still provides about one third of the work for the department. When other state agencies began to make loans, it seemed logical to have a single department process all loans. Loan Analysis already had the necessary expertise and control systems in place and received the business.

Until recently no state loan funds could be released by any agency until Loan Analysis provided complete paperwork. However, a recent reform law permits an agency to contract for services outside the government if the cost is at least 10 percent below the internal agency's charges for the same quality work. An agency can also go outside if it can document major problems with the work of an internal service agency. This law was part of a recent campaign to reduce the cost of government services, while improving the quality and timeliness of these services.

Loan Analysis has always prided itself on the quality of its work. Now, much to the chagrin of the department's chief administrator, there are a number of complaints about the cost and timeliness of service, and requests to take business external have emerged. A quick analysis of complaints shows that the *cost complaints* are coming primarily from larger loan agencies and the *timeliness complaints* from smaller agencies.

The existing process.
When loan applications arrive from other agencies by regular mail, runner, or internal mail, a *loan logger* carefully logs each loan into a computer database and gives the application a unique number. This process takes about 10 minutes per loan. The loan applications are accumulated by submitting agency (loan type) until a group of 100 applications exists or the first application has been waiting for processing for one week. To accumulate a batch of student loans, it takes four hours. For other large agency loans, it takes two days and for small agency loans, it takes a week. All logged loan applications are stored in a controlled area until requisitioned through use of a special form. The primary reason for grouping loans into batches is that there are different requirements for each type of loan and fewer mistakes occur when "information checkers" check for the proper requirements of similar loans. This ensures compliance with legal loan requirements.

The larger agencies send enough loans to start the processing cycle several times each week. Smaller agencies frequently have loans processed only once a week. Each morning information checkers start with student loans because there are always batches of at least 100 from this agency. Once the student loans are in process, work begins on the loans from remaining agencies. Each loan batch is forwarded to the next available information checker.

The information checker reviews each application in a batch to be certain the data is complete and attaches a checklist noting incomplete data. This process takes four to six hours per batch. Large lending agencies have become fairly good about getting complete information on the applications, but at least one piece of information is missing on about five percent of smaller agencies' loan applications. Incomplete applications are sent to an *incomplete facilitator* who works with the submitting agency until all the data is complete, a process that takes 18 hours on average. As the necessary data on these incomplete applications is obtained, the loans are accumulated by loan type until there are at least five of each type. (The maximum wait time is one week.) They are then processed with the next batch of that type of loan. Completed, batched loan applications are sent to data entry twice a day. There is careful control of all complete and incomplete loans in the computerized loan log.

A *data entry specialist* enters batches of complete loan applications into a computer system using a template designed for this particular loan type. This template automatically performs several data checks and identifies questions that may require analysis. Questions

about income, eligibility, and other factors are printed and directed to individuals trained in these particular areas. There are *income analysts, eligibility analysts,* and *other issue analysts.* Usually in a full batch, three to five of each type of question require additional analysis. While these queries are being completed, the entire batch is carefully controlled at an in-process storage site. Answered queries return to a special data processing clerk for entry into the computer loan file. The template also assigns an initial loan acceptability number to each loan. A full analysis of loans from large agencies is completed in six hours. Special purpose loans from smaller agencies take approximately twice as much time because more variations in lending factors must be considered.

After clearing all queries (some loan files go to an exception area and supervisors do additional follow-up), the loans are sent to *loan data analysts.* This transfer occurs at the end of each day. The analysts select credit references and other data from each application to review. They also order credit checks and other queries. This selection processes takes about four hours per batch. Since the credit checks come back in one day, usually electronically, loan processing continues as soon as the credit checks are received. The loans are then passed to a *credit analysis* group, which ranks each loan on a predetermined numerical scale of acceptability. Once this step is complete (usually only a one-hour process), loans go to *general analysts* who follow up on other queries and make certain that all reference checks are complete. This step can take from four hours to three days (averaging 14 hours). These individuals also provide information on a numerical scale about how well the applicant meets the established lending agency criteria.

Finally a loan application reaches a *letter writer* who summarizes the loan findings by inserting the numerical analysis into a standard form letter and adding any special notations on the loan made by any individual involved in the process. The loan batch is in this area for about one day although each application letter takes only about 15 minutes.

The Loan Analysis department also has a quality department that regularly reviews a random sample of loan applications and identifies any problems. This is done before sending loan letters to the agencies. The analysis may take half a day for a typical batch of loans. Batches are returned to the originating agency on the day following inspection.

Experienced supervisors in each of the work areas monitor work and deal with any special problems that arise. State internal auditors regularly do their own analysis of the department and its procedures and issue a report about compliance with procedures in each work area.

Additional information.

The individuals working for the Loan Analysis department have several different state pay classifications (for simplicity we provide the average wage). Loan loggers, information checkers, data entry individuals, and letter writers currently earn $22,000. All of the analysis people except general analysts earn $24,000. The general analysts earn $25,000. Incomplete form and inspection people are usually more experienced and earn $30,000, as do quality reviewers. Supervisors and first level administrators earn $35,000. Most departmental accountants, programmers, and other specialists earn $40,000, while an upper level administrator earns $45,000. Benefits are assumed to add 25 percent to these amounts.

The Loan Analysis department has a modern computer system that it leases from another state agency for $6 million a year. There are also telephone and other office related costs associated with the department amounting to $2 million a year. Office space is provided by the state in one of its office buildings and there is currently no charge for this space. Similar commercial space would cost the department about $2 million a year. Consumable supplies cost $250,000 annually.

Accountants regularly provide the departmental administrator with cost data. They also report error rates in processing to supervisors. A detailed budget prepared on a yearly

basis makes some fairly sophisticated assumptions about the volume of loans that will be processed. This becomes the basis of the fees charged to other departments. Currently there is a standard fee for all loan analysis, but the department grants a five percent volume discount to agencies processing more than 5,000 loans a year and a 10 percent discount to the student loan department because of its very large volume. There have been some preliminary discussions within the administrative council about finding a pricing system that does a better job of reflecting the real cost of processing individual loans.

The problem.

The Loan Analysis department is facing a crisis. The administrator has heard rumors that the student loan department is planning to request a 20 percent price reduction for loan processing, while several smaller agencies are going to demand a 75 percent time reduction in loan processing with no increase in cost. Even more disturbing was the information that these agencies had found outside firms willing to meet these requirements. The administrative council discussed this problem in a recent meeting and was at a loss about how to react if such drastic requests came forward.

The administrator is familiar with your recent work on private sector production processes and decided to ask your advice in preparing to deal with the impending requests. You have free reign to make any comments and suggestions you like. However, the administrator would like to be certain that you address the following issues:

1. Are there fundamental problems with the existing loan analysis process? If so, what are these problems?
2. Assume we must meet a 20 percent fee reduction target for the student loan department. Suggest how this will be accomplished without any significant new capital investment.
3. Assume we must meet a 75 percent time reduction target for the smaller agencies. Identify how to make this feasible without any new capital investment.
4. Assume we must meet both targets within two years. How would you propose the agency reorganize work to meet this challenge?

Required:

Using ABM, answer the questions for the Loan Analysis Administrator. Document both existing and suggested activity flow. Cost the existing activity and make an estimate of the cost of the proposed activity. Address how quality and time would be impacted by your suggestions. Exhibits 10 and 11 provide additional data that may be useful in your analysis.

Exhibit 10
Summary of Loans Analyzed

Type of Agency	*Number of Agencies*	*Number of Loans in This Category*
Student Loans	1	37,000
Agencies with more than 5,000 loans per year	5	65,000
Agencies with fewer than 5,000 loans per year	9	20,000
Totals	15	122,000

Exhibit 11
Number of Employees by Type

Type of Employee	*Quantity*
Loan Loggers	11
Information Checkers	12
Data Entry Specialist	8
Letter Writers	5
Analysts	10
General Analysts	10
Incomplete Facilitators	6
Inspectors & Quality Reviewers	6
Supervisors	12
First Level Administrators	4
Accountants	2
Programmers	2
Specialists	4
Upper Level Administrator	1

NOTES

M O D U L E

Indirect Costs

Version 1.1

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Module Contents
Indirect Costs

Indirect Costs

THE SEVEN DOLLAR ASPIRIN

A former patient in a California hospital wrote to Ann Landers and complained about being charged $7.00 for a simple aspirin tablet during his hospital stay. Ann Landers, in her response, explained that the cost charged for the tablet included not only the amount paid to the supplier for the tablet (around $.012) but also other charges. These included costs for the prescribing physician's time, the dispensing pharmacist's time, the administering nurse's time, the medical record department's cost of keeping records, and a surcharge for the hospital's unreimbursed Medicare patient charges. The assignment or "allocation" of these "indirect costs" increased the hospital's cost of an aspirin from $.012 to $3.50. The hospital then added another $3.50 for profit, and charged the patient $7.00 for the tablet.[1]

▲ STRATEGIC IMPLICATIONS OF INDIRECT COSTS

For students of management accounting, this story about indirect costs raises several important strategic issues.

- ▲ **Quality.** Indirect costs are necessary for an organization to meet customers' demands for quality. Supervision of patients' medication for all drugs, even aspirin, reduces the risk of giving the patient the wrong medication or administering drugs to which the patient may have an allergic reaction. This policy, while making the aspirin more expensive, contributes to the quality of care provided. The strategic question is whether the size of these indirect costs are in line with the additional quality of medical care provided.
- ▲ **Cost.** Indirect costs often account for a large portion of a product or service's total cost. (Indirect costs are 99.7 percent of the total cost of aspirin in the Ann Lander's story.) How these costs are controlled, measured, and allocated influences perception of product cost and profitability. If the magnitude of this cost can be reduced by using better or more efficient means to deliver these services, the cost of medical care can be reduced and a hospital's overall profitability can be increased.
- ▲ **Time.** Indirect costs increase because the hospital maintains a twenty-four hour pharmacy. This policy provides the capacity to deliver medication with greater immediacy. While this makes the aspirin cost more, strategic decision makers may choose to incur this cost if they judge timeliness essential.

[1] "The Legacy of the $7 Aspirin," *Management Accounting*, April 1990, pp. 38–41.

▲ PURPOSE OF THIS MODULE

This module explains the measurement and allocation of indirect costs. Its purpose is to introduce the conceptual issues related to indirect costs. Specific types of allocation schemes used in organizations are discussed in other modules. After studying this module, you should understand:

- ▲ The nature of indirect costs.
- ▲ The types of indirect costs and where each occurs in an organization.
- ▲ Common terminology used to describe the indirect costs of an organization.
- ▲ Why and how to allocate indirect costs.
- ▲ How far in the organization to extend allocations of indirect costs.
- ▲ Technical, behavioral, and cultural attributes of alternative allocation schemes.
- ▲ Criteria for selecting among allocation schemes.
- ▲ Nonmanagement uses of allocations, including government contracting and external financial reporting.

▲ THE NATURE OF INDIRECT COSTS

Indirect costs are *common to more than one cost object* and therefore are not uniquely traced to a particular cost object. A *cost object* is any item (i.e., activity, function, segment, product, or service) whose cost is to be determined. *Direct costs* can be easily traced to a cost object. It is not hard to determine how much material goes into an item of clothing or how much labor was spent making the item.

Indirect cost items are more challenging. Sometimes these arise because *management makes a decision to share a cost* element among products. For example, because of expense, sewing machines are not dedicated to producing one clothing item. How much of the cost of a shared sewing machine goes into a particular clothing item? In many situations it is *physically impossible to trace a cost to a cost object*. Consider the cost of feeding and raising cattle. How much of this cost is for prime rib? How much for roast? A third reason indirect costs exist is because *accountants decide, for cost or benefit reasons, to treat an item as indirect*. Consider the thread which goes into a piece of clothing. Unlike the sewing machine, an accountant could determine how much thread is in a particular item, but may elect to treat the cost of thread as common to all clothing items produced. In practice, costs are classified as indirect if management judges that the cost of tracing them to a cost object exceeds the benefit of doing so.

In this module the term *indirect cost* is used broadly to mean a cost that cannot be traced physically, economically, or practically to a specific cost object.[2] **Two key points to remember are:**

> A cost that is indirect with respect to one cost object may be direct with respect to a different cost object.

[2] It is important to avoid confusing this general use of the term indirect costs with a more specific way accountants use it when referring to **production costs** as direct or indirect. Terms such as "indirect labor" or "indirect material" would mean that the costs were incurred by the production area but not directly related to a single product.

Consider a manufacturing cell (a production location in a factory) that molds a group of motor parts. The workers in the cell operate machinery which they reprogram as motor part specifications change. The workers' salaries are **indirect costs of a specific motor part** produced, but are **direct costs of this manufacturing cell.** Notice that the change in cost object from a specific motor part to the manufacturing cell caused the classification of the workers' salary to change from indirect to direct.

Key Point

> Even though a cost cannot be traced to a product or service does not mean that the cost is unnecessary and unimportant. Both direct and indirect costs should help the organization provide customers with quality product on a timely basis at a competitive cost.[3]

For example, rent on factory space may be indirect with respect to a product produced or to a specific manufacturing cell, but is clearly a necessary expense for production to take place.

In the aspirin example, the cost of keeping medical records is indirect to the cost object, a dose of **aspirin.** If the cost object is the cost of the **medical records department** for a time period, then the cost of recordkeeping would be direct. Also, if quality of care and timely delivery of pain medications are desired by patients, then these expenses may be necessary.

Where Do Indirect Costs Occur In Organizations?

Every organization, manufacturing or service, profit or nonprofit, government or business, has indirect costs. The size and types of indirect costs encountered depend on the nature of the organization. The terminology used to describe indirect costs also varies. It depends on where in the organization the cost is incurred and for what function. Several common types of indirect costs are described in the following text. Note that each category contains many different types of cost elements.

Corporate overhead.

Consider a company such as Chrysler Corporation. The corporate headquarters in Detroit incurs costs for top management salaries, the legal department, the accounting department, product research, insurance, and utilities. These costs are indirect with respect to the cars produced by Chrysler at its world-wide manufacturing or sales locations.

Group or division overhead.

Hughes Electronics Corporation, owned by General Motors, is organized into product groups such as Defense, DIRECTV, Automotive, and Telecommunications. Each of these groups has several production plants. Each group incurs costs for salaries, rent, utilities, and computers. These group level costs are indirect with respect to production plants or products produced.

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[3] Costs are also incurred to satisfy constraints imposed by other aspects of the business environment such as regulatory authorities, governmental programs, tax codes, or obligations to employees under labor contracts. The discussion of this issue is deferred.

Factory overhead.
Hewlett-Packard uses a soldering machine to solder many different kinds of circuit boards. The cost of this machine is part of factory overhead and is common to the different circuit boards produced. Hewlett-Packard treats other factory specific overhead costs such as rent, supervision, maintenance, insurance, and utilities as common to all products produced.

Marketing.
Book sales representatives for Irwin Publishing call on many different professors and universities on any single trip. The costs incurred for travel, food and lodging, and promotional materials describing Irwin's books are common to all textbook adoptions resulting from the trip.

Joint cost.
Farmer John sells pork. The cost of raising pigs and processing them is common to all products—bacon, sausage, chops, shoulder, and ribs. Joint costs are thus indirect with respect to the products Farmer John sells.

Exhibit 1 illustrates where indirect costs occur in an organization. It shows that indirect costs flow downward in the organization to other subunits. This is depicted as costs flowing through pipes in Exhibit 1.

▲ ALLOCATION OF INDIRECT COSTS

Allocation is the assignment or sharing of indirect costs to cost objects. Basically, allocation involves dividing indirect costs by some physical quantity. Examples of physical quantities used for denominators are labor hours, machine hours, square feet, number of employees, number of inspections, and number of parts. A great deal of effort is spent determining what should go into the numerator and denominator of this equation. To evaluate these allocation efforts, it is necessary to understand why costs are allocated.

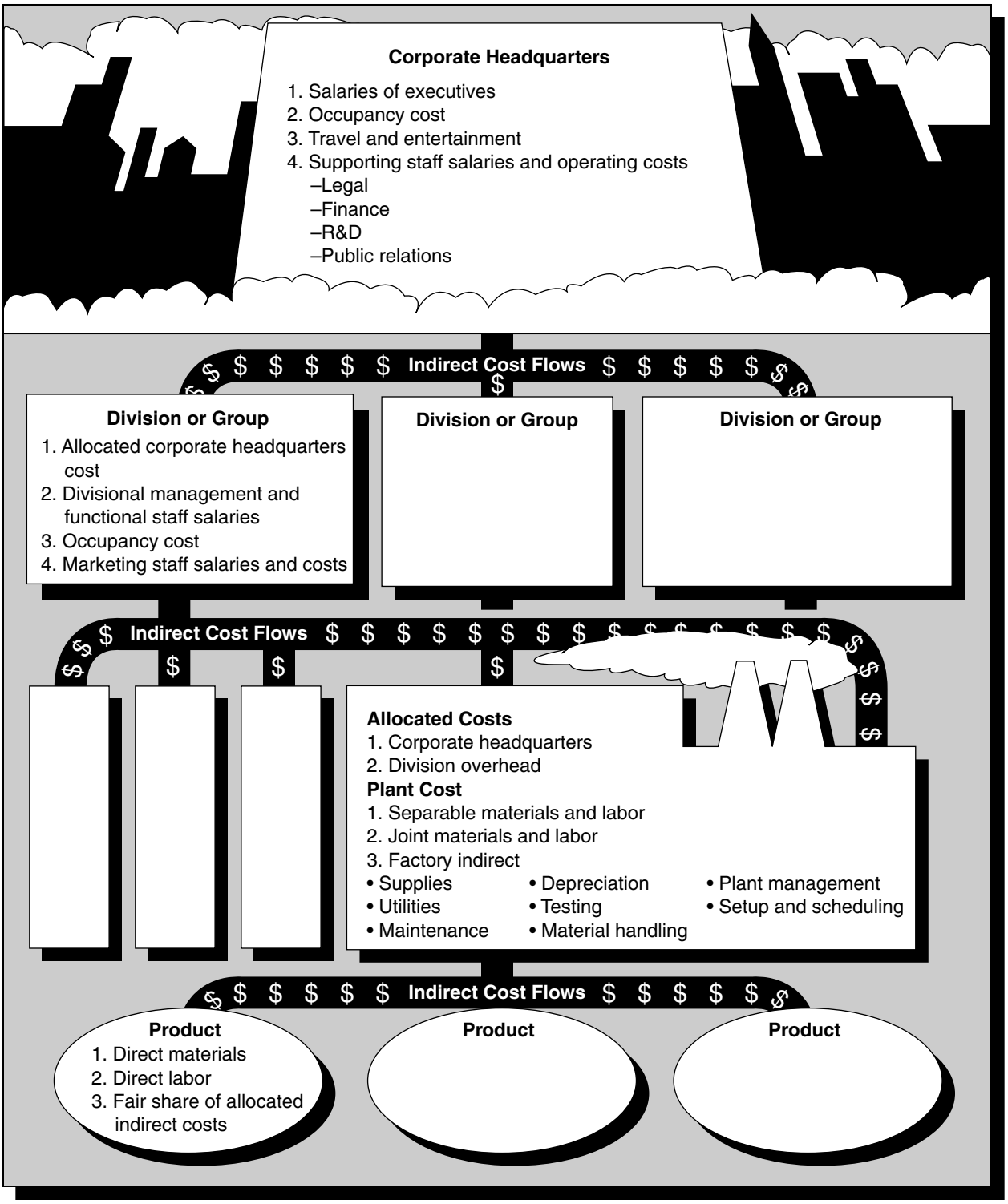
Why Allocate?

Cost allocations serve many purposes. Cost planning and cost management use allocations to estimate product costs, analyze product profitability, and insure that indirect costs are covered by selling prices. Profit planning uses allocations to remind people that their actions cause indirect costs to occur. Allocations also make people aware of the existence of indirect costs and the need to use cost factors judiciously. The following examples illustrate some of these reasons for cost allocation.

Hewlett-Packard acquires soldering machines for the production of circuit boards. Assuming some level of overall use of these machines, Hewlett-Packard allocates soldering machine cost to each circuit board. If the indirect cost allocation to the circuit board is reasonable, Hewlett-Packard can plan which products to produce and which ones to discontinue. Unreasonable allocations can lead to poor strategic decisions.

Cooperative apartments in New York often have a large monthly fee which includes a charge for utilities consumed by all tenants. If each tenant is charged a portion of the total electricity bill (perhaps determined by the square feet in their apartment divided by the total square feet in the building), there is no incentive for any tenant to conserve energy. This averaging may cause usage costs to gradually rise. Aware of this tendency, most

Exhibit 1
Indirect Costs in Organizations



apartment managers install separate meters which measure electricity consumed by each tenant. This leads to energy conservation.

A similar situation occurs when marketing personnel accept rush orders from customers or promise product modifications. Indirect costs increase due to rush orders and modifications. Production schedules are changed, product specifications are redrawn and documented, materials and processing steps may be modified. If all products are charged an average amount for these costs, then indirect costs may gradually "creep" upward. If an allocation method is used which charges these costs to the special orders, then these costs will be anticipated before the special order is accepted.

How to Allocate.

The most important measurement issue involving indirect cost is **how** to allocate these costs among different cost objects. In Hewlett-Packard's case this means estimating how much of the common cost belongs to each type of circuit board. The basic formula used is:

Allocated Cost Rate = Indirect Cost ÷ Physical Base

For example, assume that Hewlett-Packard's soldering machine is used to make five kinds of circuit boards. The cost of operating the machine is $100,000 a year. The soldering machine operated 200,000 machine hours in the year. The allocated cost rate would be

Allocated Cost Rate = $100,000 ÷ 200,000 machine hours
= $.50 per machine hour

If a circuit board requires one machine hour of soldering, it would be charged for $.50 of indirect cost. A different circuit board requiring one-half hour of soldering would be charged $.25.

Think Along

Hewlett-Packard incurs a one time expenditure when it acquires a soldering machine. Further, the amount of that expenditure does not vary with the use of the soldering machine. Is it misleading to determine the cost of a circuit board as though it contains $.50 of the machine's cost? Could it lead to misleading conclusions about the profitability of the product?

A soldering machine has limited capacity. Capacity is the maximum amount of soldering which can be performed on the machine in a time period. That capacity has a cost; it includes the one time expenditure for the soldering machine. If a circuit board takes twice as much soldering time as another, then it has consumed capacity which cannot be used on other circuit boards. The use of capacity is costed to each circuit board. If a board is produced which does not yield a profit, then the capacity should be redirected to other circuit boards which do. The allocation of soldering machine cost is important to manage how to use the machine as well as to plan which products to produce.

Key Point

It is useful to allocate indirect costs, regardless of whether they vary with production. Allocations of such costs encourage cost management.

The problems and issues in allocating indirect costs are illustrated by using a simple everyday example.

Illustration

Avi and three of his friends decide to have a meal at a Chinese restaurant. They order different dishes and share family style. At the end of the meal, the bill totals $55.00 including an appropriate tip. The problem is how to split the check.

Think Along

This is an allocation problem that you have probably faced. Take a minute to list as many different ways of allocating the bill as you can think of or have experienced.

Here are some of the ideas other students listed.

1. Divide the check equally.
2. Have the richest person pay.
3. Divide based on who ate what.
4. Allocate by the weights of the diners.
5. Divide the bill between the males in the group.
6. Have the oldest person pay.

Allocation involves dividing indirect cost by some physical quantity. In this example the indirect cost is known; it is $55, the amount of the total bill. The physical quantity, or denominator, is suggested by the allocation schemes listed by students.[4] To implement these allocation schemes, it is necessary to operationalize the physical measures.

- ▲ Dividing the check equally (1), or among the males (5), requires a simple count of the total number of people or males.
- ▲ Allocating by weight (4) or age (6) requires obtaining information on these basic physical attributes.
- ▲ Splitting the cost based on who is richest (2) is more complex. It requires defining richest and obtaining information. Richest might be who has the largest weekly allowance or the highest salary. Assume the diners defined richest as the largest current bank balance.
- ▲ Determining who ate what in a family meal (3) is also complex. When asked to explain how to determine who ate what, one student suggested putting meters on everyone's fork and spoon. This would count how many spoonfuls each person took. Another suggested making a video tape of the meal. The diners decided to count the number of servings taken by each person.

Completion of the allocation process requires collecting the necessary physical measures. Exhibit 2 shows this information for the dinner party.

[4] The same type of analysis used for the six methods can be applied to any other allocation scheme.

Exhibit 2
Information for Allocating Dinner Costs

Name	*Bank Balance*	*No. of Servings*	*Weight*	*Sex*	*Age*
Avi	$502	12	370	M	19
Sue	700	7	230	F	20
Sam	400	15	290	M	18
Homa	650	10	210	F	22

The list of allocations that result under each option are:[5]

1. If the check is divided equally, each person's meal costs $13.75 ($55 ÷ 4).
2. If the richest person pays, Sue's meal cost $55 and each of the other meals is free.
3. If the number of servings taken is the allocation base then each spoonful of food costs $1.25 ($55 ÷ [12 + 7 + 15 + 10]).

   Avi's meal cost $15.00 (12 spoonfuls × $1.25)
   Sue's cost $8.75 (7 spoonfuls × $1.25)
   Sam's cost $18.75 (15 spoonfuls × $1.25)
   Homa's cost $12.50 (10 spoonfuls × $1.25)

4. If weight is used, then each pound you weigh would cost $.05 ($55 ÷ [370 + 230 + 290 + 210]).

   Avi's meal cost $18.50 (370 pounds × $.05)
   Sue's meal cost $11.50 (230 pounds × $.05)
   Sam's meal cost $14.50 (290 pounds × $.05)
   Homa's meal cost $10.50 (210 pounds × $.05)

5. If the males divide the bill, then each meal costs:

   Avi's meal cost $27.50
   Sue's meal cost $0
   Sam's meal cost $27.50
   Homa's meal cost $0

6. If the oldest person pays, Homa's meal costs $55 and the rest of the meals cost $0.

Exhibit 3 summarizes the amounts paid by each diner under the various allocation methods.

Exhibit 3
Summary of Amounts Paid Under Alternative Allocation Methods

Name	*Equal Division*	*Richest Person Pays*	*Number of Servings*	*Weight*	*Divide Among Males*	*Oldest Person Pays*
Avi	$13.75	0	$15.00	$18.50	$27.50	0
Sue	13.75	$55.00	8.75	11.50	0	0
Sam	13.75	0	18.75	14.50	$27.50	0
Homa	13.75	0	12.50	10.50	0	$55.00
Total	$55.00	$55.00	$55.00	$55.00	$55.00	$55.00

[5] Since allocations are estimates, carrying answers out too many decimal points should be avoided.

This example illustrates that many allocation methods can be used. The choice of allocation method affects the meal cost of each diner, but not the total meal cost.

Key Point

> No matter what allocation scheme is used, the total amount of the bill allocated is still $55. Allocation does not change the total amount to be shared.

Many of the allocation methods illustrated have counterparts in organizations. For example, corporate headquarters incurs costs for the president's salary, his or her offices, utilities, and support staff. In addition staff functions are headquartered at corporate. Corporate finance, legal, human resources, and new product development usually have offices there. These costs are typically allocated to divisions and production plants to remind lower levels of management that these costs must be recovered before a profit is earned.

Consider Naffle Corporation which has $3,500,000 of corporate overhead. It has two divisions, Commercial Applications (CAD) and Governmental Applications (GAD). Within the CAD, there are 10 manufacturing plants. Within GAD, there are three production plants and a research lab.

Think Along

> How could corporate overhead be allocated to divisions?

Here are some of the ways this cost can be allocated:

1. Divide it evenly between the divisions.
2. Divide it based on how "rich" each division is.
3. Allocate it based on size of the division.
4. Assign it based on how much corporate cost is caused by each.

The first allocation method is relatively easy to operationalize. The second, how "rich" each division is, presents a problem. "Rich" could be measured a number of ways, including the amount of assets owned, cash balance, profit earned, or sales revenue dollars. Assume that sales revenue dollars are used as a measure of divisional wealth. Size of the division also can be operationalized various ways. One common way is to use the number of employees (headcount). Another way to measure size might be to count the number of plants or labs under each division. Allocating based on how much corporate cost is caused by each division might involve each staff person to keep records of what they are working on. Those records could be analyzed to estimate the percent of time spent on divisional issues. Exhibit 4 contains divisional data necessary to operationalize these suggested allocation methods.

Exhibit 4
Information for Allocating Corporate Headquarters Cost

Division	*Number of Locations*	*Number of Employees*	*Sales Dollars*	*% Staff Time*
CAD	10	2,200	$45,000,000	40
GAD	4	1,300	$30,000,000	60

The allocations to CAD and GAD which result under each of the methods are presented below:

1. If the cost is allocated equally, then both CAD and GAD are charged $1,750,000 ($3,500,000 ÷ 2).
2. If the cost is allocated based on sales dollars (the richest division pays the most), then CAD is charged $2,100,000 ($3,500,000 × 45 ÷ 75), while GAD is charged $1,400,000 ($3,500,000 × 30 ÷ 75).
3. If corporate overhead is allocated based on the number of employees, then CAD is charged with $2,200,000 ($3,500,000 × 22 ÷ 35), while GAD is charged with $1,300,000 ($3,500,000 × 13 ÷ 35).
4. If the cost is allocated based on size measured by the number of locations, then CAD bears $2,500,000 ($3,500,000 × 10 ÷ 14), while GAD bears $1,000,000 ($3,500,000 × 4 ÷ 14).
5. If assignment is based on an estimate of the work performed for each division, then CAD is charged $1,400,000 ($3,500,000 × .40) while GAD is charged with $2,100,000 ($3,500,000 × .60).

Notice that these allocation methods are similar to the ones used in the Chinese meal restaurant.

Think Along

Is there any way to use the "Dutch treat" method so each division pays exactly for services received?

Certain functions performed at corporate headquarters could be delegated to divisions. For example, each division could hire legal counsel and pay for advice as needed. Under such an arrangement, legal costs are a direct cost of a division, rather than an indirect cost.[6] While this rearrangement eliminates allocation problems, it means that economies of scale are lost. One corporate legal advisor on staff full time is less expensive than several being hired on an hourly fee basis. Further, such an arrangement might encourage dysfunctional behavior. Divisions might not seek legal counsel when it is actually needed, because they can avoid the expenditure. This increases corporate legal exposure.

Key Point

Indirect costs are often created by deliberate decisions to share costs. Work activities often can be rearranged to make the costs direct.

Regardless of allocation method used, note that Naffle's total corporate overhead remains $3,500,000. Does this mean that the choice of allocation method is unimportant? Quite the contrary! Each division's ability to achieve budgeted profit is impacted by the amount of corporate headquarters' cost allocated to it. The difference that the choice of allocation method makes is demonstrated in Exhibit 5. Compare the allocation using sales dollars to the allocation using an estimate of work performed. These are exactly the reverse of each other! The choice of allocation method would be very important to the divisional president.

[6] This would be analogous to the "Dutch treat" method in the restaurant example.

Exhibit 5
Divisional Cost Under Alternative Allocations

Division	*Equal*	*Sales Dollars*	*Number of Employees*	*Number of Locations*	*Estimate of Work Performed*
CAD	$1,750,000	$2,100,000	$2,200,000	$2,500,000	$1,400,000
GAD	1,750,000	1,400,000	1,300,000	1,000,000	2,100,000
Total	$3,500,000	$3,500,000	$3,500,000	$3,500,000	$3,500,000

Other indirect costs in business are allocated using similar techniques. Marketing costs are allocated to customers to determine their relative profitability. The allocation might be based on the number of sales calls (amount of marketing time consumed), the dollar of sales made (richest customer), the number of sales orders placed (size), or other reasonable criteria. A hospital's recordkeeping cost could be allocated to patients based on the number of times the patient is admitted to the hospital or seen in its emergency facilities (size), the number of days in the hospital (size), the number of files maintained (size), the number of entries made in files (amount consumed), or a patient's hospital bill (richest). Factory overhead costs could be charged to departments based on physical size as measured by square feet, the number of employees, wages paid to workers, hours of work performed in each department, or based on amounts assumed used or incurred for each department. Finally products receive factory indirect costs based on many schemes, for example, direct labor hours or dollars, machine hours, batch size, pounds of materials, and number of unique parts.

The measure used to operationalize an allocation method is called an *allocation base, a denominator,* or *a driver.* Technically, the term *driver describes the use of an allocation base which causes overhead costs to be incurred.* Square feet, number of employees, machine hours worked, or a patient's hospital bill are common allocation bases. When hospital recordkeeping costs are allocated to patients based on the number of entries made in files, this allocation base would be classified a driver. Presumably, indirect recordkeeping costs are caused by having to make entries in patients' records. Most organizations are moving toward using drivers to allocate overhead when possible.

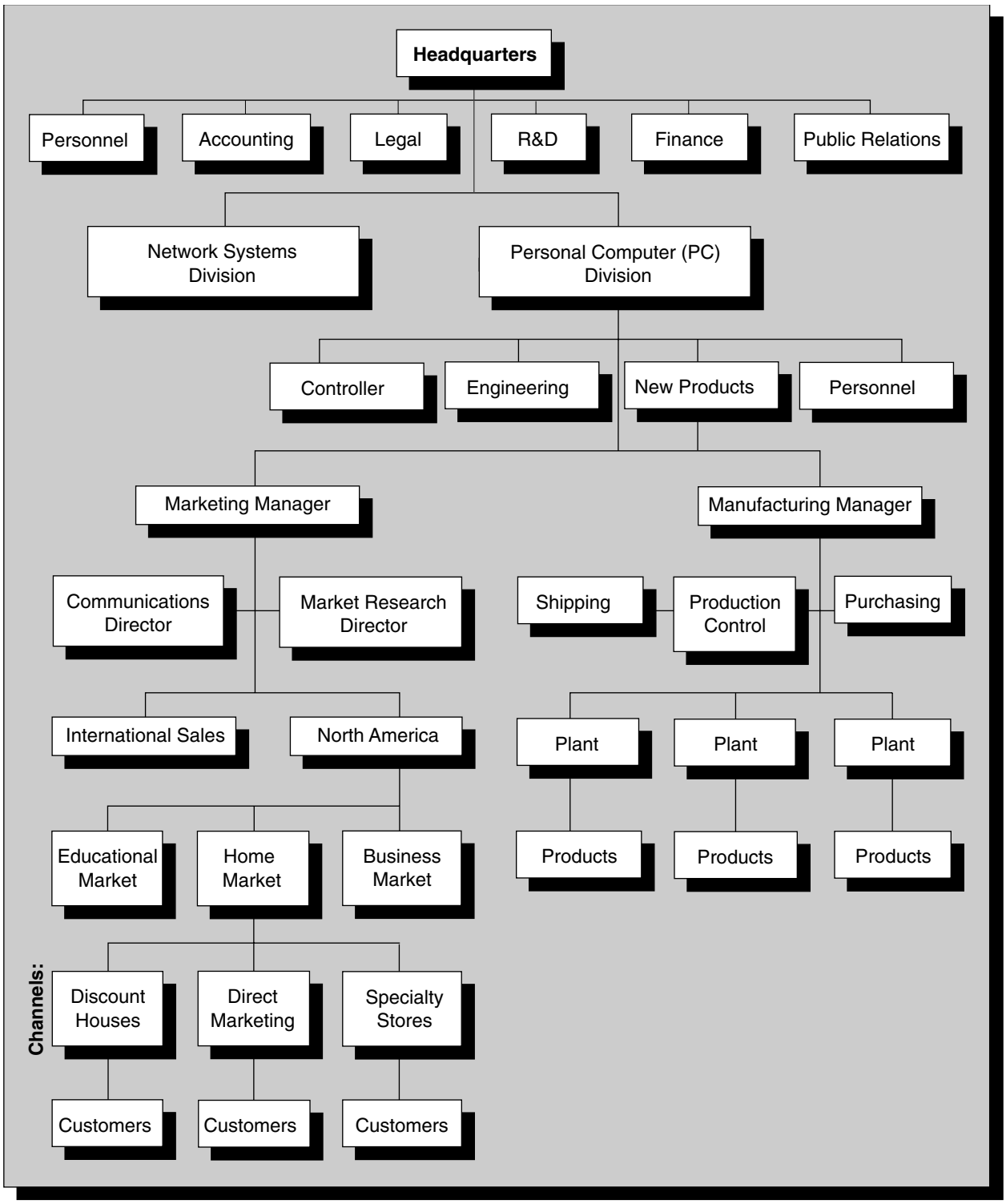
Details on indirect cost allocations are covered in several other modules: Activity-Based Product Costing, Traditional Factory Overhead Allocations, Activity-Based G&A Cost Allocations, Activity-Based Marketing and Distribution Cost Analysis, and Joint Cost Problems in Manufacturing & Service Industries.

How Far Should Allocations of Indirect Costs Extend?

Exhibit 6 provides an organization chart for a typical computer company which produces personal computers and network systems. This company uses business units, a divisional form of organization. It is called this because all functions involved in producing and marketing a specified product line are under the responsibility of a divisional manager who runs the unit as though it were a separate company.

In this organization, headquarters establishes companywide policies. In addition, headquarters' staff offices assist the divisions in specialized areas such as accounting, legal, public relations, finance, personnel, and research and development. Two divisions exist, network systems and personal computers (PC). Each division is headed by a president. Divisional presidents are responsible for planning and coordinating the work of the

Exhibit 6
Organization Chart for a Typical Computer Company



marketing and manufacturing functions. They coordinate sales forecasts with production schedules, and settle any disputes which arise between the functional areas. In the PC Division headquarters also provides staff support in areas such as engineering and personnel.

In the PC Division, marketing is headed by a manager who has staff responsible for communications and market research. Sales efforts are organized by region into International and North American sales. In North America, products are sold in three separate markets: educational, home, and business. A variety of channels support these markets. For example, the home market is supplied through discount houses, direct marketing, and specialty stores.

The manufacturing area is headed by a manager with staff to coordinate functions such as shipping and purchasing. Manufacturing is further organized into plants. Each plant is headed by a manager responsible for production cost, quality, and delivery schedules. Products include items such as modems, cards, monitors, CPUs, keyboards, cables and connectors, drives and devices, and cases.

To be successful, the PC Division needs information about the costs and profits of individual products, plants, customers, distribution channels, markets, and regions. This information requires indirect cost allocations.

Think Along

Review Exhibit 6. It shows the various places in an organization where indirect cost occurs. How far down in an organization should allocation extend? Should indirect costs be allocated throughout the organization and ultimately to products, channels, markets, and customers?

There is not a universal answer to this question. It is true that all costs an organization incurs must be recovered from sales of products and services to customers. If not recovered, the organization operates at a loss. In a sense, therefore, all costs incurred are product costs or costs of servicing customers. Mindful of this, several views exist with respect to how far allocations of indirect costs should go in an organization. One view is that only *controllable costs* should be allocated to lower organizational levels or products. Another view is that any cost which benefits an area or product should be allocated to it. This is called allocating *attributable costs*. Finally, a viewpoint exists which requires *all costs* to be allocated to lower organizational units and finally to products and customers.

Allocate controllable costs.

A controllable cost is a cost that is caused by actions or decisions of a manager. According to this view, if actions of a lower organizational unit or activity cause cost to be incurred, then the cost should be allocated. If costs are not caused by the decisions and actions of an organizational unit or activity, proponents argue, indirect costs should not be allocated. To do so might confuse and frustrate managers because they are being held responsible for costs not under their control. Consider the cost of purchasing and shipping in Exhibit 6. These costs are controllable at the product level because each is caused by the volume and variety of products being manufactured. Therefore, each should be allocated to the product level. Some of the legal, accounting, finance, research and development, or other headquarters' staff cost in Exhibit 6 may also be caused by actions or decisions at a plant, division, or product level. If so, allocate the controllable portion. If a channel such as direct marketing requires special shipping of products, then an analysis of channel profitability should include allocated shipping costs.

Allocate attributable costs.

An attributable cost is a cost that is incurred to benefit a unit or product, and is a cost that could be avoided if the unit or product did not exist. An attributable cost does not have to be controllable; attributable costs extend beyond controllable costs. Consider, for example, the costs of a plant in Exhibit 6. Plant location and physical size are typically inherited by a plant manager. These are not under his control in the sense that he cannot sell the plant, tear it down, close it, or expand it. Those decisions are made by upper management. Yet without the plant, products could not be produced. These costs are therefore attributable to and typically allocated to products. Most of corporate headquarters' costs in Exhibit 6 can probably be attributed to divisions. The finance function manages cash receivable and obtains capital. If these functions were not performed at corporate headquarters, receivables would still have to be collected and cash made available to pay bills and expand. Divisions and plants would incur costs to perform these functions anyway. These costs are attributable to the division; the division may further allocate them to plants based on products produced, or to customers' accounts to analyze the profitability.

Allocate all indirect costs.

Others believe that *all indirect costs should be allocated* to the product or service level. Proponents of this view believe that as allocations occur, people in lower levels of the organization understand that there is cost that must be recovered before profit is earned. This has been likened to a "tax."[7] Everyone understands that all that is earned cannot be spent; a tax first must be paid to cover the cost of the government. In organizational life, every plant, product, customer account, channel, and market (see Exhibit 6) must return a margin to cover the cost of administering the organization. Proponents also feel that allocating all indirect costs places pressure on upper management to manage administrative costs. The relative size of corporate, divisional, and plant indirect costs is in plain view on accounting reports throughout the organization. The numbers usually demonstrate that cost management is necessary for indirect costs at all organizational levels.

There may be behavioral pitfalls if all costs are allocated to the product and customer level. Some fear that it makes costs lack credibility. Consider, for example, public relations cost in Exhibit 4 allocated to products. The costs are so far removed from plant managers that managers have no understanding of the cost. Why was it incurred? To what extent did the product benefit? Where in the organization was the cost incurred? It is said that the managers can do nothing but "cuss and pay." In general, allocation of costs should not go below the level where managers are knowledgeable of costs and are able to ask intelligent questions and make reasonable suggestions about how to manage costs.

Key Point

Regardless of whether an organization allocates all indirect costs down to the product or service level, those costs must be recovered before a profit is earned. If an organization chooses not to allocate down to the plant or product level, required profit margins will be adjusted to cover these costs.

[7] J. Zimmerman. "The Costs and Benefits of Cost Allocations," *Accounting Review,* July 1979, pp. 504–521.

▲ CHOICE OF AN ALLOCATION SCHEME

Before choosing an allocation method, the technical, behavioral, and cultural properties of each of the alternatives should be considered. A scheme that works very well on one attribute, but performs poorly on the others, should be avoided.

Which allocation scheme(s) do you prefer? Which ones do you dislike? Why?

Technical Attributes.

Technically, allocations must provide information that has *decision relevance* and helps in understanding how the decisions and actions in *work process drives* or *causes* indirect costs to be incurred.

Decision relevance.
Good allocations help measure the profitability of plants, products, markets, channels, customers, or any other cost object of importance to management. When evaluating managerial performance, allocations of controllable costs might be most relevant. When evaluating whether to discontinue products, channels, or customers, allocations of attributable costs might be most relevant. Finally, allocations should help pinpoint areas where cost reductions are necessary. Allocating costs to managers who are knowledgeable of why these are incurred as well as the benefits they provide, can identify areas where costs may be excessive.

Work process understanding.
A good allocation method helps managers understand what *drives* or *causes* indirect costs to change. Allocations must tie work related decisions and actions to costs incurred within the organization. Understanding the link between what is done at work and the kinds and amounts of indirect costs incurred, enables indirect costs to be managed. One way to focus attention on what causes cost to change is to use an allocation scheme that reflects resource consumption patterns. In a factory, products that use more resources such as space, equipment, or electricity should have more of these costs allocated to them. This allocation scheme is sometimes identified as *cause and effect* or *benefits received.*

This type of allocation in the restaurant example is the scheme that identifies "who ate what." The number of servings taken provides the best measure (from the alternatives in the example) of allocating the meal cost by the amount of food consumed by each individual. In Naffle Corporation this was best reflected in the allocation based on the percent of staff time spent solving divisional problems.

Note that the word best was used and not "accurate" or "true" to describe this allocation. The reason for this is that we do not believe it is ever possible to get accuracy or truthfulness in accounting allocations. For example, even if the size and number of the servings in the restaurant example were metered, someone could complain that they ate only vegetables and no meat!

The only other restaurant allocation method that attempts to use a technical criterion is the one based on weight. A person's weight may have some bearing on the amount eaten, but it is confounded with metabolism, hunger, diet, and other factors. For example, if one of the diners is dieting he or she may eat very little. Similarly, in organizations, often number of employees, total wages, or the number of locations (subunits) is used to estimate

how much indirect cost is caused by a unit. Unfortunately, this is an imperfect measure in most cases.

Behavioral Attributes.

Before concluding that a *"cause and effect"* method is the best allocation scheme, the behavioral properties of these schemes should be examined. How will the choice of allocation methods cause people to behave?

In an organizational context the right behaviors will be those that lead to accomplishing the strategic objectives of producing a high quality product, at a low cost and at the right time. Consider how this behavioral criteria is applied in industry.

Many Japanese companies allocate indirect costs to products based on the number of unique parts in a product. A product with 100 different parts would get twice the amount of indirect costs as a product with only 50. These firms believe that a smaller number of parts ultimately results in lower costs, fewer quality problems, and more rapid production. Allocating indirect costs based on number of parts is not used because of its technical accuracy, but to motivate desired behavior. In this case, it is to design products with fewer parts.

Reflect on the example where marketing promised customers rush orders or product modifications. An allocation scheme charging all special orders a large portion of scheduling and engineering indirect costs would motivate marketing personnel to evaluate whether the change was necessary to the customer. If upper management does not want these judgments made, then such an allocation scheme would be inappropriate.

The four individuals in the restaurant example weigh more than average college students. Assume that they need to lose weight and become more physically fit. Allocating by weight will come closest to accomplishing this behavioral objective, since it will penalize those who weigh the most. On the other hand, if the purpose of the restaurant experience was to cement social ties, the metering method is probably the least desirable allocation scheme from a behavioral point of view. Not many people would feel comfortable, socializing while their food intake was being measured or videotaped. The method defeats the social purpose of the meal.

Think Along

Can you think of the behavioral implications of the other allocation schemes?

Cultural Attributes.

Allocation schemes have cultural values of organizations and societies imbedded in them. These cultural values can greatly influence the choice of allocation methods. Each of the six allocation schemes in the restaurant example may reflect different cultural values.

Dividing the *check equally* is considered a gesture of politeness and grace in many societies. It also reflects a norm of long range reciprocity in relationships. Having the *richest* person pay may have an appeal in societies that expect the rich to share their good fortune with others. In the U.S., the concept of "Dutch treat" is a culturally acceptable norm. The *metering* method, therefore, is acceptable and may be considered fair since people are expected to pay for what they eat. The use of *weight* would probably be unacceptable in cultures that view weight as a genetic problem and not a behavioral problem. In

some societies, *age* is given special status and the oldest person would be expected to pay. Finally, *male* dominated societies would expect men to take care of the bill.

In organizations, *fairness* is an important cultural value when indirect costs are being allocated. In the example of headquarters' costs, most would not consider an equal amount charged to each division fair. Instead, sharing based on size would probably be considered fairer. Size is associated with *relative benefits received.* In many organizations, fairness is letting the "richest," or the unit with the *greatest ability to bear the cost,* bear a proportionally larger share. Finally, most organizations today agree that the most desirable and fairest allocation is to use a *cause and effect* relationship and identify what *drives* indirect costs to be incurred.

Note that each allocation method reflects a different cultural value and may be preferred depending on the values and beliefs within that culture. Choosing a method on this criterion means examining beliefs and values and making certain each is reflected in the allocation method of choice.

▲ CHOOSING AN ALLOCATION METHOD

Criteria now exists to evaluate and choose between alternative allocation schemes. The scheme chosen must be one that provides the best balance among measuring and understanding how resources are consumed, motivating desired behaviors, and reinforcing cultural values. In the final analysis the chosen scheme must lead to the accomplishment of strategic objectives of quality, cost, and time.

For the restaurant allocation problem students seem to prefer the use of an equal allocation. They assume that the strategic objective of the meal is to strengthen social ties. Since each individual has equal opportunity to select and consume dishes, it is felt that equal allocation is not only fair, but also signals that individuals trust each other to be fair and to reciprocate in kind in the long run.

Others feel this allocation method is not fair. Often they have experienced people who order more expensive food and drinks in great quantity since they will only pay the average cost for all meals. This problem is solved by avoiding family-style meals and requesting separate checks. In a sense these individuals reorganize the entire function.

When businesses experience similar problems it is often concluded that better technical solutions which emphasize the cause and effects of indirect costs are necessary. Modern allocation techniques, such as activity-based costing system result.

▲ USING ALLOCATIONS IN OTHER AREAS

Often the allocations that organizations use in practice result from the demands of financial accounting or government regulatory requirements. These externally imposed constraints must be complied with in external reports, and should not be confused with allocation schemes used for strategic decision making.

Allocations and External Financial Reporting.

Accounting convention dictates assigning all costs of production, whether direct or indirect, to products produced. This costing convention is called "absorption costing," which literally means that each product must "absorb," or be charged with, a portion of all

production costs. While there are many technical methods of allocating indirect costs to products, it can be as simple as totaling production costs and dividing by a measure of the products produced. Products costed under absorption costing are said to be costed at their "full cost." Note that this definition of full cost only includes production costs.

Generally accepted accounting principles (GAAP) specifiy that manufactured inventory carry a reasonable portion of all factory indirect costs using absorption costing. Audited financial statements must comply with GAAP rules. The IRS also requires that certain indirect cost allocation methods be used for tax purposes. Thus, external demands for information by stockholders, creditors, and regulatory agencies require the allocation of indirect costs to products.

Allocations in Government Contracting.

U.S. Federal government procurement regulations, documented in Federal Acquisition Regulations, specify that costs be allocated to a government contract on the basis of relative benefits received or other equitable relationships. These criteria are laid down in the Cost Accounting Standards Board's (CASB) pronouncements.[8] The CASB standards provide specific criteria for classes of costs such as cost of money (CASB #414), pensions (CASB #413), and compensated personal absences (CASB #408). For costs not covered by a specific pronouncement, general criteria are used. Four general criteria used in allocations in connection with federal government contracting are: *benefits received, cause and effect, fairness or equity,* and *ability to bear.* There is growing preference for using **benefits received** or **cause and effect** criteria for allocations whenever possible. These criteria make it easier to settle disputes.

Benefits received.

This is an attempt to assign costs to those cost objects that receive more benefit from the cost than others. If records are kept of the number of hours the corporate lawyer worked on specific issues for each division of the company, then the hourly legal cost can be computed. The division using the most hours would receive the highest bill, and presumably has benefited the most from legal advice.

Cause and effect.

Managers identify which factors cause indirect costs to be incurred. The indirect costs are then charged to cost objects based on the causal factors. The purchasing department's costs increase as more parts and subcomponents are bought. A product with few new parts and subcomponents causes less increase in the purchasing department's costs than a product with many new parts and subcomponents.

Fairness or equity.

Fairness is often culturally bound and tied to a simple allocation rule. Indirect costs may be shared based on number of employees, square feet occupied, evenly, or some other simple criterion because everyone can agree on these.

Ability to bear.

This criterion uses the profitability of a cost object to assign indirect cost. It is often used to assign corporate overhead to divisions, assuming that the division that has the most sales or profits is most capable of paying for the costs of running the corporate office.

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[8] The Pronouncements of the *Cost Accounting Standards Board* can be obtained from the U.S. Government Printing Office in Washington, D.C.

▲ LESSONS LEARNED

- ▲ Indirect costs are common costs that either *cannot be unambiguously traced* to a product or service or costs which management chooses not to trace for reasons of sharing or economy.
- ▲ Indirect costs can be allocated to cost objects using many different methods.
- ▲ The method used to allocate indirect costs *does not change the size* of these costs. It is simply a redistribution of existing costs.
- ▲ Organizations with similar cost factors often use different allocation systems. There is often a disagreement in how far to allocate costs within the organization. This makes it difficult to *compare* costs among competing firms.
- ▲ An important reason for allocating indirect costs is to *manage* these costs and to determine whether each is providing the strategic services needed. Thought should be given to determine if there are more economical and effective ways of performing the services.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

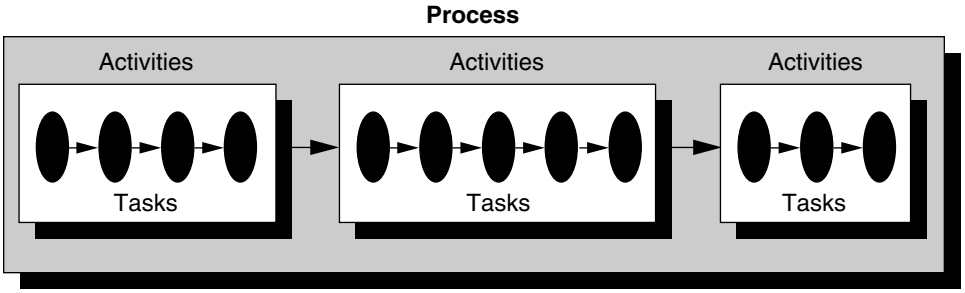
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. Define the term *direct cost,* and describe its relationship to *cost object*. Give examples of direct costs.

b. Define the term *indirect cost,* and describe its relationship to *cost object*. Give examples of indirect costs.

c. A cost item, for example the salary of a plant manager, can be both a direct cost and an indirect cost. Do you agree? Explain and give an example of when a plant manager's salary is direct and when it is indirect.

d. Indirect costs are those that can never be traced directly to cost objects. Do you agree with this statement?

e. What types of indirect costs exist? Give an example of each.

f. Define allocation. Why are allocations needed?

g. List the attributes that should be considered in choosing an allocation scheme for indirect costs. Explain these attributes.

h. What is a cost driver? Explain. Give an example of a cost driver for materials handling cost.

i. Explain how the cost of tracing an indirect cost can exceed the benefit of doing this tracing. Use a specific example.

j. Give an example of a cost that is direct with respect to one cost object but indirect with respect to another cost object. Specifically identify the cost and the different cost objects.

k. If common costs cannot be uniquely assigned to a cost object, why does it matter how much is assigned to each?

l. Why are the cause and effect or benefit received criteria not always used for allocations?

m. Why aren't the allocation methods required by regulatory agencies always used for internal purposes?

n. List the four general criteria of allocating that are used in connection with federal government contracting. Explain these criteria.

2. Friday's, a popular restaurant, has people functioning as servers, cooks, bartenders, hosts/greeters, and busing staff.

a. For each of these classifications of people, indicate whether the salary is a direct or an indirect cost of a meal.

b. Provide suggestions for how to allocate the salary cost of the individuals to the cost of a meal.

c. If Friday's wants to encourage extensive cooperation among the employees, is there an allocation method that is more likely to encourage cooperation?

3. Weyerhaeuser maintains large pulp mills that process lumber into various commodities such as paper, plywood, and cardboard. These mills consume vast amounts of electrical power.

a. How might the utilities costs associated with operating the company's plant be allocated to the various product lines of the company?

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* Some problem material contributed by Nishat Abbasi of Metropolitan State College of Denver, Colorado.

b. If management believes that energy costs are going to rise quickly, what type of allocation scheme might be used to encourage conservation?

4. Large corporations are normally staffed with internal auditors. For each of the following scenarios, suggest at least three methods that a firm might use to assign the cost of internal auditing to departments. Show how each of your methods performs technically, how each influences behaviors, and how each reflects or helps change organizational culture. Treat each situation as if it were independent.

a. All departments are subject to random internal audits. Every department is audited at least once every three years, and departments that are larger or have prior internal audit problems are subject to more frequent audits.
b. A department manager may request an internal audit whenever there is any potential for a problem or when a new product or service is introduced.
c. Top management wants to encourage individuals to request help from internal auditing.

5. A land developer hires a utility contractor to grade and construct roads, curbs, and driveway inserts for a new subdivision. This is a development cost of the entire subdivision, and some portion should be assigned or allocated to each individual lot the developer eventually sells. The costs associated with each individual lot is difficult to calculate due to different lot sizes and various other obstacles. For example, some sections of the property may have trees, others may have gullies, hills, or require cutting or filling.

a. List five different ways to allocate the development costs to lots.
b. For each proposed allocation method:
   i. What information must be available to actually allow use of your suggested approach?
   ii. What are the possible behavioral effects of using each allocation method?
   iii. What cultural influences may be factors to consider for this allocation method?
   iv. Considering your answers to parts a and b, recommend how to allocate in this situation.

6. The marketing department of a major department store extensively advertises all products. The firm currently allocates these costs to store departments based on sales dollars.

a. Suggest other methods of allocating this cost.
b. Is the existing allocation scheme fair? Why or why not?
c. For each method you suggested in part a, discuss whether costs are allocated based on:
   i. Benefits received?
   ii. Cause and effect?
   iii. Fairness or equity? or,
   iv. Ability to bear?

7. Charles Kroeger, an electrical engineer, belongs to a local club. He pays annual dues of $240, and uses the club solely for lunches, which cost $6. Charles has not used the club in recent months and is wondering whether to continue his membership.

Required:

What is the cost per lunch if Charles ate at the Club once a year? One hundred and twenty times a year? Two hundred times a year?

8. Tahoe Company is a manufacturing enterprise which has both direct and indirect cost elements. Headquarters and factory share a common location in northern California. Tahoe produces two kinds of snowboards in its factory—the "weekend warrior" (WW) and the

"performance pro" (PP), both of which use different raw materials and different aerodynamic designs. Tahoe Company employs two production workers: Cindy Fisher, who works solely on the production of WW, and David Mathews who works solely on the production of PP.

Required:

1. Classify each of the following costs as direct or indirect manufacturing costs with respect to products as cost objects. (Use N/A if not applicable.)
2. Classify each of the following costs as direct or indirect with respect to the factory as a cost object. (Use N/A if not applicable.)

Cost Item	***Classification with Products as Cost Object***	***Classification with Factory as Cost Object***
Annual salary of the factory manager		
Cost of raw material consumed during production		
Property taxes for corporate facilities		
Depreciation on machinery used to produce both products		
Marketing department expenses		
Cindy's daily wages		
Salary of a materials handler/shipping clerk		
Factory utilities		
Wax used on boards in finishing		
Parking lot shared by entire organization		
President's salary		

9. A marketing manager for a major corporation must call on two customers. One is located in Boston, the other in New York City. The marketing manager is located in Phoenix and has immediate family in New York City. The manager could visit the customer in New York on Friday, visit with her family over the weekend, and visit the other customer in Boston on Monday. The firm's travel agent has checked ticket prices. A roundtrip ticket from Phoenix to Boston without a Saturday night stay is $1,500. A roundtrip ticket from Phoenix to New York without a Saturday night stay is $1,200. A roundtrip ticket from Phoenix to both New York and Boston with a Saturday night stay is $800. The manager opts for the latter ticket.

Required:

Your organization tracks the profitability of each customer account and drops those which are not yielding adequate profits. Each customer's account will be assigned a portion of the manager's trip cost as a part of this analysis. How much should each be charged for airfare? Show how you calculated the allocation, and justify it with criteria from the module. Do you believe that your allocation method provides good technical information? Does it encourage the correct behaviors? Is it consistent or reinforcing of corporate culture?

10. Charles Olson and his wife, Beth, have just returned from a trip to Niagara Falls where Charles visited his company's plant to assess some expansion possibilities. They incurred the following expenditures relating to the trip:

• Airfare, round trip for Charles	$300
• Airfare, round trip for Beth	300
• Taxicab fare, tips, etc.	50
• Hotel accommodations	100
• Meals	100
	$850

Charles' company, Consolidated Metals, will reimburse him for business expenditures related to his trip. The *basis* of cost allocation, as per the policy of Consolidated Metals, is to include all the costs attributable to Charles.

Required:

1. Explain how to operationalize "attributable" in this circumstance. How much should Charles charge to Consolidated for his trip? Why?
2. What implications, if any, does the cost allocation method used by Consolidated Metals have on:
   a. the *quality* of Charles's assessment of the expansion possibilities for the plants,
   b. the *cost* of his trip, and
   c. the total *time* taken by Charles for his visit? Elaborate.
3. Does it advance the understanding of what drives the cost of Charles's trip? Elaborate.
4. Does the measure signify any cultural attributes, for instance, ethical values and beliefs, mindsets representing the collective world view of entities involved, and/or political values?
5. Suppose that the airline Charles chose to travel was slightly more expensive than other airlines, but offered a $25 "take a friend fare" which was used for Beth's ticket. Should Charles charge Consolidated the same amount you determined in part 1 above? Does this impact your evaluation of the allocation method?
6. What additional information would you like to obtain in this regard in order to have proper cost allocation? Elaborate.

11. Review Exhibits 1 and 6 from the module. These exhibits contain many indirect costs which may be allocated. The following page lists some of these indirect costs. For each category, list at least three kinds of expenditures that would be included therein, and indicate how those expenditures impact an organization's ability to achieve its strategic QCT goals.

Indirect Costs

1. Purchasing department
2. Public relations
3. Market research director
4. Personnel department
5. Occupancy cost
6. Shipping
7. Internal auditing
8. Legal services

12. Refer to the indirect costs in problem 11. For each indirect cost category, assume that a decision has been made to allocate to lower organizational units or to products. Given below are a list of possible allocation bases or cost drivers. Choose a base or driver for each of the indirect cost items listed in problem 11, and justify your choice by referring to the TBC properties of accounting measures.

Cost Driver

a. Actual usage
b. Payroll dollars
c. Headcount
d. Dollars of material used
e. Square feet
f. Number of units
g. Sales dollars
h. Number of unique parts
i. Number of customer orders

13. A land developer hires a contractor to grade and construct the roads, curbs, and driveway inserts for a new subdivision. The contract price is $8,000,000. For this price the contractor will finish three miles of road, pour six miles of curbing, and cut the poured curbing for each lot in consultation with the builder. Half the land is heavily wooded and two-thirds of the wooded lots in each category are on steep grades. The subdivision will include 500 lots with the following characteristics. Twenty-five percent of all lots of each type are corner lots.

Type	*Number*	*Size*	*Percent Wooded*
A	100	1 Acre	30
B	200	3/4 Acre	70
C	200	1/3 Acre	40

a. List at least five different ways to allocate this common development cost to lots.
b. For each proposed allocation method:
   i. What information must be available to allow use of your suggested approach?
   ii. What are the possible behavioral effects of using this allocation method?
   iii. What cultural influences may be factors to consider for this allocation method?

c. For two methods which you believe are technically, behaviorally, and culturally sound, calculate the amount of development cost allocated to each lot type.

14. Theobald Enterprises, a management consulting company headquartered in Chicago, Illinois, has two divisions: North American Division, headed by Jack Frost, and European Division, headed by Sam Margiotta. Both divisions report to Thomas Theobald, who is the founder, president, and Chief Executive Officer of the company. Theobald has a group of 20 staff professionals in the head office in Chicago that report to him and help in advisory/staff capacity in overseeing the two divisions and other aspects of the business.

Information for the divisions and the head office for 1996 are given in the table below. Financial information in the table is in millions.

Description	*North American Division*	*European Division*	*Head Office*
Revenues	$260	$200	
Labor costs	200	160	$16*
Other expenses	30	30	4
Headcount	2,500	1,500	40
Head office staff hours spent researching and responding to Division's inquiries on clients' projects	20,000	5,000	
Number of clients	10,000	8,000	
Square feet of space	24,000	18,000	6,000
Direct labor hours	5,000,000	3,000,000	

*Fifty percent of Head Office salaries are for the ten top executives of the company.

Required:

1. The European Division has not been profitable in recent years and has required a great deal of upper management's attention. Management is considering divesting and refocusing efforts on the North American Division. What criteria would you use to allocate head office costs to the division? What dollar amount would you allocate to the division? Prepare a performance report for the European Division with your suggested allocation. What action plan would be necessary if the European Division were divested?
2. Ignore the information in requirement one. Assume that head office cost is allocated to the two divisions as a reminder that corporate costs must be recovered for the organization to be profitable. What criteria would you use to allocate head office costs to the division? What dollar amount would you allocate to each?
3. Ignore your responses to requirements one and two above. Assume that the purpose of the overhead allocation is to evaluate the performance of each of the division's presidents. What criteria would you use to allocate head office costs to the division? What dollar amount would you allocate to each? Why?

15. Team Project. Visit a local company. Prepare a diagram of the organization similar to Exhibit 1 with sample indirect costs at each organizational level. Write a memo describing how those indirect costs are allocated to lower organizational levels, how far allocations extend, and the purpose(s) of those allocations. Evaluate the cost allocation schemes using the TBC triangle.

16. Team Project. Brainstorm a process that a hospital could use to deliver aspirin to patients at a lower cost on a timely basis without reducing the quality of care. Describe that process.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

Case 1: Stealthy Vs. U.S. Air Force.

Stealthy Company works on U.S. Air Force and commercial aircrafts and is paid for government work based on cost plus fixed fees contracts. Based on a prior agreement with government auditors, general indirect costs of Stealthy are allocated to each contract on the basis of direct labor costs. In 1996, Stealthy's direct labor was used one third on government contract work and two thirds on commercial work. Accordingly, one third of all general indirect costs were reimbursed by the government. In that year, general indirect costs amounted to $60 million.

The contract between Stealthy and the government specified, in one of its many provisions, that double assignment of any indirect cost is disallowed. This provision explains that double counting occurs when the same cost element is included both as a direct cost of a contract and as an item in a group of indirect costs. This contract provision is in conformity with the Cost Accounting Standards Board Standard #402, "Consistency in Allocating Costs Incurred for the Same Purpose."

Stealthy has a centralized security department that performs security for the entire company. This department's costs were $4 million in 1996. This cost is considered a general indirect cost and is allocated to contracts based on direct labor costs. In 1996, Stealthy received a contract for producing a portion of a new top secret project—the BZ2000 bomber. Because of its top secret status, work on the BZ2000 could only be performed under heightened security. Stealthy hired a special security force approved by the defense department. This force provided security services solely for the BZ2000 bomber, and cost Stealthy $1 million in 1996. This $1 million was charged directly to the BZ2000 contract and was included in its $40 million direct labor cost in 1996. It was not included in the $60 million of indirect costs allocated to contracts.

Governmental auditors, conducting routine, periodic audits of cost data and accounting systems of defense contractors, objected to Stealthy's practices. The auditors concluded that there was double counting on this contract, and the Air Force should claim a refund from Stealthy. Specifically, the auditors charged that Stealthy should not have allocated indirect security costs to this contract.

Required:

1. Do you think that the Air Force is entitled to a refund? Why or why not?
2. Calculate the amount of the claim that the Air Force would be entitled to based on the comments of the auditors.
3. Suppose that Stealthy can negotiate with Air Force representatives for their reimburse-

ment for security costs. Prepare a reasoned memo to the Air Force supporting the maximum amount to which you believe Stealthy is entitled without violating the double counting provision.

4. Suppose that the auditors also disallowed some $8 million of general indirect costs because they believed the items to be related solely to commercial activities. Calculate the additional refund, if any, that the Air Force could claim.
5. Consider the auditors' claims in part four. Do you believe that allocating indirect costs based on direct labor could be implicated in Stealthy's difficulty with assignment of indirect cost elements to contracts?

Case 2: ProSport.

ProSport, Inc.,[9] a manufacturer of children's soccer balls, prepared the following income statement for the year ended December 31,1996:

Sales (1,900,000 units)			$7,600,000
Cost of Sales			4,560,000
Gross Margin			$3,040,000
Delivery Costs:			
Containers	$183,500		
Labor	442,500		
Freight	751,500	$1,377,500	
Selling Costs:			
Sales Manager	$36,000		
Sales Salaries	64,000		
Commissions	48,000		
Sports Consortium Commissions	60,000		
Bad Debts	25,000	233,000	
Advertising			
Educational Media	114,000		
Sports Industry Media	87,000	201,000	
General Business Support		129,500	$1,941,000
Operating Profit			$1,099,000

The company sells soccer balls to schools, children's sports teams, and sporting goods stores. The selling price per unit is $4.

Large public and private schools receive advertising through educational media, and place orders directly to the manufacturing plant. No sales staff calls are made. Orders are received through the mail, fax, telephone or by computer. School districts arrange for their own delivery and send a truck to the plant to pick up orders when they are ready.

Smaller private schools located within a 500 mile radius of the plant are visited by salesmen. These salesmen are paid commissions, and are not company employees.

Sporting goods stores within a 1,000 mile radius of the plant are visited by four salesmen who are company employees and are paid a salary.

Children's sports teams within a 1,000 mile radius of the plant are contacted through a sports consortium which sells to leagues. Advertising is done through sports industry

[9] This problem is based on one originally included in *Cost Accounting: Analysis and Control* by Gordon Shillinglaw, Irwin, 1967.

media. The cost of that advertising is shared 50/50 with the sports consortium. The sports consortium receives a commission on their sales.

Soccer balls are sold in containers of three different sizes: namely, 16's (small), 32's (medium), and 48's (large). Each order is comprised of a case lot of appropriate containers. The following are the unit costs associated with packaging each case:

	Small	***Medium***	***Large***
Container	$2.00	$3.00	$4.00
Packing & shipping labor	6.00	7.00	8.00

In addition, delivery freight is charged to ProSport based on the number of containers shipped and the delivery miles.

During 1996, an analysis of the marketing operations was made. The following table shows the result of that analysis:

	Total	***Large Schools***	***Small Private Schools***	***Sporting Goods Stores***	***Sports Team Sales***
Number of orders:					
Small Cases	22,500		2,500	20,000	
Medium Cases	30,500	7,500	5,000	15,000	3,000
Large Cases	11,750	7,500			4,250
Provision for Uncollectable accounts					
% of Sales		.25%	.125%	.375%	.50%

Required:

1. Prepare a statement showing the profitability of each type of sales, i.e., large schools, small private schools, sporting goods stores, and sports team sales. Prepare supporting schedules to show the allocation of cost items. Describe and defend the basis on which costs were assigned or allocated to each.
2. Prepare a statement showing the profitability of each container size of soccer balls sold. Prepare supporting schedules to show the allocation of cost items. Describe and defend the basis on which costs were assigned or allocated to each.

M O D U L E

Manufacturing Overhead Allocation Traditional Versus Activity-Based

Version 1.0

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Manufacturing Overhead Allocation: Traditional Versus Activity-Based

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RINGING UP WRONG NUMBERS AT TELECO

"I never thought I'd being saying this, but it's depressing being the product manager for our traditional products these days." Pete Malloy, product manager for Standard phones at Teleco, commented over lunch to Rene Pappas, manager of the product cost analyst group. "Our sales group works harder and harder to compete against overseas producers who are selling phones at prices close to our costs. Through lots of work we've managed to achieve our budgeted sales volume, yet the report I received this morning shows that our traditional, standard model phones hardly make a profit! I personally don't see how that could be. All the cash that's generated in this company is flowing into our newer products, and I see the time and attention those product lines get from engineering, purchasing, scheduling, and the plant manager. I'm no accountant, but I think something is wrong! I think we're paying the bills for the other product lines, and they're showing our profits!"

"Pete," began Renee, "you know that older established product lines are always cash cows used to support new products. They pay the bills."

"Yes," Pete interrupted, "but they show profits, and our line isn't. It's depressing, and I feel cheated. I think something is wrong with the way costs are figured around here. We're subsidizing the new lines. I'm sure of it! You can't make phones with all those added features and not think they cost more than these reports show."

"Pete," Renee continued, "I can see that you're upset by this report, but you're making a valuable contribution to the company. Our group analyzes product costs, and you know that a sophisticated cost system was put into place when we expanded our product lines. It tracks costs by departments and cost pools, and product lines are costed based on how much machine time products require for plastic extrusion as well as the labor time they require to assemble."

"Well," Pete grumbled, "I know you're doing your job carefully, but I tell you those new products cost more to produce than the reports show. I was in production for 15 years before this job. If your product costing system is so good, can you tell me why we didn't earn the profits that were budgeted? Every product line met its budgeted sales volume."

"We're having cost problems in our support and service departments, that's why," replied Renee. "We're trying to get to the bottom of it and correct the problems."

"Or those fancy new products cost more to make than your system shows," retorted Pete.

▲ STRATEGIC IMPLICATIONS OF OVERHEAD COST ALLOCATIONS

For students of management accounting this story about Teleco raises several important strategic issues.

▲ **Quality.** Management decisions about adding features to a product or increasing its level of reliability often lead to increases in manufacturing overhead costs. A good manufacturing overhead allocation system provides information about the

costs of features and reliability. If these costs are not assigned to the product with the enhanced feature or reliability, management can add features to products that customers are not willing to pay for.

- ▲ **Cost.** Manufacturing overhead is a substantial part of a product's cost. Good product cost data is critical for strategic market positioning. Organizations, relying on an inappropriate cost allocation system, may surrender profitable portions of a market to competitors and may continue to sell in market segments that are unprofitable.
- ▲ **Time.** To compete effectively on time, a company must manage its production and shipment schedules. Altering schedules or using alternative processes increases costs. A good allocation system distributes the cost of altering these factors to products in a manner that reflects the way resource use changes when schedules are changed.

▲ PURPOSE OF THIS MODULE

The purpose of this module is to describe the nature and types of manufacturing overhead costs and to compare and contrast the two major methods of allocating such costs to products—the traditional volume-based and the more recent activity-based cost allocation methods. We discuss when each method is appropriate for determining manufacturing costs of products and consider the technical, behavioral and cultural attributes of these methods in making a choice between them. After reading this module you should understand:

- ▲ The nature and components of manufacturing overhead costs.
- ▲ The basics of allocating manufacturing overhead costs.
- ▲ The traditional volume-based overhead allocations methods.
- ▲ The more recent activity-based allocation methods.
- ▲ A comparison of the traditional volume and activity-based allocation methods.
- ▲ Desirable technical, behavioral and cultural properties of an allocation scheme.

▲ NATURE AND COMPONENTS OF MANUFACTURING OVERHEAD COSTS

Manufacturing overhead costs include all costs incurred to manufacture a product that cannot be uniquely or economically traced to that product. Other names for these costs are indirect manufacturing costs, manufacturing burden, factory overhead, or factory expenses. Manufacturing overhead includes the cost of support activities performed to produce a product or a service.[1] These include purchasing; storing; and issuing materials; maintaining machinery; supervising line workers; cleaning supplies for machines or plant facility; planning and scheduling production; recordkeeping; and providing utilities; janitorial services; gardening and parking lot cleaning for the manufacturing facility.

[1] This module focuses on manufacturing overhead. However, students should remember that manufacturing is only one kind of a production situation. The problem of allocating indirect costs also holds for service activities. We use the term manufacturing and product only as substitutes for the more general phrases "*production function*" and "*cost objects*."

Exhibit 1
Classification of Factory Costs for an Ice-cream Manufacturer

Cost Item	*Account Classification*
Milk, sugar, flavoring	Direct raw materials
Fruit pulp	Direct raw materials
Machine operator salaries	Direct labor
Production supervisor salary	Manufacturing overhead—indirect labor
Maintenance engineer salary	Manufacturing overhead—indirect labor
Electricity, water, gas, and phone	Manufacturing overhead—factory utilities
Janitorial supplies	Manufacturing overhead—indirect materials
Janitorial salaries	Manufacturing overhead—indirect labor
Factory manager salary	Manufacturing overhead—indirect labor
Factory payroll clerk	Manufacturing overhead—indirect labor
Depreciation on machinery	Manufacturing overhead—equipment depreciation
Property taxes on factory building	Manufacturing overhead—factory taxes

Raw materials and labor that can be traced directly to products comprise the other major category of manufacturing costs. These are often referred to as *direct or prime costs*. In a Pepsi bottling plant, for example, carbonated water and syrup become a part of the Pepsi during manufacturing, and their costs are direct materials. The cost of laborers who physically work on bottling or on other machines that manufacture Pepsi, is classified as direct labor cost. The remaining costs collectively are called manufacturing overhead costs. They are indirect costs.

Indirect manufacturing costs include many cost elements and have a large material and labor component. For example, packing supplies, stationery, forms, cleaning products, and lubricants are referred to as indirect materials. Salaries for personnel such as plant managers, supervisors, schedulers, accountants, inspectors, materials handlers, janitors, and engineers are part of indirect manufacturing costs. These are often referred to as indirect labor. In addition costs for items such as training programs, safety programs, and environmental programs are part of manufacturing overhead costs.

A recent study of 32 plants in the electronics, machinery, and automobile components industries shows that direct materials, direct labor, and manufacturing overhead average 65, 9, and 26 percent of manufacturing costs.[2] This means that indirect manufacturing costs are a very large and important component of product costs. Exhibit 1 shows a typical set of cost items included in the three categories for an ice-cream manufacturer. These items are classified as either direct costs or as (indirect) manufacturing overhead.

▲ BASICS OF OVERHEAD ALLOCATION

Because manufacturing overhead costs are not or cannot be traced to individual products, they must be assigned or shared among products that benefit from these costs. *The process of assigning or sharing manufacturing overhead is called allocation.*

To understand the allocation process, let us begin with a very simple situation. Assume that Teleco assembles two types of telephones—a Standard desk model and a

[2] R.D. Banker, G. Potter, and R.G. Schroeder, "An Empirical Study of Manufacturing Overhead Cost Drivers," *Journal of Accounting and Economics,* January 1995, pp. 115–138.

Exhibit 2
Teleco's Estimated Overhead Costs

Overhead Cost Item	*Amount*
Indirect materials, supplies & tools	$ 1,134,000
Indirect labor	3,090,000
Administrative salaries	4,410,000
Utilities	2,240,000
Depreciation	6,250,000
Property taxes	1,200,000
Total	**$18,324,000**

Designer trimline model. Both telephones are assembled by hand using very simple parts that are purchased from outside vendors. Both telephones have roughly the same number of parts and require the same number of production runs per year in the same batch size. These simplifying assumptions will be relaxed later.

Allocating manufacturing overhead to the two telephones in this situation is a three step process.

Step 1: Estimate the manufacturing overhead for the coming year.

This process is shown in Exhibit 2. The total is $18,324,000 for the six major components of manufacturing overhead costs in Teleco.

Step 2: Select and estimate an appropriate physical measure of work to allocate the cost to the products.

The physical measure used to assign manufacturing overhead to products is called an *allocation base* or a *driver.* An *allocation base* is a general term that describes any measure which is used to assign overhead. The number of direct labor hours, the number of machine hours or the pounds of materials processed are often used as allocation bases. When possible, an allocation base is selected that varies as manufacturing overhead costs vary. This means that a statistical relationship usually exists between an allocation base and manufacturing overhead costs. The term *driver* is used for a special kind of allocation base. A driver *causes* a manufacturing overhead cost to be incurred. A driver is used as an allocation base when a work process is well understood, that is, when the factors that cause work and its related costs have been identified.

Think Along

What allocation base or driver do you think Teleco should use?

The manufacturing overhead costs listed in Exhibit 2 will vary by the amount of work required to produce each telephone. Because of our simplifying assumptions that both phone types are similar on dimensions such as number of parts, batch sizes, number of inspections, and so on, the overhead costs will vary directly with the number of units produced for each type of telephone. The telephone with more units produced will consume more indirect material and labor, require more work space, use more utilities, and need more supervisory personnel.

Exhibit 3
Per Unit Manufacturing Overhead for Teleco

Style (1)	Labor Hrs. per Unit (2)	Units Produced (3)	Total Labor Hours (4)	Alllocation Overhead (5)
Standard	.50	2,440,000	1,220,000	.50 LH × $9.00* × 2,440,000 = $10,980,000
Designer	.80	1,020,000	816,000	.80 LH × $9.00* × 1,020,000 = $7,344,000
Totals		**3,460,000**	**2,036,000**	**$18,324,000**

* $9.00 = $18,324,000/2,036,000

Since the production process is labor intensive, a good estimate of the volume of work is the direct labor hours used. Therefore, the two types of phones will consume manufacturing overhead costs in direct proportion to the number of direct labor hours used in producing them.

Key Point

Traditional allocation systems assign or allocate indirect manufacturing costs to products using measures of production volume such as direct labor hours or machine hours worked. These volume measures are used instead of counting products because most companies produce more than one product. A volume measure that is common to all products is selected.

Step 3: Develop an overhead rate and apply it to products.

An overhead rate results from dividing total overhead cost by the selected allocation base. An overhead rate is also called a *burden rate,* a *charge rate,* or an *application rate*.

Assume that the Standard model takes 0.5 hours to assemble and that the Designer model takes 0.8 hours to assemble. In the next year Teleco expects to produce 2,440,000 units of the Standard phone and 1,020,000 units of the Designer phone. This level of production will require a total of (2,440,000 × .5 + 1,020,000 × .8) 2,036,000 direct labor hours. The overhead rate for Teleco is $9.00 per direct labor hour ($18,324,000 manufacturing overhead cost ÷ 2,036,000 direct labor hours = $9 per direct labor hour).

Exhibit 3 shows the overhead costs allocated to total production.

As Exhibit 3 shows, the cost of each style of telephone will include manufacturing overhead based on the number of direct labor hours it requires multiplied by the overhead rate of $9. This rate is used to assign all the manufacturing facility's overhead to products. It is called a *plantwide overhead rate,* because it includes all the manufacturing plant's overhead.

On a per unit basis, a standard telephone would be assigned $4.50 of manufacturing overhead cost ($9.00 overhead rate * .50 labor hours), while a designer telephone would be assigned $7.20 ($9.00 overhead rate * .80 labor hours).

Note that an overhead rate is typically developed in advance of production. This rate is called a *predetermined overhead rate*. Developing a predetermined overhead rate requires the use of estimated or budgeted manufacturing costs and production volume. Using the predetermined rates, products are charged for overhead as they are produced. This process is called *overhead application* or *overhead absorption*.

Behaviorally, the use of a predetermined overhead rate places cost pressure on production personnel. They understand that output will only contain predetermined amounts of overhead costs and that overhead costs incurred beyond normal monthly amounts will result in negative performance evaluation. Fearing unfavorable performance evaluation, they may avoid incurring costs such as preventive maintenance on machinery during periods when high overhead costs are being incurred. Such behavior can lead to dysfunctional results.

Think Along

Why do firms use a predetermined rather than an actual overhead rate to assign manufacturing overhead costs to products?

A predetermined overhead rate is used for two reasons. First, it speeds up and simplifies internal recordkeeping. Product costs can be determined without waiting for all actual indirect cost bills to be received and for all production to be finished for a time period. If actual indirect cost was applied to actual production, then both of these would have to be known before the actual costing could be done. Second, many costs are not incurred evenly. For instance, factory heating costs are higher in winter, repairs may be done during off-peak season, and so forth. To charge products produced in winter for higher heating costs penalizes them for production scheduling when there is no basic variation in the fundamental cost factors.

Think Along

What happens if there are many different products that require different types of production activities many of which are not affected by the production volume? Can a single plantwide overhead rate using one volume measure give good product cost data?

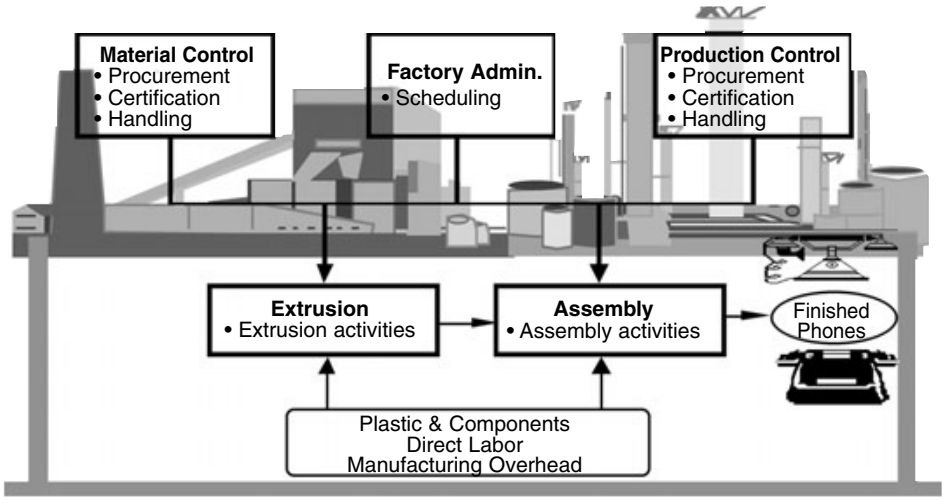
▲ DEPARTMENT BASED OVERHEAD ALLOCATION

In the previous section we saw that if both telephones require a similar production process, then Teleco's manufacturing overhead will vary by the number of units produced. This simplicity of the production environment makes it possible to collect all costs into one *plantwide cost pool* and then assign it to products using a single *volume based* measure such as direct labor hours.

Manufacturing environments are seldom this simple. Teleco does not make two telephones. It makes a whole line of standard and designer phones. The lines combine various features such as caller ID, automatic redial, speaker, hold button, and so forth. In addition, the designer line offers different styles such as character phones in the shape of Mickey Mouse, Minnie Mouse, Donald Duck, Daffy Duck, Tasmanian Devil, Tweetie, Sylvester, and Yosemite Sam. These products require many different work activities which makes the production process more complex than depicted in the previous section.

One way in which firms handle the complexity created by many products and activities is to assign manufacturing overhead to products using departmental overhead rates. Departments are headed by supervisors or managers who are responsible for coordinating work activities. They are responsible for procuring, safeguarding, and accounting for the resources they need to perform work in their respective units. A departmental view of Teleco's operations is provided in Exhibit 4.

Exhibit 4
Departmental View of Teleco's Factory



As shown in Exhibit 4, Teleco's factory has five departments or responsibility units.

The Materials Control Department performs activities such as vendor certification, procuring materials, receiving, warehousing, and coordinating the arrival of all subcomponents into assembly at the proper time (materials handling). The primary costs in this area are salaries, supplies, and space.

The Factory Administration Department schedules machines, processes factory payroll, and supervises production. The primary costs of the department are clerical and supervisory salaries.

The Production Control Department is responsible for engineering design, quality assurance, and machine setups. The primary cost in production control is salaries.

The Extruding Department has plastic extrusion machines that form the outer plastic body for the telephones. Direct materials and direct labor costs are incurred in this department. The primary indirect costs in this department are associated with equipment depreciation, maintenance, and operating supplies.

The Assembly Department uses direct laborers and robots to assemble phones from various components and parts that are accounted for as direct materials. The primary indirect costs of the assembly department are indirect labor, materials, depreciation, and supplies.

There are three important things to note about Teleco's departments.

First, Extruding and Assembly Departments work on manufacturing the telephones. These departments are called *production centers*. The remaining departments exist to provide service and support to the production departments. They are called *service* or *support centers*.

Second, each department performs many different types of activities. For example, the Materials Control Department performs vendor certification, materials procurement and

materials handling. Performance of many varied activities is common since departments are created to utilize managers and employees fully and economically. Housing multiple activities within a single department reduces employee idle time and saves on supervisory and managerial salaries.[3] Exhibit 4 lists only some of the activities performed within these departments.

Finally, products may not draw upon the activities of all departments equally. For example, a Mickey Mouse telephone that has caller ID, automatic redial, and a hold button will require greater production coordination, more quality inspection, and materials handling than a standard push-button desk telephone.

A departmental system of manufacturing overhead cost allocation has two *purposes:*

- ▲ To hold departments accountable for resources entrusted to them.
- ▲ To determine unit product costs.

We listed accountability first because a departmental system is based on the key concept of *responsibility accounting*. Its primary focus is on controlling costs through the management structure by measuring the services and support that departments receive from each other.

Key Point

Note that accountability is based on who consumes resources, not on who acquired the resources.

This sometimes leads to political and behavioral problems because managers perceive that they are being assigned costs that they have no control over. The assignment is done to reduce overconsumption of services and resources. Culturally, it is desirable for managers to perceive this accountability system as fair and equitable and reflective of the services each uses.[4]

To determine *product costs,* the departmental allocation method traces costs to departments and then assign those costs to products. Since service departments and factory-wide cost pools do not work on products, a departmental system allocates all service department and common pool costs to production departments prior to allocating them to products.

Illustration of Traditional Volume-Based Allocation Systems.

Allocation of manufacturing overhead costs using a departmental system requires six steps.

Step 1: Estimate manufacturing overhead costs by different cost categories.

This was done previously in Exhibit 2, and the total amount is $18,324,000.

[3] Economists refer to the utilization of common assets to perform related operations cost effectively as "economies of scope."

[4] For an interesting article on fairness, see "Figuring Fairness by the Numbers," The Los Angeles Times, *Column One,* April 26, 1996.

Exhibit 5
Manufacturing Overhead Classified by Departments and Cost Pools

	Plantwide	*Materials Control*	*Factory Admin.*	*Production Control*	*Extruding*	*Assembly*	*Totals*
Overhead Costs							
Indirect materials/supplies	$20,000	134,000	86,000	110,000	450,000	334,000	$1,134,000
Indirect labor	25,000	10,000	15,000	137,000	1,242,000	1,661,000	3,090,000
Administrative salaries	1,440,000	1,520,000	1,208,000	242,000			4,410,000
Utilities	2,240,000						2,240,000
Depreciation	3,500,000	137,000	85,000	115,000	2,035,000	378,000	6,250,000
Property Taxes	1,200,000						1,200,000
Totals	**$8,425,000**	**1,801,000**	**1,394,000**	**604,000**	**3,727,000**	**2,373,000**	**$18,324,000**

Exhibit 6
Selected Volume-Based Drivers for Departments and Plantwide Cost Pool

	Plantwide	*Materials Control*	*Factory Admin.*	*Production Control*	*Extruding*	*Assembly*	*Totals*
Square feet	14,000	12,000	3,000	6,000	9,000	6,000	50,000
Number of requisitions		70	250	180	5,000	10,500	16,000
Number of employees	15	35	90	45	55	590	830
Maintenance/ planning hours					90,000	50,000	140,000
Machine hours					1,435,000		1,435,000
Direct labor hours						2,036,000	2,036,000

Step 2: Assign overhead costs to production and support centers and any remaining costs to a central cost pool.

Exhibit 5 shows the reassignment of the $18,324,000 in manufacturing overhead costs to the various production and support departments. In addition to these five departments, Teleco also has a group of costs which are common to the entire manufacturing facility. These costs include utilities, depreciation, and property taxes. Teleco grouped these costs into one cost pool labeled *"plantwide costs."*

Step 3: Choose an allocation base for each department.

The choice of an allocation base to charge departmental costs to user departments should reflect what causes costs to vary. This process typically requires estimating the relationship between operating statistics that provide measures of volume and the behavior of costs in a department. Exhibit 6 shows some of the bases or drivers available for allocation purposes.

Exhibit 7
Allocation of Service and Central Support Costs to Production Departments

	Plantwide	*Materials Control*	*Factory Admin.*	*Production Control*	*Extruding*	*Assembly*
Before allocation totals (from Exhibit 5)	$8,425,000	1,801,000	1,394,000	604,000	3,727,000	$2,373,000
Allocation of plantwide costs	(8,425,000)				5,055,000	3,370,000
Materials Control		(1,801,000)			580,968	1,220,032
Factory Admin.			(1,394,000)		118,868	1,275,132
Production Control				(604,000)	388,286	215,714
After allocation totals	0	0	0	0	$9,870,122	$8,453,878

Think Along

Which base is the most appropriate for each department?

Reviewing the statistics and costs in the various departments, it appears reasonable to use the following bases.[5] Since plantwide costs are related to space occupancy, the best measure seems to be square feet occupied. Number of purchase requisitions appears to be the most reasonable measure of work volume in the Materials Control Department. The Factory Administration Department's costs are related to the volume of administrative work, which in turn depends upon the number of employees in the other departments. Production Control provides engineering, production planning, and scheduling. Its work can be best measured by the number of planning hours. For production departments, number of machine hours best measures the activity and cost consumption in Extruding, and direct labor hours measures the activity within Assembly.

Step 4: Allocate all central and service department costs to production centers.

In practice, there are three methods for assigning service department overhead to production departments: the direct method, the step method, and the simultaneous method. Only the direct method is presented here. The other two are discussed in an appendix to this module.

The direct method allocates the cost of service and support departments and cost pools directly to production departments. It ignores any services that service departments provide to each other. The advantage of the direct method is its simplicity. Of all the departmental methods, it requires the fewest calculations and the least data. Starting with any cost pool,[6] the costs of all pools and service centers are allocated to the two production centers based on service use.

Exhibit 7 provides the results of the direct method of allocation using Teleco's data from Exhibits 5 and 6.

[5] In practice this might be decided on the basis of statistical analysis of cost behavior.
[6] Since no allocations are made to other service departments, the starting point does not matter in this method of allocation.

Explanation of Allocations[7]

(1) **Plantwide cost:** Allocation base is space as measured by square feet.

Extruding square feet	9,000	60% × 8,425,000	$5,055,000
Assembly square feet	6,000	40% × 8,425,000	3,370,000
Total production	15,000	100%	$8,425,000

(2) **Materials control cost:** Allocation base is number of requisitions.

Extruding requisitions	5,000	32.25% × 1,801,000	$580,968
Assembly requisitions	10,500	67.74% × 1,801,000	1,220,032
Total	15,500	100%	$1,801,000

(3) **Factory Administration:** Allocation base is number of employees.

Extruding employees	55	8.52% × $1,394,000	$118,868
Assembly employees	590	91.47% × $1,394,000	1,275,132
Total production	645	100%	$1,394,000

(4) **Production Control:** Allocation base is number of planning hours.

Extruding planning hours	90,000	64.28% × $604,000	$388,286
Assembly planning hours	50,000	35.72% × $604,000	215,714
Total production	140,000	100%	$604,000

Step 5: Develop a departmental overhead rate for each production center.

The revised costs, after all allocations, for the Extruding and Assembly Departments can be used to develop departmental overhead allocation rates. The Extruding Department's overhead rate is determined by taking the new departmental total costs and dividing by the number of machine hours. The Assembly Department's overhead rate is determined by taking the new departmental total costs and dividing by the number of labor hours. Exhibit 8 shows the two rates.

[7] There are slight rounding differences from the numbers shown in Exhibit 7 due to calculator versus spreadsheet calculations.

Exhibit 8
Overhead Rates Determined by Direct Departmental Allocation

Description	*Extruding*	*Assembly*	*Total*
Total overhead after allocations	$ 9,870,122	$ 8,453,878	$18,324,000
Total machine hours	1,435,000		
Total labor hours		2,036,000	
Overhead rate per machine hour	$6.8781		
Overhead rate per direct labor hour		$4.1522	

Exhibit 9
Overhead Allocation to Products Using the Direct Method

Model $\Rightarrow$	*Standard*	*Designer*	*Total*
1. Machine hours/unit	0.40	0.45	
2. Direct labor hours/unit	0.50	0.80	
3. Extruding Department Overhead	$ 2.7512 ($6.878 $\times$.40)	$3.0952 ($6.878 $\times$.45)	
4. Assembly Department Overhead	$2.0762 ($4.15 $\times$ .5)	$ 3.3217 ($4.15 $\times$.80)	
5. Manufacturing overhead, per unit	$4.8274	$6.4169	
6. Planned Production	2,440,000	1,020,000	
7. Total manufacturing overhead (Row 5 $\times$ 6)	$11,778,742	$6,545,258	$18,324,000

Step 6: Assign overhead to products as they pass through the production center.

As each product passes through the two departments, it is assigned overhead costs based on the rates shown in Exhibit 8. To do so we need to know the amount of machine hours that each phone receives in Extruding. (Recall that we previously stated the number of labor hours in Assembly as .5 and .8 for Standard and Designer phones respectively.) Assume that the Standard phone uses .4 machine hours and the Designer model uses .45 machine hours in Extrusion. The overhead cost allocated to the two telephones is shown in Exhibit 9.

Compare the overhead costs assigned to the products in Exhibit 3 using a plantwide rate with the overhead assigned to products using the departmental rates in Exhibit 9. Why do the two methods yield different manufacturing overhead costs for the products? Which one is better?

Based on rates in Exhibit 3, standard telephones are assigned $4.50 of overhead ($9 plantwide rate * .50 labor hours) and designer telephones are assigned $7.20 of overhead ($9 plantwide rate * .80 labor hours). In Exhibit 9 these same telephones are assigned

approximately $4.83 and $6.42 of overhead costs, respectively. The small differences are caused because departmental assignments use **both** direct labor hours and machine hours. Since both products have similar machine hours, the overhead assigned to product using the departmental method will be more similar ($4.83 for standard and $6.42 for designer) than in the plantwide method where direct labor alone is used as an assignment base ($4.50 for standard and $7.20 designer).

▲ ACTIVITY-BASED OVERHEAD ALLOCATION

An activity-based cost (ABC) allocation system focuses on work activities instead of on departments and assigns indirect manufacturing costs to products according to the activities that are performed on them.[8] It represents a work process focus rather than the responsibility focus used by departmental allocation systems.

Products are produced by performing a sequence of ordered and coordinated activities. Activities consist of many tasks. For example, an activity such as extrusion *setup,* which is needed when a new product is placed into production, includes tasks such as resetting dials, installing new molds or dyes, testing, calibrating machinery, changing colors and materials, coordinating material deliveries to machine requirements, and adjusting the flow of production line items.

While some activities reside within the formal boundaries of a department, many activities cut across departmental lines. As we saw in Exhibit 4, departments typically undertake many different types of work activities.

Think Along

What happens if two products draw on activities in the same department differentially?

Examples of typical activities in a manufacturing facility are: ordering materials, receiving materials, scheduling production, inspecting quality, setting up machines, handling materials, shipping finished goods, cleaning the plant facility, processing payroll, and so on. Work activities consume material and personnel time which explains the logic of an activity-based cost allocation system.

Key Point

Products consume activities and activities consume resources; therefore, costs should be assigned to products in the proportion in which they consume activities.

Two products that use different amounts of an activity receive different cost allocations in an ABC system.

ABC systems use five key steps in assigning manufacturing overhead to product costs.

[8] Peter Turney, "Using Activity-Based Costing to Achieve Manufacturing Excellence," *Cost Management,* Summer 1989.

Step 1: Identify activities used by products and determine their cost drivers.

Activity-based allocation starts by identifying the *activities* in the production process.[9] Instead of activities varying as production volume varies, they are generally described as varying at four levels:[10]

Unit-level activities are performed each time a unit is produced. For example assembly activities which consume supplies and indirect labor are performed for each unit of product produced.

Batch-level activities are performed each time a batch of products is placed into production. For example, each batch of products requires scheduling, material handling, and machinery setup activities.

Product-level activities are performed to support a product or product line. For example, each product line (not each unit) requires engineering activities such as design, modification, documentation, instruction manual preparation, and technical support.

Facility-level activities are performed to support and provide space to the entire production facility. Items such as insurance, property taxes, general maintenance of the plant and parking lots, and the employee cafeteria are included in the facility-level category. Facility level activities are very similar to central cost pools used in departmental allocations (see step 2 of departmental allocations).

We assume that Teleco has performed an activity analysis. Hundreds of activities could be identified in Teleco's manufacturing process, but this is not practical for costing purposes. A 1995 CAM-I study of best practices showed that around 32% of best practice companies identify between 101 and 250 activities, about 25% identify between 26 and 100, and around 18% identify less than 25 activities.[11] After an activity is identified we determine the causes or drivers of the cost of this activity. This is called a *cost driver.*

To keep our illustration simple we identify only nine major activities for Teleco's manufacturing operation. Our purpose is to illustrate the mechanics of cost allocation, and not to provide a complete representation of Teleco's manufacturing process.

Vendor certification includes tasks involved in identifying and approving vendors. It also includes inspecting samples of delivered items and tracking on time delivery to maintain statistics on vendor performance. These tasks are performed for each unique part used in a telephone; therefore, the more unique parts a telephone contains, the higher the cost for that model. This activity is driven by the number of parts in a product (further, this activity is classified as a product level activity).

Materials procurement includes the costs of placing orders and arranging transportation and storage. These activities have to be performed each time a purchase order is placed. Orders are placed for each part within a product. Accordingly, this activity is driven by purchase transactions, which is measured by the parts in a product times the quantity

[9] The Activity Based Management (ABM) module in this series demonstrates how to perform activity analysis, how to cost activities, and how to improve them.

[10] Robin Cooper, "Cost Classification in Unit-Based and Activity Based-Manufacturing Cost Systems," *Journal of Cost Management* 4, No. 3 (Fall 1990), p. 6.

[11] George Foster, J. Miller and D. Swenson, "Activity-Based Management Consortium Study." Consortium of Advanced Management-International (CAM-I), 1995, p. 17.

produced divided by the purchase order size. (Again, this activity is classified as a product level activity.)

Engineering support includes work performed to modify existing products because of customers' requests, raw material changes or problems during production. Usually an engineering modification benefits a particular product and can be traced to that product when made. Since the number of engineering hours spent on each product is routinely tracked, *engineering support is no longer an indirect cost that has to be allocated. It should be reclassified as a direct cost, and engineering hours is the cost driver for this activity.*

Materials handling includes moving materials from the receiving area, within production areas, and to packing areas. Each product line has pre-established material moves. The number of material moves required is the cost driver for the materials handling activity. (Again, this activity is classified as a product level activity.)

Quality assurance comprises all the tests performed on products. The more tests a product requires, the more Teleco spends on quality assurance. The number of inspections or tests required for each product is the cost driver for this activity. (This activity is also classified as a product level activity.)

Extrusion activities use plastic molding machines and workers to mold plastic, which is a direct cost of the product, into the outer shell of telephones. Extrusion activities consume indirect costs such as machinery, tools, software, indirect materials, as well as labor time spent cleaning or adjusting machinery. For this activity, indirect costs vary with the pounds of plastic extruded. Accordingly, allocation base for extrusion stations is pounds of plastic. (This activity is performed on each unit of product and is thus classified as a unit level activity.)

Assembly activities use a small number of skilled laborers and robots to combine the various pieces of telephones into completed units. The number of assembly operations required for a telephone causes costs and time to increase. Assembly operations are a function of both the parts in a product and the quantity of products produced. Number of assembly operations (parts in a product times quantity produced) is the cost driver for this activity. (This is also a unit level activity.)

Production scheduling tasks assure that proper extrusion machines are available, raw materials arrive on time, assembly operators with proper tools and skills will be available when extruding is finished, and that work load is smoothly averaged to avoid idle machine time or overtime while meeting customers' required shipment dates. These tasks are required every time a batch of products is put into production. The cost driver for scheduling is the number of batches of product started. (This activity is classified as a batch level activity.)

Setup activity involves installing proper molds to produce telephone shells, calibrating extruding machinery for proper plastic shell thickness and for smooth edges, and color testing plastics against prototypes for each product. The cost driver for these activities is the number of setups that have to be performed, which is the same as the number of batches started. (This activity is also a batch level activity.)

Exhibit 10
Activity View of Teleco's Manufacturing Process

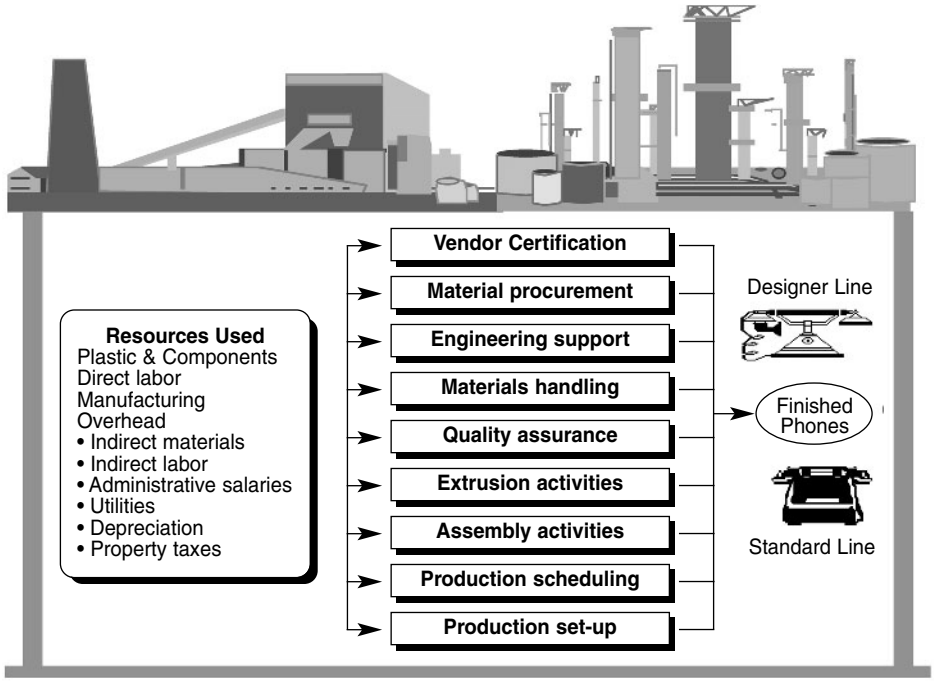


Exhibit 10 provides an activity view of Teleco's manufacturing process. Compare Exhibit 10 to Exhibit 4, which provided a departmental view.

Step 2: Trace costs to activities.

Activities consume resources such as indirect labor, materials and supplies, equipment, software, space, utilities, etc. Although most of these items can be traced to an activity or assigned based on a driver which reflects use of resources, some costs cannot be handled in this way. These costs are included in a cost pool and allocated to activities in a fair and equitable manner. At Teleco, the common activity cost pool contains items such as building depreciation, utilities, property taxes, accounting, and payroll that exist for the common good of the entire manufacturing facility. As previously discussed, these are referred to as "*facility-level*" costs. These costs support all activities and need to be allocated to activities. Because most of the costs are space related, square feet within each activity was selected for that allocation.

Exhibit 11 shows the costs in the common activity cost pool. Exhibit 12 shows the costs directly traced to each activity and the amount allocated from the common activity cost pool. In addition, Exhibit 12 shows the cost driver to be used for each activity (discussed in step 1 previously).

Notice that the total activity cost shown in Exhibit 12 is the same as the total indirect cost shown in Exhibit 5 ($18,324,000). The difference between the two exhibits is the way the data is organized. In Exhibit 5, costs are arrayed by departments and the type of expenditure, for example, indirect labor or materials. In Exhibit 12 those same costs have been organized according to work performed, or activities.

Exhibit 11
Common Activity Cost Pool

Depreciation on Building	$3,500,000
Property Taxes	1,200,000
Utilities	2,240,000
Total	$6,940,000

Exhibit 12
Activities and Drivers

Activity	*Costs Directly Traceable To Activities*	*Space Used in Square Feet*	*Allocation of Common Activity Costs*	*Total Activity Cost*	*Driver*
Vendor certification	$3,383,384	4,000	$771,111	$4,154,495	# of parts
Materials procurement	386,367	4,000	771,111	1,157,478	# of purchase transactions
Engineering support	534,969	1,000	192,778	727,747	engineering hours
Materials handling	891,616	8,000	1,542,222	2,433,838	# of moves
Quality assurance	936,196	1,500	289,167	1,225,363	# of inspections
Extrusion stations	2,689,707	11,000	2,120,556	4,810,263	lbs. of plastic used
Assembly stations	386,367	4,000	771,110	1,157,477	# of parts × quantity
Machine setups	1,615,905	500	96,389	1,712,294	# of set-ups or batches
Production scheduling	559,489	2,000	385,556	945,045	# of set-ups or batches
Totals	**$11,384,000**	**36,000**	**$6,940,000[1]**	**$18,324,000**	

[1] The common cost pool of $6,940,000 is allocated according to the square feet used to support each activity. This value has to be measured or estimated. Each activity is charged costs based on its square feet divided by total square feet. For example, materials procurement: (4,000 square feet in procurement * 36,000 total square feet) × $6,940,000 = $771,111 (rounded).

Step 3: Reclassify and combine activity costs.

In practice an allocation worksheet like Exhibit 12 will contain several hundred activities.

Think Along

If several hundred activities exist with different cost drivers, how can managers deal with the technical complexity of an ABC system?

If several hundred drivers were used for cost allocation purposes, the system would be far too complex, detailed, and costly to be useful. When many activities have a common driver, a better approach is to group costs of activities together into larger groupings. This method not only makes the system more manageable, but also focuses attention on key cost drivers. This information is very useful for cost planning.

Activities with the same driver, therefore, are combined into a single cost pool. This reduced set of cost pools and drivers is used for product costing. The CAM-I best practices

Exhibit 13
Combination of Activities with Common Drivers

Activity or Cost Pool	*Total Activity Cost*	*Driver*
Vendor certification	$4,154,495	# of parts
Materials procurement	1,157478	# of purchase transactions
Engineering support	727,747	engineering hours
Materials handling	2,433,838	# of moves
Quality assurance	1,225,363	# of inspections
Extrusion stations	4,810,263	pounds of plastic used
Assembly stations	1,157477	# of assembly operations
Machine setups & production scheduling	2,657,339	# of set-ups
Totals	**$18,324,000**	

study reports that about 25 percent of the companies use between 6 and 10 drivers, and 20 percent use 5 or fewer drivers.[12]

In Teleco both machine setups and production scheduling share number of batches or setups as their driver. The costs of these activities are combined into a cost pool in Exhibit 13. This combination leaves eight drivers for allocating overhead costs to products. One of these, engineering hours, is not an allocation base. It is a driver for tracing direct costs to each product.

Think Along

Even in our simple example, eight cost drivers are used. How can an ABC system be managed cost effectively?

Firms might combine even more activities. Consider material procurement and assembly. Each part in a product must be procured and assembled. These two activities might be combined into one cost pool and assigned to products based on the number of parts in each. This not only simplifies the process, but also encourages product engineers to redesign products with fewer parts.

Step 4: Collect data on the use of cost drivers for each activity and determine the over head cost per driver.

Key Point

To determine the cost of products, manufacturing overhead costs should be assigned to products in the proportion that they consume activities.

Statistics must be kept on total cost drivers consumed. These are maintained for each product, and show how much each product normally requires of each activity.

Exhibit 14a contains product data required for ABC. It shows expected consumption of drivers for total planned production for the next time period. The data in Exhibit 14a is

[12] G. Foster, J. Miller and D. Swenson, "Activity-Based Management Consortium Study." Consortium of Advanced Management-International (CAM-I), 1995, p. 17.

Exhibit 14a
ABC Cost Drivers for Product Lines

ABC Cost Drivers (1)	*Standard (2)*	*Designer (3)*	*Total (4)*
Planned production in units	2,440,000	1,020,000	3,460,000
Pounds of plastic used	610,000	1,530,000	2,140,000
Engineering hours	3,460	6,500	9,960
Number of parts per product	98	145	243
Number of purchase transactions*	239,120	295,800	534,920
Number of quality inspections	14	18	32
Number of material moves	168	400	568
Number of assembly operations	239,120,000	147,900,000	387,020,000
Number of batches (set-ups)	30	110	140

* Each purchase order is assumed to be for 1,000 standard items and 500 designer items.

Exhibit 14b
Activity Cost per Unit of Driver

Activity or Cost Pool	*Activity Cost/Driver*	*Driver*
Vendor certification	$17,096.69	per unique part
Materials procurement	$2.16	per purchase transaction
Engineering support	$73.07	per engineering hour
Materials handling	$4,284.93	per material move
Quality assurance	$38,292.58	per inspection
Extrusion stations	$2.25	per pound of plastic used
Assembly stations	$0.0030	per assembly operation
Machine setups & production scheduling	$18,980.99	per set-up

calculated by multiplying expected production by driver specifications for the two products. Exhibit 14b shows the per driver cost of each activity. It is obtained by dividing activity cost, shown in Exhibit 13, by the total use of cost drivers, shown in Exhibit 14a.

Step 5: Assign costs to products.

The manufacturing overhead cost of each product is calculated from the data in Exhibits 13 and 14. This calculation is a fairly simple and routine. Each product is assigned activity cost by multiplying the per unit activity cost (Exhibit 13 costs divided by Exhibit 14a column 4) by the drivers used by each product (Exhibit 14a column 2 or 3). For example, vendor certification has a total cost of $4,154,495 (Exhibit 13). There are 243 total parts which means that vendor certification costs $17,096.69 per part (Exhibit 14b). Because the standard phone has 98 parts, it is allocated a cost of $1,675,475 (98 × $17,096.69).[13] This

[13] If you are using a hand-held calculator to compute the numbers in Exhibits 15 and 16, you may be off from the numbers in the exhibits. We prepared the exhibits in a computer spreadsheet that does not round intermediate calculations. We strongly recommend that you build these calculations on a generic spreadsheet to reinforce your learning.

Exhibit 15
Activity Costs Incurred by Product Line Under ABC

	Standard	*Designer*	*Total*
Vendor certification	$1,675,475	$2,479,020	$4,154,495
Material procurement	517,416	640,062	1,157,478
Engineering support	252,812	474,935	727,747
Materials handling	719,868	1,713,971	2,433,838
Quality assurance	536,096	689,267	1,225,363
Extrusion stations	1,371,150	3,439,113	4,810,263
Assembly stations	715,147	442,331	1,157,478
Machine setups & production scheduling	569,430	2,087,909	2,657,339
GRAND TOTALS	**$6,357,393**	**$11,966,607**	**$18,324,000**

Exhibit 16
Manufacturing Overhead per Product Under ABC

Manufacturing Overhead	*Standard*	*Designer*
Vendor certification	$0.69	$2.43
Material procurement	0.21	0.63
Engineering support	0.10	0.47
Materials handling	0.30	1.68
Quality assurance	0.22	0.68
Extrusion stations	0.56	3.37
Assembly stations	0.29	.43
Machine setups & production scheduling	0.23	2.05
Total	**$2.61**	**$11.73**

value represents the vendor certification costs consumed by the Standard phone product line. Since Teleco plans to produce 2,440,000 Standard models, (Exhibit 14a) each Standard phone contains a 69 cent charge for using vendor certification activities ($1,675,475 ÷ 2,440,000 units).

Exhibit 15 shows the amount of overhead costs caused by and therefore allocated to each product line.

Compute the total and the per unit activity cost allocated to the two phones for the other activities shown in Exhibits 15 and 16.

Step 6: Determine unit product costs.

To determine the unit cost of products, divide the budgeted activity cost assigned to products[14] (Exhibit 15), by the planned production of each product (Exhibit 14a). This results in a planned overhead cost per product (Exhibit 16). This is sometimes referred to as a "*bill of activities*" since it lists each activity required and its contribution to the cost per unit of product.

[14] While we demonstrate ABC determining the cost of a product, it is often used to determine the cost of jobs or processes.

Exhibit 17
An Overview of the ABC Allocation Process

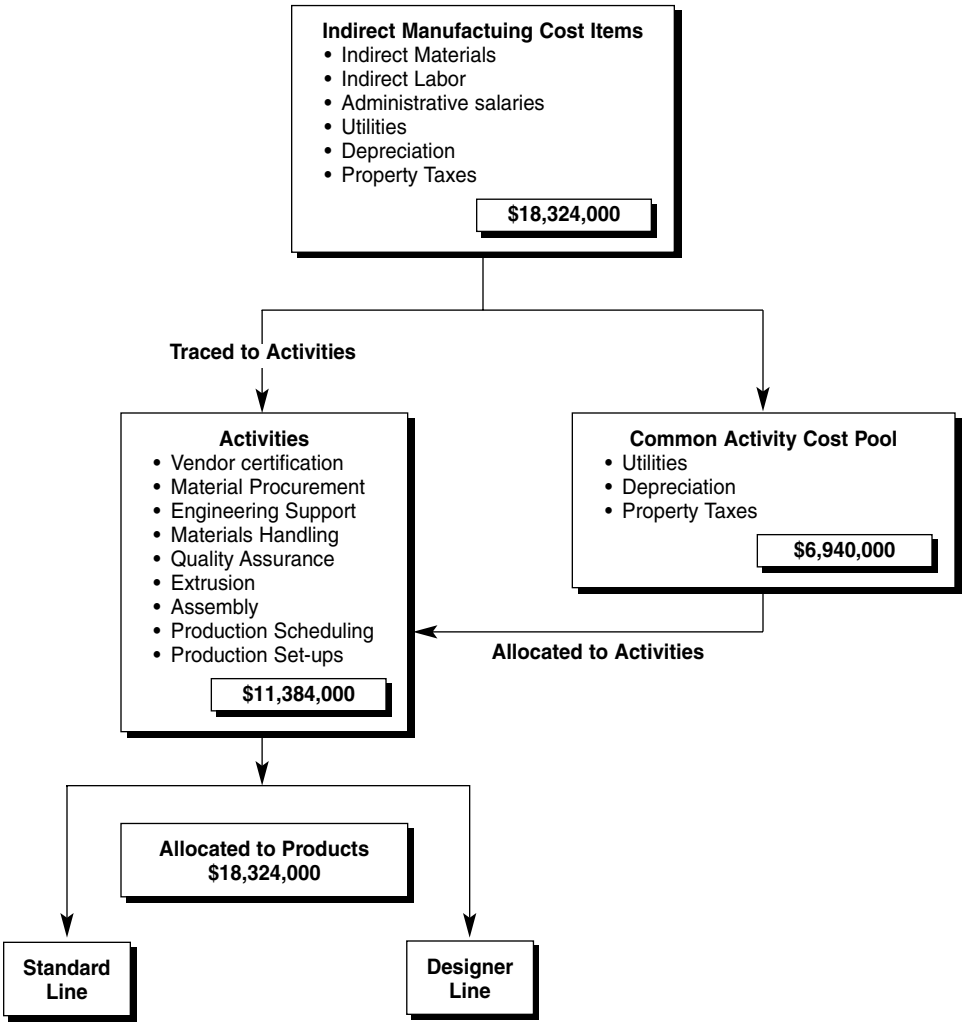


Exhibit 17 graphically summarizes the entire ABC cost allocation process.

Key Point

ABC assumes that costs are caused by many factors or cost drivers while traditional allocation assumes that costs are caused by volume.

Key Point

In ABC, many costs can be traced directly to activities and from there to products; yet, certain type of costs, for example, facility level costs, require allocations to activities and products. ABC does not eliminate allocations and does not provide a "true" product cost.

Exhibit 18
Comparison of Manufacturing Overhead Allocation Systems
Traditional versus ABC

	Standard	*Designer*	*Difference*
Traditional department-based (direct) allocation	$ 4.82	$ 6.42	33%
ABC overhead allocation	2.61	11.73	350%
Difference	2.22	(5.32)	
	85%	−45%	

Think Along

ABC has been described as yielding "true" and "accurate" product costs. This results because more costs are directly traced to products, or cost drivers are used to charge the cost of activities to products. Does ABC yield "true" and "accurate" product costs?

▲ COMPARISON OF TRADITIONAL AND ABC OVERHEAD ALLOCATIONS

The two prior sections demonstrate how Teleco's manufacturing overhead costs would be allocated under traditional and ABC systems. Exhibit 18 presents a comparison of the manufacturing overhead allocations under the department-based and the ABC systems.

As Exhibit 18 shows, there is only a moderate cost difference (33 percent, ($6.42−4.82)/ 4.82) between the Standard and Designer phones in a traditional departmental overhead allocation system. Under an ABC system, however, the Designer phone is assigned nearly 350% (($11.73−$2.61)/$2.61) more cost than the Standard phone! (Remember Pete Malloy's complaint from the opening story.) The traditional system reports the Standard model at a higher cost (85 percent or $2.22/$2.61) and the Designer model at a much lower cost (−45 percent or ($5.32)/$11.73) as compared to the ABC system.

Note Pad

Can you reconcile these cost differences to the cost allocation system?

Three key differences between the two allocation approaches explain the cost differences between the products. These are: (1) types of allocation bases used, (2) focus of costing system, and (3) steps in the allocation process.

Types of Cost Drivers Used.

A traditional system typically uses a volume related allocation base. The basic logic is that costs change with number of units produced. A review of Exhibit 9 shows that the traditional method allocates overhead based on volume measured by machine and labor hours. Since the two phone styles use roughly the same amount of machine hours, there is little difference in their costs as far as the Extruding Department overhead is concerned. Their main difference is in the use of labor hours. Since the Designer phone uses more labor hours, it also gets more of the Assembly Department overhead costs.

Now review the statistics on ABC cost drivers in Exhibit 14a. Costs are distributed to the two products by pounds of plastic; engineering hours; and number of parts, assembly operations, inspections, material moves, and setups or batches. These drivers reflect differences in batch size and design characteristics between the products. The large differences that are revealed when comparing the drivers across product lines result in large cost differences. The standard models cost less than designer models under ABC because they have fewer parts, require fewer quality inspections, and for the volume of products sold, they have relatively few engineering hours, material moves, and batches put into process.

Focus of the Costing System.

A traditional department-based system primarily focuses on management responsibility for costs. Its cost allocation follows the logic of the formal organization structure. It assumes that within a department there is no variability in how products consume resources. Therefore, a single driver, such as machine hours, is sufficient to capture costs consumed by products in that department. Consider what happens to vendor certification costs. They are first merged with the total for the Material Control Department. From there they are charged to the Extruding Department based on number of requisitions and then allocated (almost equally) to the two products based on machine hours used. How much vendor certification each product requires is lost in this departmental focus.

ABC systems have a *process focus*. They capture and assign costs by how products consume work activities. Multiple drivers are commonly used to provide a more refined picture of resource consumption by products. Therefore, ABC traces vendor certification activities to each product and charges costs accordingly.

Steps in the Allocation Process.

Both systems use a two step allocation process. However, the steps are different. A traditional system assigns overhead costs first to departments and second to products. Consequently, multiple and often diverse activities are combined and assigned using a single cost driver. Support department costs go through another step. They are allocated first to production departments and then to products.

In contrast, an ABC system assigns costs first to activities and then to products. The department or departments that perform these activities makes no difference to the cost allocation for product costing purposes. The direct relationship between products and activities is the base for allocation. Exhibit 19 presents this difference graphically.

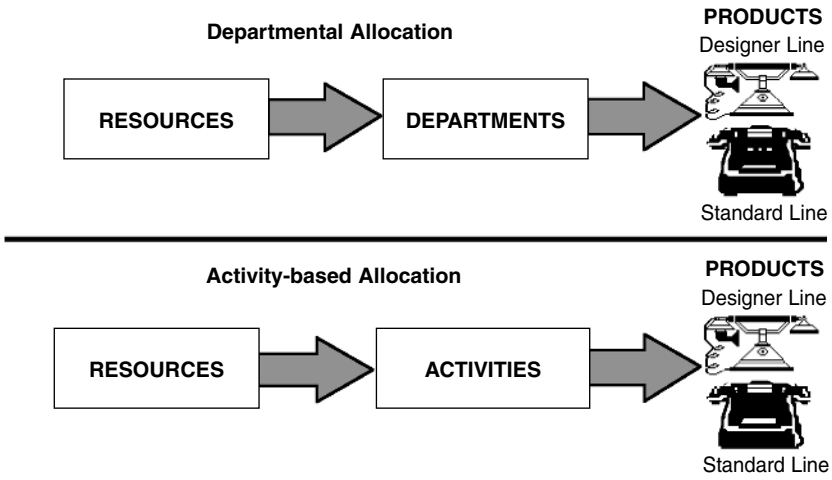
Think Along

Which of these two methods do you think we should use?

▲ EVALUATION OF ALLOCATION METHODS

To select an appropriate allocation system, we should consider the technical, behavioral, and cultural attributes of the two systems and use the one that has better properties in all three areas.

Exhibit 19
Comparison of ABC and Departmental Allocation Methods



Technical Attributes.

A good cost allocation system provides *decision-relevant information* and enhances manager's *process understanding*.

Decision-relevance.

Many strategic decisions, such as what markets and customers to target, how to establish product prices and profitability plans, which products to promote, the level of quality or service to provide, and how to manage costs and allocate resources, require good product cost data. Without good assessments of product profitability, Teleco could easily be in the wrong market segment or provide features too costly for customers. In the opening story Pete Malloy's complaint that Teleco is under-emphasizing older products goes to the heart of this strategic issue. Whether the older products are indeed losing money, depends upon which cost allocation system we believe provides a better measure of resources consumed by a product.

The choice of an allocation scheme depends upon the nature of the production process. If Teleco were to use a traditional mass manufacturing process, *the two systems will most probably yield very similar cost allocations*. A typical mass production system produces relatively few homogenous products in large quantities.[15] Because they are produced in large quantities and are basically similar, there is little difference between products on variables such as the number of setups, engineering support, production planning, parts purchasing, and so on.

When product variety is large, the production process becomes more complex. Products now consume setups, quality inspections, production planning activities, parts purchasing, and so on differentially. *It is precisely because these factors represent the costs of variety and complexity that the ABC system chooses them to be the drivers for cost allocation*. Since Teleco produces a large variety of telephones, the ABC system will probably provide a better measure of overhead costs consumed by each product.[16]

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[15] For a discussion of mass production environments, their cost structures, work processes, and environmental conditions, see *Management Accounting in the Age of Lean Production* in this modular series.

[16] The *Indirect Cost* module in this series discusses acceptable criteria for allocating indirect costs. Readers may recognize ABC as similar to the "who ate what" solution to the restaurant example in that module.

Key Point

Traditional and ABC allocations of manufacturing overhead costs will not be vastly different in mass production environments where product variety and process complexity are low. Traditional allocations work in such environments because products are homogenous enough so that overhead costs can be averaged across them.

Think Along

Can ABC data provide any useful information in mass production environments?

Even if product costs show no variation across products, the "bill of activities" shown in Exhibits 14b and 16 provides valuable information for product design and cost management. These exhibits show that the cost of manufacturing telephones varies by parts used, pounds of materials consumed, batch sizes, engineering support, and other such activities. It also pinpoints how much cost each unit of driver consumes which provides very useful information to product designers. They can determine how much will be saved by redesigning products so they use fewer parts, require less engineering support, have simpler setups, and so on. ABC creates a bank of cost data readily useable by product designers.

Process understanding.

ABC leads to better process understanding by documenting activities. It shows the relationship between costs incurred and work performed in an organization. It also pinpoints how actions taken by employees or how work performed in one activity causes work and cost in other activities. Understanding why work occurs and what drives costs are the first steps in process improvement. Traditional allocations simply tell us that lower production volume lowers overhead costs. This method does not provide useful information about how to manage overhead costs.

If ABC allocation yields better cost for decision making purposes, does it follow that if a product is dropped or redesigned, then the amounts of overhead allocated by the ABC system will be avoided by the organization? ABC cost allocations contain some costs which are flexible and respond quickly to production stopping or product redesign. Many product and batch level costs are flexible and would be saved. ABC allocations also contain less flexible costs that must be proactively managed over a longer time frame to affect reductions. Many product level and facility level costs are committed, less flexible costs, that will not respond quickly to dropping a product from a line or from redesigning it. For these committed costs to change, they must be diverted to other productive ventures, or they must be discontinued. Discontinuing such costs generally requires a time frame which exceeds a year.

Behavioral Attributes.

ABC systems also have several desirable behavioral properties not present in traditional systems. Well executed ABC systems can make a cost structure visible to decision makers, facilitate communication with operational personnel, and empower employees. When not executed well, ABC can lead to a sense of disappointment and detract from a customer focus.

Cost structure visibility.

In most organizations operating personnel create costs by the way they design and deliver products or services. For example, in manufacturing firms it is design and manufacturing engineers, in hospitals it is doctors and nurses, in universities it is faculty and

administration who decide what will be offered and how it will be delivered. Cost management requires that the cost structure be visible to those whose decisions influence costs. Through the choice of cost drivers, management can make visible the organization's cost structure. For example, Teleco's ABC system, in Exhibit 13, shows that number of parts drives both vendor certification and material procurement costs. The behavioral message is to reduce the number of parts in the product. Since overhead costs will be allocated based on these drivers, design engineers will be motivated to reduce them. Many Japanese manufacturers have allocated overhead costs to products based on number of parts for this very reason. If cost drivers do cause costs, then in the long run, this visibility will help to reduce costs.

Facilitates communication with operating personnel.
Closely related to visibility is the need to communicate the cost structure to operating personnel. Cost management is possible only if operating personnel understand the financial implications of their decisions. Operating people speak operational language. They understand soldering circuit boards, performing blood tests, or designing curricula. If accountants want operating people to understand the financial implications of their actions, the accountants must learn to communicate in an operational language. This type of communication is not easy with traditional product cost information arrayed by type of expenditure, such as indirect materials or indirect labor, and by department. By reporting activity costs, accountants create a link between what people do and the financial impact of their actions on an organization. For example, Exhibit 15 shows that the work of certifying vendors is one of the most expensive work activities for Teleco costing $4,154,495 in total or $17,097 for each unique part certified.

Employee empowerment and motivation.
The departmental focus of traditional allocations is designed to assign responsibility to managers. It is a "fix blame" orientation in which managers are motivated to blame other departments for cost over-runs or to take short-term measures, such as postponing needed maintenance, to cut costs. This orientation creates poor morale all around. ABC is a "process" orientation. It shows how work is interrelated and creates costs upstream or downstream. The focus shifts to how to work and not who to blame. Implementing ABC gets employees involved because their knowledge is required to understand activities, select cost drivers, and make operations more efficient. When improvements occur, they are attributed to employee participation. This response can reinforce a sense of empowerment and motivate employees further, since they can link their actions to tangible improvements.

Failed expectations.
In many organizations, ABC implementations have caused a sense of disappointment because ABC has been sold as a method for determining the "true" cost of a product. Many people assume that ABC does not entail allocation. This false assumption leads to disappointment during implementation when they discover that allocations still exist, and that people may classify activities differently, disagree on how to cost them, or disagree on what drives their cost. Further, allocations in traditional systems often are determined politically. People assume that such political behavior is eliminated with ABC. To the extent that fewer costs are allocated in an ABC system, political allocations may be lessened. Politically determined allocations are not eliminated by ABC. ABC does not determine true cost; it is an attempt to have product costs better reflect resource consumption patterns.

No link to customer.
ABC does not automatically provide a link to customers. It is an internally focused, cost efficiency tool. Managers sometimes think that installing ABC will solve all their problems.[17] This belief is untrue. ABC needs to be combined with other cost management tools which have a strong customer orientation, such as target costing and total quality management (TQM). Without this tie, managers may focus exclusively on internal operations and efficiency and forget about quality and timelines, which are issues of importance to customers.

Cultural Attributes.

ABC promotes a functional organizational culture by encouraging a process orientation and encouraging cross-functional participation.

Process culture.
ABC reorients the organizational mindset to think in terms of activities, their drivers, and costs. Process improvement, not who to blame, becomes the dominant cultural value. Organizations lacking a process culture are placed at a relative disadvantage over world class organizations that routinely analyze the way work is performed. Traditional allocations make matters worse by masking operational data behind responsibility and financial structures. Further, the order in which service and support center costs are allocated in departmental systems is often political. Traditional systems focus on who spent money and used services, instead of analyzing what activities are performed and what activities are strategically important.

Encourages cross-functional participation.
Activities cut across department lines. ABC restructures traditional cost reporting from departments to activities. This approach causes costs to be collected and analyzed across departmental lines. Reducing activity costs requires cross-departmental cooperation and reduces the functional isolation that typically occurs within organizations. To succeed in an ABC environment, employees must abandon their departmental and functional orientation and work together on activities. Traditional allocation systems reinforce this functional isolation by emphasizing departmental responsibility.

Key Point

An ABC system has better technical, behavioral and cultural properties compared to a traditional system of cost allocation. These properties are particularly important when operating in complex production environments that have high product variety.

[17] H. Tom Johnson, "It's Time to Stop Overselling Activity-Based Concepts," *Management Accounting,* September, 1992, reprinted in *Activity-Based Management in Action,* IMA, 1994, pp. 40–49.

▲ LESSONS LEARNED

- ▲ Indirect manufacturing overhead costs are typically allocated to products using either a traditional department-based or an activity-based cost systems (ABC).
- ▲ The primary focus of a traditional department-based allocation system is to assign costs to responsibility units headed by management. The focus is *resource stewardship* and this same focus is used for product costing as well.
- ▲ ABC systems are *process-focused*. They identify costs by activities and use them to assign costs to products. The logic is that activities consume resources and products consume activities.
- ▲ The traditional departmental system of allocation is acceptable for product costing in a manufacturing environment that produces a *few* products in *large* quantities using a *simple* manufacturing process.
- ▲ An ABC system is particularly suited for product costing in manufacturing environments that produce *many* products in *small* quantities using a *complex* manufacturing process. In these situations products draw differentially on production related activities.
- ▲ ABC systems are good cost management tools because they highlight the drivers that cause cost and focus attention on how the way we work causes costs to be incurred.
- ▲ A well executed ABC system can empower and motivate employees and build a strong process-oriented management culture that values continuous work improvement instead of assigning blame.

▲ APPENDIX—OTHER DEPARTMENTAL OVERHEAD ALLOCATION METHODS

In practice, two other variations of the departmental method are used to allocate manufacturing overhead costs. They are called the ***step down method*** of allocation and the ***simultaneous allocation method.*** Both these methods recognize that service departments receive benefit from other service departments. For example, purchasing may order material used by production and factory administration. Similarly, the plant cafeteria will service all employees whether they work in production or service centers.

These methods add another step to the calculations. A cost pool or service department's costs are allocated first to all other departments, service or production, that receive services. They are then charged to production departments. The service department totals, however, include cost allocations from other service departments.

Step Down Method.

The *step down method* usually allocates the service department that is the largest or has provided the most service to other service centers first. Rules for step down allocation specify that once a service department's costs have been allocated, that department cannot receive further allocations, even if it receives services from other departments. In some organizations this rule politicizes the selection of the order in which to allocate cost pools and service department costs. Hospitals are prime examples of organizations where the earlier a department's cost is allocated, the lower its total costs appear.

Exhibit 20
Overhead Allocation Using the Step Down Method

	Plantwide	*Materials Control*	*Factory Admin.*	*Production Control*	*Extruding*	*Assembly*
Total costs before allocation	8,425,000	1,801,000	1,394,000	604,000	3,727,000	2,373,000
Allocation of plantwide costs[1]	(8,425,000)	2,808,333	702,083	1,404,167	2,106,250	1,404,167
Revised total		4,609,333				
Materials Control[2]		(4,609,333)	72,337	52,083	1,446,746	3,038,167
Revised total			2,168,421			
Factory Admin.[3]			(2,168,421)	141,419	172,845	1,854,157
Revised total				2,201,668		
Production Control[4]				(2,201,668)	1,415,358	786,310
Revised total					8,868,199	9,455,801
Total machine hours					1,435,000	
Total labor hours						2,036,000
Rate per machine hour					$6.18	
Rate per labor hour						$4.64

[1] Plantwide cost is allocated based on square feet. Total square feet in all departments (excluding plantwide) is 36,000.
Material Controls: 12,000 square feet * ($8,425,000/36,000) =$2,808,333

[2] Materials Control total cost, $4,609,333, after the allocation of plantwide costs, is allocated based on the number of purchase requisitions issued for the remaining departments, 15,930 (16,000 total less 70 for Materials Control. For example:
Factory Administration: 250 requisitions * ($4,609,333/15,930) = $72,337.

[3] Factory Administration's total cost, $2,168,421 after previous departmental allocations is allocated based on number of employees in other departments. Excluding Plantwide, Materials Controls, and Factory Administration, employees total 690. This cost is allocated to Production Control for example as:
Production Control: 45 employees * ($2,168,421/690) = $141,419.

[4] Production Control's total cost after previous allocations, $2,201,668, is allocated based on total planning hours (140,000) performed for each of the remaining departments.
Extruding: 90,000 hours * ($2,201,668/140,000) = $1,415,358.

Step down allocation for Teleco is illustrated in Exhibit 20. These allocations are based on information contained in Exhibit 6 in the module. Refer to that exhibit now.

Verify each of the allocations in Exhibit 20. Follow the notes to Exhibit 20, remembering to include statistics from unallocated service departments as well as production departments.

Step-down allocation yields a rate per machine hour of $6.18 for the Extruding Department instead of the $6.88 rate developed under the direct method. For the Assembly Department, the step-down method yields a rate of $4.64 compared to $4.15 under the direct method.

Simultaneous Allocation Method.

The simultaneous allocation method recognizes the mutual services provided by departments to each other. It therefore uses a series of linear equations, one for each production and service center, to allocate costs. Each department's equation specifies its direct cost and its percentage share of other department's cost. For example, the equation for Materials Control would be:

Materials Control Cost = $1,801,000 + (12,000/50,000) Plantwide Cost + (70/16,000) Materials Control Cost + (35/830) Factory Administration Costs

Because Teleco has six departments or cost pools, six simultaneous equations would be solved. This calculation typically would be done on a computer using matrix algebra. The results would yield slightly different overhead rates for the Extruding and Assembly Departments than the direct and the step down methods yielded.

Although the simultaneous method improves the mathematical accuracy of the step down method by recognizing mutual services provided and received, *it does not solve the basic problem of meaningful product cost allocations.* Both these methods suffer from the same problems (discussed previously) as the direct method when it comes to meaningful product cost allocations. Their use is particularly problematic in high variety, complex production environments. In fact, their mathematical precision may create an unwarranted illusion of precision.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

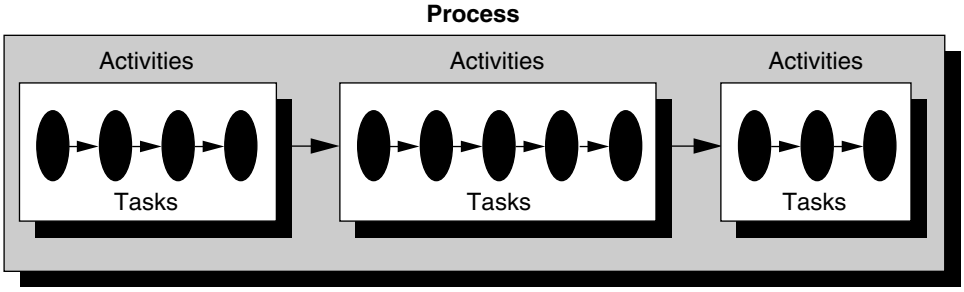
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. How can a good manufacturing allocation system help organizational members meet quality needs of customers?
b. Give three examples of how indirect cost allocations can be useful to cost management efforts.
c. How do indirect cost allocations impact the time taken to respond to customers' orders?
d. Define manufacturing overhead or indirect manufacturing cost.
e. How large is manufacturing overhead in electronics, machinery and automobile components manufacturers?
f. Give some examples of costs included in the category, indirect labor.
g. Give some examples of items found in indirect materials and supplies.
h. What is overhead allocation? Why do organizations allocate overhead?
i. What is a plantwide overhead rate? Where or when is it useful?
j. What is the measure of output used to establish an overhead rate called?
k. What terms are used to describe an overhead rate?
l. Why is a predetermined overhead rate often established?
m. What information is required to develop a predetermined overhead rate?
n. Traditional volume based overhead allocation was developed for what type of manufacturing environment?
o. What kinds of items or activities are included in the indirect cost category, setup?
p. Why do traditional overhead allocation systems use volume measures as the denominator or allocation base for overhead cost allocations?
q. What measures of volume are commonly used in traditional allocation systems?
r. What happens if a plantwide rate is used when different production departments with different volume measures exist?
s. What are the three departmental methods of allocating indirect costs?
t. Why is the direct method of allocating overhead costs called direct? What does the term "direct" refer to?
u. How does step down allocation differ from direct allocation of indirect cost?
v. In step down allocation, what happens if a service or support department, such as maintenance, has been charged for costs of another service department, such as scheduling, but maintenance also provides service to the charging department, scheduling?
w. Where are activity based costing systems appropriate for overhead allocation?
x. What is an ABC system?
y. What are "activities" as used in ABC systems?
z. What happens if ABC costing is used when costs vary with volume?
aa. Technically, which gives better product cost information, ABC or traditional systems?

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*Some material for this section was contributed by Paul D. Dierks, Wake Forest University-MBA, Paul Juras, Wake Forest University, and Oksana Melamed, California State University-Northridge.

bb. How does ABC provide good technical information for product design?
cc. How does ABC assist cost management efforts?
dd. What kind of work process understanding does ABC provide?
ee. How does ABC information make strategic variables visible and lead to good behaviors?
ff. How does ABC lead to employee empowerment?
gg. Does ABC yield true, accurate product cost?
hh. How does ABC help instill a process oriented culture in organizations?
ii. How does ABC help foster cross-functional participation in organizations?

Exercises, Problems and Cases.

2. Mass producers expect economies of scale. What are the sources of economies of scale that cause volume to be such an important cost driver?

3. Printworks Co. produces various assembly parts for high quality commercial printers including color ink cartridges. The cartridges are manufactured on a job-order basis. Most business is obtained through competitive bidding. To stay competitive and earn a desired profit, Printworks bids full cost plus a 20 percent markup. The company operates two producing departments and two service departments. The Equipment Repair Department provides service to all other departments. It is responsible for routine maintenance as well as repair of equipment malfunctions. The Quality Control Department inspects the quality of products at the end of each production activity, case construction and ink filling. The quality of a cartridge case is evaluated using simple tools. In the Ink Filling Department, quality control personnel use fairly sophisticated equipment that is susceptible to frequent breakdowns because when defects occur in ink filling, the ink fouls the testing equipment.

The budgeted costs and the normal activity levels for each department are given below:

	Service Departments		***Producing Departments***	
	Equipment Repair	*Quality Control*	*Case Construction*	*Ink Filling*
Overhead costs	$30,000	$30,000	$200,000	$100,000
Number of breakdowns	—	25	5	30
Quality control hours	—	—	70	10
Labor hours	—	—	5,000	1,000
Machine hours	—	—	2,000	6,000

Departmental overhead rates are used to assign costs to products. The Case Construction Department uses labor hours; the Ink Filling Department uses machine hours.

The Case Construction Department spends 2 labor hours to produce a cartridge case; the Ink Filling Department uses 0.15 labor hours and 0.5 machine hours to fill a cartridge.

Direct materials and direct labor costs for a cartridge are $157.

Required:

a. Using direct labor hours, compute a plantwide overhead rate.

b. Compute a bid price using the plantwide overhead rate.

4. Refer to the data in Exercise 3.

Required:

a. Allocate the service costs to the producing departments using the direct method.

b. Compute a bid price under the direct method.

5. Refer to the data in Exercise 3. While departmental methods of allocating overhead, such as step down or simultaneous, are supposed to provide greater accuracy in product costing, complaints have emerged that they distort the assignment of cost items to products. Some organizations use the direct method because of this problem.

Required:

a. Allocate the service costs to the producing departments using the step method. Assume that the direct costs of the Equipment Repair Department are allocated on the basis of the number of equipment breakdowns, while those of the Quality Control Department are allocated on the basis of quality controls hours.

b. Compute a bid price under the step method.

c. Do you think the step down allocation method might cause a distortion in the cost of a cartridge? Explain how this could happen. (Hint: Carefully study the pattern of equipment breakdowns that occur.)

6. Newline produces two kinds of video game controller pads: a standard pad that normally is packaged with video game systems and a deluxe "warrior" pad that provides enhanced movements and is packaged with upgraded systems.

Overhead costs have been assigned to various production activities:

Equipment Maintenance	*Setups*	*Packing*	*Total Overhead Costs*
$80,000	$100,000	$90,000	$270,000

Routine maintenance of equipment has to be done after each 10,000 hours of continuous machine work. A maintenance worker lubricates and cleans the equipment. Setups are done every time a batch of materials has to be fed into a machine. Additionally, setups are performed when a machine has to be prepared to work on a different part of a product.

The controller pads are packed into boxes and sent to the manufacturers of video games.

The two products use resources as follows:

			Cost Drivers		
Product	*Quantity (units)*	*Prime costs (DL + DM)*	*Machine Hours*	*Number of Setups*	*Number of Boxes*
Standard	200,000	$800,000	30,000	100	40,000
Warrior	50,000	$250,000	10,000	80	25,000

a. What will be the unit cost of product if a traditional volume-base costing system is used?
b. What will be the unit cost of product if an activity-based costing system is used?

7. Classify the following activities as being incurred at the facility level, product level, batch, or unit level. Identify a cost driver for each activity.

a. Packing
b. Receiving
c. Purchasing
d. Planning and scheduling
e. Shipping
f. Setups
g. Maintaining machinery
h. Supervising line workers
i. Recordkeeping
j. Gardening
k. Material handling
l. Plant depreciation
m. Machinery depreciation
n. Product design
o. Utilities
p. Product testing
q. Vendor certification
r. Quality inspection

8. Syracuse Graphics is noted for the quality of its graphic design and printing of advertising brochures. Producing brochures in bulk for national organizations has always been the greatest profit generator for the firm. However, the sales department has recently been able to capture a great deal of the low-volume, custom-design work.

At the weekly manager's meeting the sales manager was asked why the firm had won so many custom bids. He responded, "It really has not taken much effort at all. From what I hear, no one has been able to come close to our price. I guess we must be more efficient than the competition or the economies of scale of the bulk production work has made us the low cost provider."

Brenda White, the CEO, interrupted, "I am glad you think we are so far ahead of our competition, but I don't think we hold an edge in terms of efficiency or economies of scale. I think I understand our processes fairly well and I know we run an efficient operation, but I also know the people over at Upstate Graphics have some new equipment that can produce product a heck of a lot faster than we can. I would like to review the bidding process to be sure we are not missing something."

Jim Crowder from accounting responded, "I can tell you that currently a bid is based on the cost of materials, graphic design hours, and an assignment of overhead using machine hours. We use machine hours because we run the machines for quite awhile to produce those bulk order brochures. The machines run for a lot less time when we print a custom job."

Chuck Driver from production chimed in, "The machines may not run as long on a custom job, but the machines are tied up for a long time because custom jobs normally have multiple colors rather than the two colors that most bulk orders have. That means we have to spend extra time setting the machines to handle each additional color."

Required:

a. Do you think the company is using an appropriate method to assign overhead when preparing a bid?
b. What change would you suggest they make in assigning overhead to determine a bid price?

9. Jason Helms, CFO, was considering a suggestion from Terri Sands, the corporate controller, to move from a traditional costing system to an activity-based system. Jason knew that the company was facing an increasingly competitive market and that if it could not get costs under control, projected financial results would be dismal.

"Perhaps the activity-based system would help" Helms said to himself, "but I wish I knew more about the basics of such a system." He decided to schedule a meeting with Terri to find out more about activity-based systems. As part of her preparation for the meeting, Sands asked her assistant to prepare a 15 minute presentation on the following aspects of an activity-based system:

- ▲ The objectives of an ABC system and how they affect where management should focus their attention.
- ▲ Who should be involved in the ABC implementation process.
- ▲ The two main phases to ABC: costing activities and products.
- ▲ The pitfalls or obstacles might be encountered in implementing or adopting ABC.

Required:

Take the role of the controller's assistant and prepare an outline for the presentation. (This assignment could be done on presentation software so the outline would then become the basis for computer-based slides.)

Advanced:

10. Era Company produces two kinds of women's hand bags: a designer label bag and a private label bag. Price competition in the private label market is very strong. Therefore it is very important to accurately allocate overhead costs between designer label products and private label products. To achieve that goal Era uses activity-based costing.

The information about Era's products is as follows:

	Designer Bag	***Private Label Bag***
Quantity produced	5,000	10,000
Material handling (# of moves)	12,000	13,000
Engineering hours	5,000	2,000
Setups	40	20
Maintenance (hours used)	1,000	1,000
Inspection hours	2,000	500

The overhead costs associated with the activities are given below:

Activities	*Overhead Costs*
Material handling	$30,000
Engineering	140,000
Setups	72,000
Maintenance	26,000
Inspection	40,000
Total	$308,000

a. Allocate all overhead costs to the two products using activity-based costing.
b. Compute the unit cost of each type of bag.
c. List types of organizations in which ABC may be more/less likely to succeed. Why might there be resistance to adopting an ABC allocation approach?

11. Chestnut Furniture Company manufactures a full line of hardwood dining room chairs. While the most popular product is the standard armless chair, Chesnut is also known for its custom-work captain's chairs. The company produced 10,000 standard chairs and 2,000 custom chairs last year. Total overhead was $250,000 for the year. Analysis showed that the overhead could be evenly attributed to labor and machine use. The following table summaries of the production results for last year.

	Materials	*Labor*	*Labor Hours*	*Machine Hours*
Armless	$500,000	$100,000	10,000	20,000
Captain's Chairs	$120,000	$60,000	6,000	7,000

Required:

a. Determine the cost per unit for each type of chair using direct labor hours as the allocation base.
b. Determine the cost per unit for each type of chair using machine hours as the allocation base.
c. The analysis revealed that the overhead costs should be evenly assigned to two cost pools. Determine the cost per unit for each type of chair using two cost pools.
d. The three approaches to assigning overhead used above resulted in different unit costs. Which of these three methods would you suggest the company adopt and what criteria would you use to select?

12. Deacon Corp. is a forms distribution company that captured market share by offering to store a client's forms and then will pick, pack, and ship requested forms on demand. Clients are charged for the direct cost of the forms and an overhead charge based on square footage of storage space used during the year. Overhead is budgeted at $200,000 per year.

In order to get a better understanding of the cost of servicing clients, an ABC system was proposed. After interviewing a number of production personnel, the ABC project manager identified the following activities and drivers for the coming year:

Activity	Budgeted Cost	Driver	Available Capacity
Processing orders received	$ 30,000	# of orders	1,000 orders
Picking orders	$ 50,000	picking hours	4,000 hours
Forms storage	$120,000	square feet	5,000 sq. ft.

The activity profiles of two clients for the past year were also prepared to determine whether or not the extra effort to compute the more detailed cost analysis would result in any differences in cost assignment.

Item	Customer 1	Customer 2
Direct cost of forms	$3,000	$5,000
Number of orders	50	12
Picking hours	250	18
Square feet used	100	150

Required:

a. Calculate the cost of servicing each customer using square footage as the overhead allocation base.

b. Calculate the cost of servicing each customer using the proposed ABC system.

c. What accounts for the difference in the cost per customer between the two overhead assignment methods?

▲ PROBLEMS AND CASES—ADVANCED LEVEL

Case 1. Blue Ridge Manufacturing.

Blue Ridge Manufacturing produces knit apparel in a modern plant located in the Blue Ridge Mountain region of North Carolina. Overall, the company is profitable, as the performance report below indicates.

The company sells three product lines, which differ in the amount of customization. The sports line is a v- or crew-neck sweater customized for school color and yarn type (bulky versus fine gauge). Each sweater order requires an artistic development of the school's logo. After development, the logo is either knitted into the sweater or sewn on it (like athletic letters). The children's line is a collection of infant sweater and pull on pants. These are standard and vary only by color and size. The designer line contains a variety of standard products, redesigned each season, and is sold to department stores. These lines vary in sales volume, with the designer line selling most, the children's line selling a close second and the sports line having the smallest sales.

	Total	Designer	Children's	Sports
Sales	$8,451,012	$3,464,915	$3,246,687	$1,739,510
Variable product costs	4,944,487	1,829,464	1,977,798	1,137,225
Commissions	640,013	236,805	256,006	147,202
Contribution margin	$2,866,512	$1,398,646	$1,012,783	$455,083
Indirect expenses	1,409,232	687,601	497,903	223,728
Income	$1,457,280	$711,045	$514,880	$231,355

Recently, sales of the sports line have increased, although the nature of the products has not changed. Management cannot account for the increasing market share and wants more information before devoting an even greater share of production resources to this market segment.

The cost accounting system is fairly sophisticated with respect to variable product costs, but thus far indirect costs have been allocated to products based on their contribution margin. Management has concern that indirect manufacturing expenses may be affected by which product line is produced.

During a review of the issue, management realized that many general overhead items represented resources consumed in proportions different than the relative gross profit of the product line. Management decided to use ABC to determine product line profitability. The following table contains the results of management's analysis.

Cost	*Amount*	*Driver*	*Designer*	*Children*	*Sports*
Designer pay	$488,260	Work Hours	10,105	3,857	14,760
Supervisory pay	163,176	Work Hours	76,411	82,606	47,498
Samples	218,711	# Items	2,223	2,224	1,229
Setup costs	76,220	# setups	15,806	15,807	11,290
Travel for design	47,266	hours/line	3,985	2,213	6,476
Scheduling	67,142	# orders	246	1,870	11,990
Customer service	13,369	# calls	118	882	13,580
Design office costs	7,925	Sq. Ft.	900	811	1,004
Supervisory, setup and schedulers office costs	66,665	Sq. Ft.	1,800	1,622	2,008
Inspection	13,501	# of inspections	1,897	1,297	7,113
Purchasing	175,356	# of unique items	1,870	246	11,990
Materials handling	71,641	# of material moves	118	882	13,580
Total	**$1,409,232**				

Required

a. What amount of overhead is attributable to each product line? (Use a spreadsheet software for this assignment.)

b. Using sales and variable costs given originally and your findings from part one, determine the profitability of each product line. (Use spreadsheet software.)

c. What issues are raised by the results of question two?

Case 2: Piedmont Siding.**

It all started one hot day in July 1993. Duane Smith, president of Piedmont Siding, slammed down the phone and asked his secretary to have Bill Johnson, the CFO, come to his office. A few minutes later, Bill walked in asking, "What's up Duane?"

**This case is adapted from a case prepared by Paul E. Juras of Wake Forest University and is intended to be used as a basis for class discussion rather than to illustrate either effective or ineffective handling of the situation. The names of the organizations, individuals, and financial information have been disguised to preserve the organizations' desire for anonymity. The original case was presented to and accepted by the refereed Society for Case Research.

Duane responded, "I just received a call from our majority shareholder Thompson Jeffries. He wants to talk about the financial results for the first half of the year. He thinks our profit margin is too low and wants to meet with us to discuss a plan for next year. He will be here this afternoon."

Later that day, Thompson Jeffries, Duane Smith, and Bill Johnson were in a meeting, Thompson Jeffries was speaking. "Duane, you have done an excellent job cultivating a customer base of reputable building contractors. While you have built Piedmont Siding into a $2,000,000 company in four years, I just don't think you can continue to run this operation by the seat of your pants any longer. You need a plan for action."

Duane responded, "I have a plan! My plan is to expand the replacement vinyl market. We both know that there is a large number of older homes in need of updating. I think we can get quite a few people to put siding on instead of repainting. I even hired a salesman to build volume in this market."

"I know that is your plan, I just question whether we should be in the replacement vinyl market at all. I would like Bill to do an analysis of the profitability of each of our major markets," said Thompson.

"I know how to bid a job to make it profitable. I also know that, while the replace-ment vinyl business offers a less than 10% margin on each job, with a high enough volume we can build a healthy bottom line." Duane continued, "Besides, Bill is already so over worked with all the time he spends on reconciling receivables, verifying payables for materials, and calculating the amount due to each of the installation crews that he doesn't have time to do this type of detailed analysis. Why should Bill waste his time on it?"

"Duane, I think you just answered your own question," Thompson said. "I'll tell you what. Have Bill break the income statement results for the past six months into five columns, one for each of our four major markets, and a column for the totals. That chore should not take long, and it may provide some insights to both of us."

With that last statement, Thompson got up to leave. "I expect that revised income statement to be ready when I come back on Monday morning," he said as he walked out the door.

Background and Financial Information.

Over the following weekend Duane Smith's thoughts turned back to that day in 1989 when he landed the first vinyl siding installation contract for his newly formed company. Times were simpler then. As the sole shareholder of his company, he had called all the shots. He used to be the one ordering the materials from vinyl siding manufacturers and doing all the installation. And as long as he had money in the bank, he knew he was making a profit. However, even back then he knew that his fifteen years of experience in construction did not prepare him to handle the paperwork and other operational details involved with running a business. In early 1991 Duane could afford to hire someone to handle the day-to-day operations of the business. That person was Bill Johnson.

In the following years the company grew rapidly. While Duane was still heavily involved with bringing in business, the company was now contracting with new home builders to install the vinyl siding as well as continuing to put siding on older homes (replacement vinyl). Piedmont Siding still purchased all the materials, but now the company hired crews to do the installation. The company served an area known as the Piedmont Triad, which had been experiencing a growth in new home construction.

The company's growth caused cash flow problems, and by the end of 1992, Duane needed cash to keep his business out of bankruptcy. Thompson Jeffries provided the necessary cash in exchange for a majority interest in the company. All Thompson wanted was an

Exhibit 21
Six Month Analysis of Profit by Customer Group

	Six Month Total	*Shade Hills*	*Triad Builders*	*Other Builders*	*Replacement Business*
Sales	1,051,200	453,600	422,880	93,120	81,600
Materials	476,160	204,240	192,240	40,800	38,880
Direct labor	315,840	131,760	122,712	25,728	35,640*
Gross margin	259,200	117,600	107,928	26,592	7,080
Payroll costs	108,640				
Liability insurance	39,000				
Office expense	30,000				
Vehicle expenses	19,264				
Warehouse	17,496				
Other	27,520				
Pretax profit	17,280				

* Includes sales commission.

adequate return on his investment. He did not want to be involved with the daily operations of the business. Because of poor profit margin, he is considering selling his shares.

Piedmont Siding has two major customers, Shade Hills and Triad Builders. Both customers are large residential developers, and Piedmont Siding receives a large volume of their business in the Piedmont Triad. Piedmont Siding also works with small, independent contractors on new construction and competed for replacement vinyl installation contracts.

Piedmont Siding had three major cost categories: direct labor and direct materials, constituting seventy-six percent of costs; salaries and benefits, fourteen percent of total costs; and all other general and administrative expenses. Because all materials are ordered on a job-by-job basis and all installation is done by subcontractors, direct materials and labor are easily traced to each job. With this information, Bill prepared the statement contained in Exhibit 21.

On Monday morning Thompson reviewed the figures in Exhibit 21 with Duane and Bill.

"See," Duane said, "we have a over a 9% margin on replacement work. If we build volume, we can really improve the bottom line."

"What about these costs?" asked Thompson, as he pointed at the lines for payroll and general and administrative expenses. He continued, "Shouldn't we see if any of these costs can be attributed to any of the specific customer groups?"

Bill responded, "I don't know of any way to spread the costs other than to use a simple allocation base."

Fortunately, Thompson Jeffries served on the advisory council of a local university and asked Peter Johnson, one of the faculty members, for help on this project. Peter's suggestion was to have the company attempt to do an activity-based analysis of the items that appear on the income statement below gross margin. Since payroll represented the largest of the expense items, that was the starting point. The goal was to accurately determine how much time the employees spent performing various activities. However, management did not want to deal with the burdens of keeping detailed logs of activities. Instead, they simply estimated the amount of time spent on tasks which supported each broad group of customers. Exhibit 22 contains the results of the time analysis.

Exhibit 22
Results of Two Stage Time Allocation

	President	*Vice President*	*Scheduler-Purchaser*	*All Other Personnel*
Shade Hills	30%	25%	33%	18%
Triad Builders	30%	25%	32%	19%
Small contractors	15%	25%	15%	33%
Replacement business	5%	10%	15%	20%
Other*	20%	15%	5%	10%
Annual salary & benefits	70,000	60,000	35,000	52,280

* Reviewing bids for proposals, directly overseeing one time large contracts, etc.

Required:

a. Using the information in Exhibits 21 and 22, recalculate the profit by customer group after assigning payroll costs.
b. In light of your results from requirement 21, evaluate Duane's plan to expand the replacement business.
c. Provide some suggestions as to what could be done with the general and other administrative costs to help complete this analysis.
d. How can an activity-based system help management develop a long range business plans?

Case 3: Guys & Dolls.

Guys & Dolls Inc. specializes in producing miniature mechanical porcelain toy figurines. These figurines, used in retail displays and sold as collectors' items, use popular movie or cartoon characters such as Mickey Mouse, Goofy, etc. Over the years there has been a steady increase in product variety. The company now makes many different products in various batch sizes. These products vary in number of details, special features such as movements or voice, parts needed, machines required to produce them, size of production runs, and quality inspections. In recent years Guys and Dolls has invested heavily in automated machinery and realized a steady decline in labor cost.

The company's manufacturing plant is organized into two production and two support departments. Production takes place in Machining and Assembly. Parts are ordered, stocked, and moved into production by the Material Department. The other support department, Maintenance, does all the repair and upkeep of the machinery.

A conventional cost system is in use. Overhead costs are budgeted by the four departments and a sequential (step) method of allocation is used to allocate manufacturing overhead from support to production departments. The following allocation bases are used:

Property taxes:	square footage
Utilities:	kilowatt hours
Material Dept:	requisitions
Machine Dept:	machine hours

Overhead is charged to products using machine hours as a base in Machining and Direct Labor Hours as a base in Assembly. A mark-up of 100% is applied to manufacturing costs to arrive at product prices. The budgeted overhead costs and bases for 1997 are:

Budgeted Costs and Bases For 1997					
Costs	***Materials***	***Maintenance***	***Machining***	***Assembly***	***Total***
Property taxes					140,000
Utilities					250,000
Salaries	560,000	250,000	350,000	440,000	1,600,000
Supplies	80,000	150,000	220,000	60,000	510,000
Depreciation	120,000	360,000	840,000	180,000	1,500,000
Total	**760,000**	**760,000**	**1,410,000**	**680,000**	**4,000,000**
Bases					
Square footage	20,000	5,000	15,000	20,000	60,000
Kilowatt hours	5,000	15,000	50,000	30,000	100,000
Material requisitions		800	4,800	2,400	8,000
Machine hours		10,000	35,000	5,000	50,000
Direct labor hours			12,000	28,000	40,000

In recent years the company had been facing stiff competition from overseas manufacturers. Cost and manufacturing efficiency have become very important. Leslie Newcome, president of Guys & Dolls, has been studying the possibilities of using some modern manufacturing methods and activity-based cost systems (ABC). In particular, he was struck by two ideas: reorganizing manufacturing into "focused manufacturing cells," instead of functional departments, and using activity-based cost pools and drivers for cost allocation. Newcome discussed this plan with his VP of production and manager of cost analysis and asked them to study and recommend changes.

After an extended study, the two reported back to Newcome with a plan to reorganize production into two manufacturing cells and to create seven cost pools. According to the new plan, the two manufacturing cells would do their own maintenance, machining and assembly. Only Materials would remain a separate organization. However, the costs of the Materials Department was split into two pools: procurement related and materials handling related. The work cells include basic utilities and property taxes that did not vary by products. Other pools included Detail and Feature. Detail-related pools represented costs associated with the number of details, such as colors and expressions in a product. Feature-related pools included voice and movements. These pools were identified as lump sum average costs. The analysis assumed that beyond some basic product, additional details and features add a fixed cost to that production run. Other pools were quality control and production setup related. The following cost pool data and associated drivers were identified:

Pools	***Cost***	***Drivers***	
Work cells	$300,000	Square feet	60,000
Materials handling	400,000	Material moves	100,000
Materials procurement	360,000	No. of parts	2,000
Detail related costs	800,000	No. of details	8
Feature related costs	1,000,000	No. of features	10
Quality control	600,000	No. of inspections	6,000
Production setups	540,000	No. of set-ups	18,000
Total budgeted overhead costs	**4,000,000**		

In 1997, two of the items going into production were the Flintstone and the Lion King figurines based on recent popular movies. The Company expected to produce 20,000 of both these figurines and sell them at a price of $125 and $90 per unit, respectively. The following production data was collected:

	Flintstone	*Lion King*
Direct materials + direct labor costs (20,000 units)	$200,000	$180,000
Machine hours	10,000	8,000
Direct labor hours	5,000	5,000
Square feet required	6,000	2,000
No. of materials moves	15,000	3,000
No. of parts	400	100
No. of details	5	2
No. of feature	6	2
No. of quality control inspections	60	20
No. of product runs (setups)	25	5

Required:

a. Compare the cost, price, and profits per unit for the two products using departmental overhead allocations with those using the new manufacturing system and activity based cost pools?
b. Which set of numbers would you rely upon in making product mix and pricing decisions? Why? Support your answer with arguments.

NOTES

M O D U L E

Management Accounting in the Age of Lean Production

Version 1.1

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Module Contents
Management Accounting in the Age of Lean Production

Management Accounting in the Age of Lean Production

CRUNCH TIME AT *SPORTS ACTION*

"Gentlemen, we have a problem! As you know, we are struggling to control rising costs while meeting subscriber demands for a higher quality magazine with more current stories. Our growing circulation has helped us meet the cost challenge. Our major competitor, *Sports Illustrated,* did daily color editions of the 1996 Atlanta Olympic games.* Further, they are now planning to let subscribers' customize their subscriptions! A subscriber can request extra coverage of the Dallas Cowboys, the Boston Red Sox, or any other pro team. How can they do this economically? Our budget shows that the way to keep costs down is to increase circulation, not to add more versions of the magazine." With this bombshell, Sarah Green, the CEO of *Sports Action* magazine, opened the weekly executive committee meeting.

"Pete, I know the *Sports Illustrated* action is consistent with your market research that shows that subscribers want customized publications and custom editions will increase our total circulation. However, John's production people point out that we would have to print custom editions in much shorter print runs, and the amount of typesetting and changeover time would rise dramatically. Our presses operate best when we print large quantities of the same material. Fred, your accounting analysis supports John's point. The accounting data shows that costs will go up with smaller quantities because we will lose 'economies of scale.' What can we do? How can we bring costs down for the smaller print quantities of custom editions? Can we change our production process? Are there better ways for us to use materials, labor, and equipment?"

"Sarah, your questions are important, but you are asking me about things our accounting system does not currently address. Our focus has been on satisfying external demands for information. Our system effectively costs inventory, reports labor efficiency, and tracks costs for different production volumes. We have never tried to answer the management questions you just asked. To provide this type of information we will need to rethink the focus of our accounting system."

▲ STRATEGIC IMPLICATIONS OF PRODUCTION PROCESSES

Production processes are the ways firms combine raw materials, labor, and other resources and physically transform them into products or services. The production method used by a firm impacts its cost structure and what it measures and reports. These in turn influence the type of strategic decisions it makes. The *Sports Action* story illustrates how a firm that uses mass production methods tends to think of competitive strategy only in terms "economies of scale," that is achieving higher volume levels. It also shows how over time a management accounting system can reinforce these beliefs about how to compete.

* See article on *Sports Illustrated* in *Advanced Imaging*, September 1996.

- **Quality.** The production method a firm uses affects its ability to provide customers with the quality of products and services desired. A magazine like *Sports Action* uses printing equipment and technology capable of producing millions of identical magazines with a certain quality of paper, clarity of print, and variety of color. Its management accounting information shows that custom editions are too costly because it is reinforcing the belief that all costs are driven by production volume.
- **Cost.** In a competitive market, cost is a fundamental concern. A firm's existing production method determines the cost at which it can provide products or services. For instance, *Sports Action* uses skilled labor throughout the production process. Its costs are different from other publishers that may use unskilled labor or subcontract printing operations. *Sports Action's* management accounting information system tells its management what it costs to produce under the existing production method.
- **Time.** In order to compete on the basis of time, a firm must design and produce products faster and get to market quicker. Management accounting systems analyze the cost of getting products to market faster based on existing production methods. A firm that uses a volume driven cost system can ignore or miscalculate the cost not delivering products on time.

▲ PURPOSE OF THIS MODULE

This module illustrates how an organization's environment, strategic choices, and production methods influence the design of its management accounting system. The primary focus is on comparing how mass and lean production methods affect a firm's cost structure and its management accounting system.[1] After completing this module you should understand:

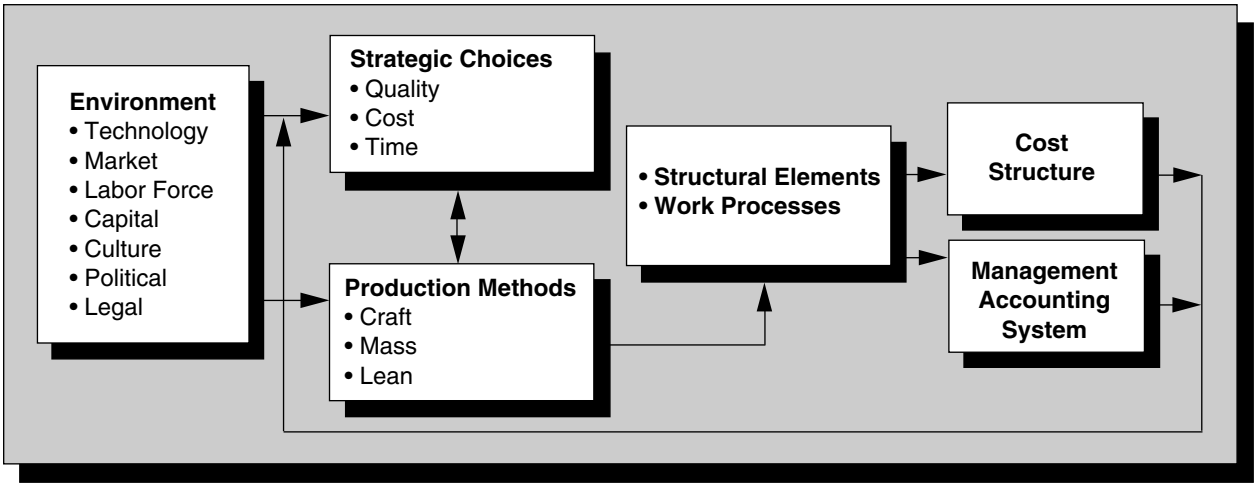
- The determinants of cost structures and management accounting systems.
- How environment affects the choice of production methods.
- Structural differences between mass and lean production systems.
- Work process differences between mass and lean production systems.
- The cost structure differences between mass and lean production.
- Management accounting systems in mass and lean production environments.
- Technical, behavioral, and cultural attributes of management accounting systems that support mass and lean systems.

▲ DETERMINANTS OF COST STRUCTURES AND MANAGEMENT ACCOUNTING SYSTEMS

Decision makers use their understanding of the existing environment to decide: (1) how to compete on quality, cost, and time; and (2) what production methods to use. These choices are simultaneous and interactive. Strategy and production methods, in turn, determine a firm's cost structure and the design of its management accounting system. Over time these

[1] Lean production is a broad concept and encompasses terms such as flexible production, mass customization, and even agile manufacturing.

Exhibit 1
Determinants of Management Accounting Systems



choices loop back to strategy formulation and determine production method choices in future periods. Exhibit 1 presents these relations in a flow diagram. The key elements of this diagram are explained in this section.

As shown in Exhibit 1, a firm's environment influences how it chooses to compete. There are two types of factors in a firm's environment, key resource factors and community related variables. The first set includes resources that an organization needs to carry out its task or mission. These include technology, market size, and the type and quantity of labor and capital available. The second set of environmental factors are the legal, political, and cultural factors that constrain or limit the way in which a firm can operate within a society.

Based on their understanding of the environment, leaders at *Sports Action* chose to produce a weekly sports magazine using high speed, high volume printing presses. This choice probably reflected a large market for a standard weekly magazine. Custom editions were neither in demand nor was the technology available for economic production.

Sports Action's decision to produce a weekly magazine in high volume logically led to the choice of a mass production system. This system was probably the most cost effective way to produce large quantities of magazines at a desired quality level. Mass production systems, described in greater detail in the next section, create unique structures and work processes in the organization. Structures refer to the way a firm employs capital, labor, and other factors of production. Work processes refer to the relationships between the various parties, suppliers, workers, dealers, and so on who carry out the connected set of work activities.

The nature of structures and work processes creates a cost structure for a firm. For example, *Sports Action's* high speed press is expensive and needs a high volume of business to be cost effective. It is also costly to stop and change the presses. Longer, uninterrupted production runs are more cost effective. Longer production runs require large quantities of paper and ink inventory so production is not disrupted. This creates inventory holding costs.

Finally, the structures and work processes determine the key success factors for a firm. These key success factors are the focus of a firm's management accounting system. At *Sports Action,* the management accounting system will probably report on magazine

subscriptions sold, the volume of magazines produced, and the cost and efficiency of the firm's use of material and labor. This is because these factors are needed to manage for success. If a management accounting system only reports on these factors without providing a good understanding of the reasons that lead to the cost structure and success factors, there may be a tendency to view all choices within the existing cost system. At *Sports Action* this tendency is apparent from the fixation that managers demonstrate with the need to have high volumes. This can lead to a flawed analysis of available choices. The numerical analysis of *Sports Action* later in this module will demonstrate how this can occur.

▲ TYPES OF PRODUCTION METHODS

The prior section showed how environment plays a key role in a firm's selection of production methods. In practice, there are three basic production methods used by firms: craft, mass, and lean. Each of these production methods works most effectively in a particular environment.[2]

Craft production is the process of making unique, or one of a kind, products typically with simple tools or technology, limited amounts of capital, and skilled labor. Usually the market size is small, and customers expect high variety or one of a kind products. For example, Meissen Porzellan Manufaktur of Germany is world famous for its fine china. For 300 years the company has produced china by using molds to create "greenware," furnaces to bake china, and then hand paint each piece.

Craft production was the dominant production process until early in the 20th century when technological advances and available capital made other production methods more lucrative. Today movie making, animated cartoon production, custom furniture, and works of art use craft production methods.

Mass production is the process of making a large number of identical products. It typically requires high levels of large single-purpose machinery and large amounts of capital and unskilled labor. Henry Ford played a critical role in the development of mass production. Ford used machining advances that allowed precision cutting of standard parts and a large pool of unskilled labor to create a production system that successfully exploited the vast markets opened by railroads and telegraph. The Fordist system of mass production turned out large numbers of identical, low cost, automobiles.

By the 1950s mass production was the world's primary production method. This system was well suited for the post World War II environment, particularly in the United States. A strong demand for civilian products had built up during the depression of the 1930s and during World War II. Standard products were acceptable. Production technology, enhanced by the production demands of the war, allowed manufacturing firms to produce great quantities of standard products in large plants using thousands of unskilled or semi-skilled laborers.

Lean production is a manufacturing process that allows firms to quickly turn out small batches of customized products. (Agile or flexible manufacturing and mass customization are other terms sometimes used for lean production.) Lean production combines sophisticated technology and high capital investment with skilled laborers capable of varying task assignments. It allows firms to produce complex, high variety products quickly. Eiji Toyoda and Taiichi Ohno of Toyota Motor Company played a critical role in the development of lean production.

[2] Note that the term *production* is used, rather than manufacturing, to reflect the broad scope of this transformation process.

Exhibit 2
Contrast of Environment by Production Method

Environment	*Craft*	*Mass*	*Lean*
Technology	Simple	Mixed	Sophisticated
Labor	Skilled	Unskilled	Multi-skilled
Capital	Low	High	Very high
Market size	Small	High volume	Large volume
	High variety	Low variety	High variety

In the 1950s Toyota faced a small, fragmented domestic market, had a limited amount of capital, and had a lifetime commitment to its labor force. These environmental factors caused Toyota to perfect lean production. These lean production methods have created customers who now expect new product designs, high product variety, and low cost. Lean production methods have been adopted by a number of world class organizations in the U.S., Europe, and Asia.

Exhibit 2 summarizes the differences between craft, mass, and lean production methods on the four primary environmental resource factors. Many modern production processes typically have characteristics of more than one production method. An extreme contrast is used only to sharpen the distinctions between mass and lean production systems. One method is not good and another bad. What is critical is that the production method chosen should be appropriate for the environment in which it is used.

▲ STRUCTURAL DIFFERENCES—MASS AND LEAN PRODUCTION

Structural elements refer to the way a firm employs capital equipment, labor, and technology in production. There are three key differences in the *structural elements* of mass and lean producers.

Inflexible single purpose versus flexible multi-use equipment.

Mass production typically uses inflexible, single purpose equipment that produces large numbers of standardized parts or products. For example, Ford[3] invested millions of dollars in presses capable of stamping out large numbers of identical automobile parts. In contrast, lean producers, such as Toyota, use flexible multi-use equipment that is capable of producing a wide variety of customized parts or products in small quantities. Ford's approach worked well for the large homogeneous U.S. markets. Toyota's approach was well suited for its smaller market which demanded greater product variety.

High versus low setup time.

High setup time is a characteristic of the equipment used in mass production. Setup occurs whenever a new product batch with different specifications is started. For example, switching from production of red cars to white cars in a dedicated paint operation means stopping production, cleaning equipment, loading the new color, and testing for proper paint color. Setup costs typically include wages and benefits for change over specialists, spoiled

[3] Ford and the automobile industry is consistently used as an example in the discussion of mass production because of the role this firm had in the creation of mass production methodology. Ford today does not use a classic mass production approach to manufacturing. Instead it uses a combination of mass and lean production processes.

Exhibit 3
Mass versus Lean—Structure Differences

Mass	*Lean*
1. Inflexible single purpose equipment	1. Flexible multi-use equipment
2. High setup time for equipment	2. Low setup time for equipment
3. Simple tasks and low skilled labor	3. Complex tasks and skilled labor

materials during machinery calibration, new machinery parts (tools, dies, saws, stamps, punches, etc.), modification of equipment parts, utilities, and cleaning.

Low setup time is characteristic of lean producers. Engineers consider setup time and difficulty as design parameters for lean production equipment. Technological advances have made setup as simple as the insertion of a new software design program into a computer controlled machine in many industries. To appreciate the difference in setup time between the two production methods consider that when General Motors was using an entire day and several specialists to make a stamping die change, Toyota's production workers changed their own stamping dies in three minutes.

Labor skill level.

Mass production methods require a low level of labor skill because work is split into a series of simple repetitive tasks such as mounting a wheel, bolting down a floorboard, or installing a headlight. Workers don't have to understand the production process or need costly training to do their work. They simply have to do their task and meet output standards established by management.

In contrast, lean production requires a versatile, skilled labor force. Production takes place within "cells" (usually a "U" shaped arrangement of workspace). A production cell typically has several pieces of flexible equipment, each capable of performing a variety of different operations. Within a cell, an entire product, such as a lawnmower engine, may be completely manufactured. Cell workers are responsible for knowing how to setup and operate all cell equipment, as well as for moving materials, controlling quality and performing routine maintenance tasks. A flexible, skilled labor force is necessary to perform all these tasks. Individuals are trained to setup, operate, and maintain several different types of machinery. They also are expected to perform a variety of tasks, to understand the organization of the work process, and to accept responsibility for the quality of their output. Lean producers invest heavily in worker training.

Exhibit 3 summarizes the structural differences between mass and lean production systems.

▲ WORK PROCESS DIFFERENCES—MASS AND LEAN PRODUCTION

Work processes refer to the way a firm organizes its work relationships. These relationships include those between the firm and its employees, suppliers, and customers, as well as the work flow relationships among the functional areas (e.g., between the manufacturing and design departments). There are four fundamental differences between a mass and a lean producer.

Extent of worker control.
A mass producer relies on managerial and supervisory levels to control the manufacturing operations. The role of management is to figure out the best way to do a task and then teach workers this best way. Workers simply follow instructions. If a problem occurs, workers notify supervisors. Only supervisors can decide to shut down production. Until the supervisor decides to stop production, workers continue to produce even if this means that all output is defective.

A lean producer "empowers" workers by giving them detailed operating and financial information and the power to make decisions throughout the process. Lean producers rely on workers to produce, correct minor machinery problems, and stop production if quality problems exist. Assembly workers identify production or quality problems using a method Toyota calls the *five whys.* Workers keep asking, *why,* until they get to the root cause of a problem. Workers use this information to make suggestions for improving the manufacturing process or for engineering design changes to products.

Relations with suppliers.
A mass producer tells suppliers precisely what is needed through detailed product specifications. Since the product being purchased is also a standard mass produced item, there are many suppliers typically competing on the basis of price. Mass producers use only short term contracts as a way to leverage their position with suppliers. Under this system there is no incentive for suppliers to offer suggestions to improve products or share information on costs.

In contrast, lean producers maintain extensive direct contact and information sharing with suppliers. Lean producers tell suppliers what is needed, but not how to design and produce the part or product. Suppliers work to design both the parts and the manufacturing process to satisfy the lean producer. They work on long-term contracts that include incentives for identifying cost savings. Suppliers also have direct involvement with product design and are members of manufacturing teams.

Relations with customers.
Mass producers design and deliver standardized products that change little over an extended time. Once it is determined what can be produced with existing technology it is produced, and marketing is expected to develop a customer demand for the product and sell it. There is no effort to involve customers in product design decisions.

In contrast, lean producers design and deliver heterogeneous products that meet the needs of market niches. There is extensive direct contact and information sharing with customers. Lean producers constantly work with customers and try to determine what product features they want and what they are willing to pay. For example, the Japanese automobile manufacturers have engineers attend automobile shows so they can hear what potential customers are saying about cars.

Nature of product development.
Specialization of work in mass production results in a linear or sequential product development process. Product designers develop products without any input from manufacturing or service engineers. When a design is complete, it is "thrown over the wall" to production who is told "make this!" This creates lost productivity and quality problems on the factory floor as production tries to adapt the design for mass production. If the design cannot be adapted successfully, it is sent back to design, restarting the entire process.

Exhibit 4
Mass versus Lean—Process Differences

Mass	*Lean*
1. Top down control of employees	1. Empowered workers
2. Supplier relationships arms length	2. Cooperative relationship with suppliers
3. Limited relationships with customers	3. Continuous customer focused organization
4. Linear design process	4. Concurrent design of product and process

In a lean production facility, product design engineers work "concurrently" with process design engineers, service engineers, production workers, and others to ensure that products are easy to make, assemble, ship, and repair. This integration cuts down on design and production time, saves cost, and ensures better quality products.

These process differences between mass and lean producers are summarized in Exhibit 4.

The following sections will show how the differences in structure and work processes, summarized in Exhibits 3 and 4, determine the cost structure and influence the type of management accounting system that a firm uses. Data from *Sports Action* is used to illustrate these differences.

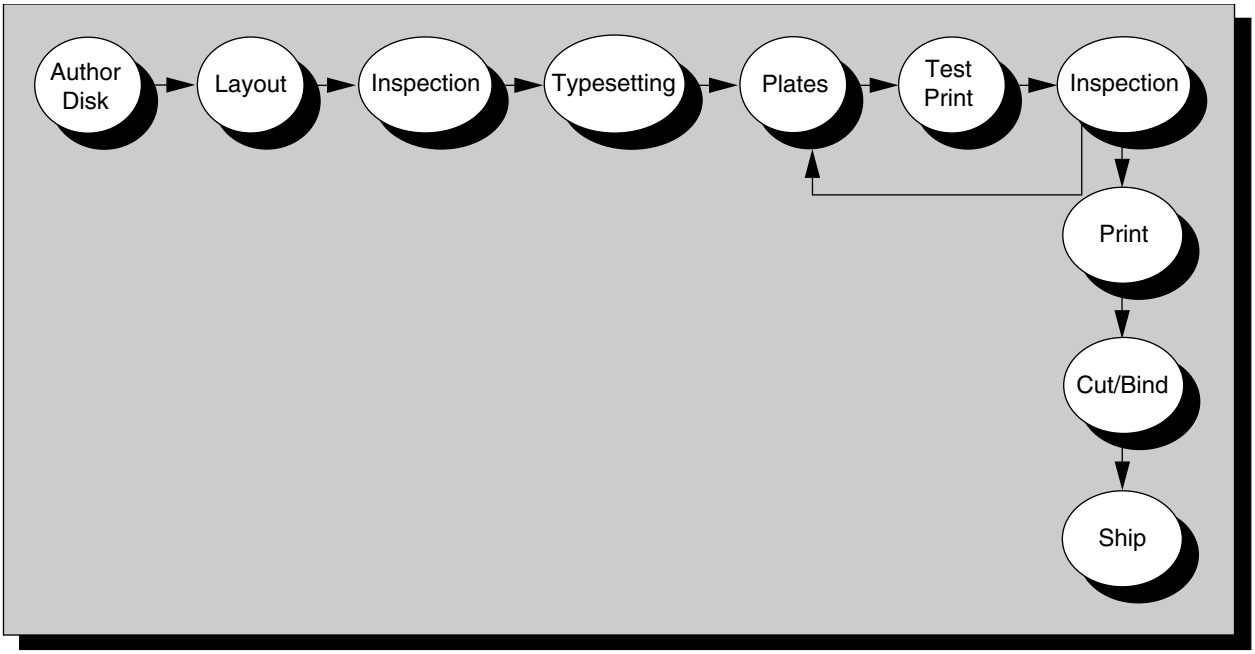
▲ COST STRUCTURE—MASS PRODUCTION

The accounting system at *Sports Action* was designed to support a mass production system. Exhibit 5 shows the steps involved in producing magazines under the current production method. Authors submit articles and pictures on disk. Specialists in the pressroom, using a special page maker computer program, develop a page layout for articles from authors' disks. This layout is inspected for incorrect separations of graphs, pictures, and text. Next skilled typesetters use a special film process and prepare printing plates. Employees then set up the magazine press using those plates. The press requires a new setup for *each* print run. After setup there is a test print run and print quality inspection. When print quality becomes satisfactory the printing of usable pages begins. After completing all necessary print runs, pages are cut and bound into finished magazines. These magazines are shipped to subscribers and wholesalers.

Sports Action currently produces and sells 600,000 magazines a week. This is equal to 31.2 million magazines a year. The production department employs a variety of resources to produce these magazines.

- ▲ It leases a special purpose, high volume, magazine press that prints 16 pages at a time. Each issue of the magazine requires six or more print runs.
- ▲ *Sports Action* uses clerical employees skilled in computer page making software to do layout. Other clerical workers then inspect articles for layout problems. The company subcontracts with a typesetting firm to film and prepare printing plates. It employs skilled proofreaders to review each printed page for print darkness, smudges, color, and paper quality. Pressroom laborers operate the press, while setup and maintenance laborers clean the press and perform needed setups.
- ▲ *Sports Action* has two different types of setup in its printing process. A change from one black and white setup to another requires only the insertion of new

Exhibit 5
***Sports Action* Mass Production Process**



printing plates and takes little time or test printing. Color setups are more complex and require more time because the presses are cleaned to remove prior colors. This setup activity uses a large amount of paper and ink as part of the test print process.

- The production department keeps a one month supply of paper and ink on hand. This inventory helps the firm avoid delays in production if suppliers experience delivery delays or there are problems with the paper quality.
- Purchasing specialists buy large quantities of magazine-quality paper, ink, and other printing supplies. The purchasing group negotiates intensively with suppliers on a weekly or monthly basis for the lowest cost.

Cost per magazine is a key variable management uses to evaluate its strategic choices. Exhibit 6 summarizes the production cost structure at *Sports Action* at the current and at a projected level of circulation.

Why Volume Lowers Unit Cost.

As Exhibit 6 shows, at the current volume of 600,000 copies a week, *Sports Action* spends $41.5 million in a year, and the cost per unit of the magazine is $1.33. If the circulation of *Sports Action* increases by 33 percent, to 800,000 a week, the total annual production costs increase about 18 percent to $49.1 million. However, the cost per unit drops about 12 percent to $1.18. This is the magic of increasing the volume of a mass produced product (economies of scale).

What causes this unit cost change? A study of Exhibit 6 shows that when production volume increases by 33 percent, some costs such as paper, ink and cleaners, and supplies also increase by 33 percent. Such proportional changes occur because each magazine

Exhibit 6
***Sports Action's* Annual Production Costs**

Production Costs	*Cost at 600,000 Weekly (31.2 M annually)*	*Cost per Magazine (rounded)*	*Cost at 800,000 Weekly (41.6M annually)*	*Cost per Magazine (rounded)*
Materials				
Paper	$9,000,000	$.2885	$12,000,000	$.2885
Ink and cleaners	3,000,000	.0961	4,000,000	.0961
Subtotal	12,000,000	.3846	16,000,000	.3846
Labor				
Typesetters	7,000,000	.2243	7,000,000	.1682
Press room	9,000,000	.2885	12,500,000	.3005
Proofreaders	4,000.000	.1282	4,000.000	.0962
Clerical/janitorial	2,000,000	.0641	2,000,000	.0481
Setup/maintenance	2,000, 000	.0641	2,000, 000	.0481
Other salaries	1,000,000	.0321	1,000,000	.0240
Subtotal	25,000,000	.8013	28,500,000	.6851
Other Production				
Equipment lease	4,000,000	.1282	4,000,000	.0962
Other supplies	300,000	.0096	400,000	.0096
Building rent	200,000	.0064	200,000	.0048
Subtotal	4,500,000	.1442	4,600,000	.1106
Total	**$41,500,000**	**$1.3301**	**$49,100,000**	**$1.1803**

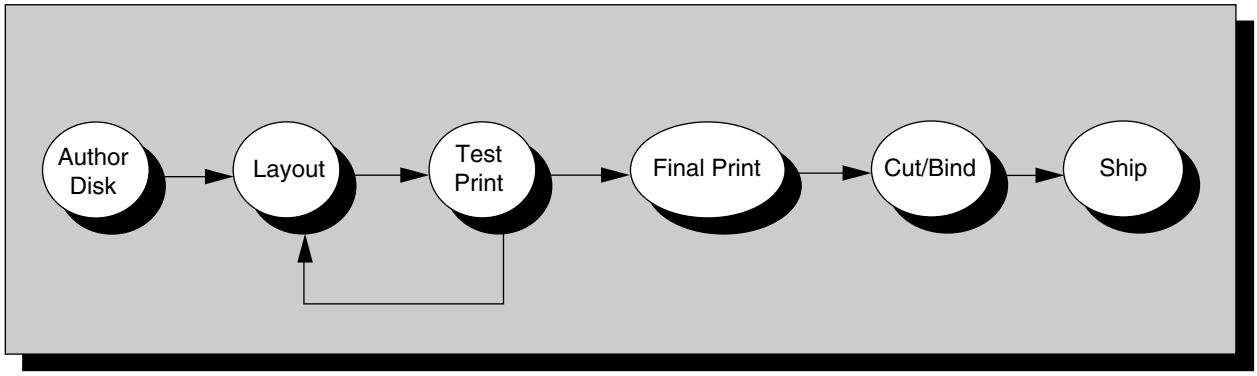
produced requires the same amount of paper, ink, and other supplies to produce it. There is a slightly larger increase (39 percent) in pressroom labor costs because the firm would need to hire and train additional workers to print the additional copies.

However, many of the other costs remain unaffected by the change in the production volume.

1. Capital equipment and salaried employee costs remain unchanged in total, but these costs are spread over a larger number of units. This lowers the average cost of each magazine.
2. The number of print runs and the number of setups remain constant since additional copies of the same magazine are being printed. These costs remain unchanged in total but are spread over a larger number of units, lowering the average cost per magazine.
3. Additional copies of the same magazine do not increase production complexity. The firm still buys the same type of paper and ink, negotiates with the same supplier set, uses the same type of equipment, performs the same tasks in production, and employs the same employee groups. No additional costs are incurred to manage, because the production is not more complex.
4. An increase in production volume means the company will need to inventory more paper and ink. This increases costs roughly proportional to the volume change. The

To cement your understanding of the existing cost structure, calculate the unit cost if *Sport Action's* volume was 100,000 magazines per week. (Answer appears at the end of the module.)

Exhibit 7
Sports Action—Lean Production Process



need for more inventory will increase the inventory and its associated holding and processing costs. (These are not production costs and are not shown in Exhibit 6.)

▲ COST STRUCTURE—LEAN PRODUCTION

Think Along

> How would *Sports Action's* cost structure be affected if it adopted lean production methods?

Adoption of lean production methods would cause several fundamental changes in *Sports Action's* work structures and processes. These changes, summarized below, would change its cost structure.[4]

- ▲ *Sports Action* will lease several smaller, more flexible, digital presses capable of printing eight custom editions of 100,000 magazines a week to replace the large, single purpose printing press. Digital presses use computerized instructions to make print plates instead of specialized workers performing layout and filming activities.[5]
- ▲ The firm will install a just-in-time inventory system for raw materials and give suppliers, who agree to meet negotiated delivery schedules, long-term supply contracts. This would replace the current month-to-month negotiations with suppliers.
- ▲ *Sports Action* will train and reassign employees to do editorial and story preparation tasks, like disk layout or quality inspection, or to operate and maintain the digital presses or inspect for print quality. It will terminate the typesetter contract.

[4] The ability of a firm to make these changes depends on many environmental factors. For example, without digital presses this is not possible. There are also a variety of labor issues that are part of the change process. Many of these problems are assumed not to exist in this example.

[5] Lauren Bielski, "We've Heard of on Demand . . . but Are Digital Presses in Demand? *Advanced Imaging*, August 1995, pp. 68–71.

Exhibit 8
***Sports Action's* Costs Under Mass and Lean Production**

Production Costs	*Mass Production*	*Cost per Magazine (rounded)*	*Lean Production*	*Cost per Magazine (rounded)*
Volume	**800,000/week (One edition)**		**800,000/week (Eight editions)**	
Materials				
Paper	$12,000,000	$.2885	$10,000,000	$.2404
Ink and cleaners	4,000,000	.0961	3,800,000	.0913
Subtotal	16,000,000	*.3846*	13,800,000	*.3317*
Labor				
Typesetters	7,000,000	.1682	0	0
Press room	12,500,000	.3005	11,500,000	.2764
Proofreaders	4,000.000	.0962	4,000,000	.0962
Clerical/janitorial	2,000,000	.0481	2,000,000	.0481
Setup/maintenance	2,000, 000	.0481	300,000	.0072
Other salaries	1,000,000	.0240	1,000,000	.0240
Subtotal	28,500,000	.6851	18,800,000	.4519
Other Production				
Equipment lease	4,000,000	.0962	5,000,000	.1202
Other supplies	400,000	.0096	400,000	.0096
Building rent	200,000	.0048	200,000	.0048
Subtotal	4,600,000	.1106	5,600,000	.1346
Total	**$49,100,000**	**$1.1803**	**$38,200,000**	**$.9182**

Exhibit 7 shows the new production process. Note that the process has fewer activities than the mass production process currently in use (see Exhibit 5).

Exhibit 8 summarizes the effects of the proposed changes on the production department by comparing the costs, at the projected weekly volume of 800,000 a week, for lean production (eight editions of 100,000) and mass production (800,000 of a single edition). *Notice that even though the circulation for each custom edition is only 100,000, or one-eighth of the single edition volume, both the total cost and the cost per unit are less than in mass production.*

Volume does not provide a cost advantage in a lean production system.

Why Unit Costs Are Lower with Lean Production.

The difference in *Sports Action's* unit costs is caused by several factors.[6]

1. Having five digital presses increases the rental cost the firm incurs by $1 million, to a total of $5 million a year. However, *Sports Action* has more production flexibility with five presses, rather than one. It can economically do shorter print runs on these smaller presses.

[6] To explain all the details and the reasons for these cost changes is beyond the scope of this module.

2. Digital presses do not require special setup because software instructions replace the printing plates used in a conventional press. This technology change allows the firm to reduce the setup and maintenance costs to $300,000.
3. A digital press also eliminates the need for typesetting and thus for the typesetters. This allows *Sports Action* to terminate the existing contract for typesetting.
4. Digital software makes proofreading easier. However, because there are now eight editions, the analysis assumes that total proofreading costs remain unchanged.
5. The new production process results in fewer activities in the press room and allows *Sports Action* to reduce the press room labor costs by $1 million.
6. Paper costs decline by $2 million and ink costs by $200,000 because there is no longer a need to do extensive test printing after a setup. In addition, there in no longer a 16 page layout factor to consider when there is a color change.

Think Along

Are there other costs that may change as a result of the introduction of a lean production system?

A decision to work more closely with small paper suppliers and have them deliver paper on a "just-in-time" basis can lead to a number of major differences in the production process that have cost implications. The costs of ordering, soliciting bids from suppliers, and holding inventory all should drop significantly. Because the paper is used almost as soon as it is received there is no need for expensive storage areas or complex inventory tracking systems. Lower inventory would also save *Sports Action* money because less capital will be tied up in inventory. This type of delivery system is also likely to help the firm meet quality and time objectives. For a more extensive discussion see the inventory management module.

Using a lean production system, *Sports Action* can produce a variety of magazines in lower volume at a cost that is less than its current mass production cost.

Think Along

Can a mass producer adopt the types of changes discussed for *Sports Action*?

If the right type of information is available there is no reason that a mass producer could not adopt several of the changes described. For example, using a technology that does not require typesetting can be an effective action even if there was no demand for custom editions. However, it is unlikely that the firm would see a need to invest an additional $1 million in smaller presses if it were producing a single magazine edition. This would leave the firm vulnerable to market changes. There is also no reason that a mass producer could not work closely with suppliers. However, these actions are a choice on the firm's part and are not necessary and critical for survival.

▲ MANAGEMENT ACCOUNTING INFORMATION—MASS VERSUS LEAN PRODUCTION

Reliance on existing management accounting information constrained *Sports Action's* CEO's thinking about options, because she believed, as a universal truth, that volume lowers costs. She did not recognize that this was true only for the existing production method. Using different production methods can change the fundamental cost relationships.

Key Point

The management accounting data available influences how a firm perceives and reacts to competitive challenges

The following text briefly compares four differences between the information provided and analyses performed in management accounting systems designed for mass and lean production. Practically, the systems used by many companies are a combination of these contrasting techniques.

Volume focused versus driver focused.

Mass producers use simple, volume based decision making models. They assume that costs either vary with output (variable cost), such as the paper it takes to produce a single magazine, or that costs are relatively constant (fixed) over a certain time period, such as the equipment rental.

Lean producers know that volume is not the major factor affecting cost. They search for "drivers" of cost by analyzing the tasks performed and the resources consumed by those tasks. (A driver is something that causes a task and its attendant cost to be incurred.) At *Sports Action* a key cost driver was setup.

Unit responsibility versus a value chain focus.

Individual and departmental responsibility are the focus of most mass production based accounting systems. Accounting reports traditionally focus on comparing budgets or standards with actual results. The emphasis is on evaluating how well an individual, or a single part of the organization, met the targets.

Lean producers put more emphasis on joint responsibility for output, and understand that all members of the "value chain," from suppliers to disposers, are necessary to achieve desired results. The management accounting system provides financial and operating data to employees and suppliers. Lean producers provide suppliers with information on the demands for parts in each time period and provide feedback on the supplier's performance, delivery time, and quality. Reports provide production cells with actual results as soon as possible to allow for corrective action and learning. In addition, cells and design engineers receive information which shows how their actions influence cost and performance in other organizational areas.

Inventory driven versus no inventory reporting.

Traditional mass producers carefully measure and report on inventory because they generally have large inventories of raw materials and supplies, goods in process, and finished products. They spend considerable time and resources tracking and controlling inventory.

Lean producers carry very little inventory so tracking and control becomes less important. Simple inventory systems are adequate for maintaining physical control and for analyzing product costs.

Labor versus indirect cost orientation.

Mass producers typically use many classes of specialized laborers and report extensively on labor efficiency. Each product produced has a specified amount of labor hours for each product. The accounting system reports the actual production and provides comparisons of the standard labor costs with the actual production costs. There is an analysis of the differences between the two, called variances, to discover the root causes.

Exhibit 9
Mass versus Lean—Management Accounting Systems

Mass	*Lean*
1. Relationship of volume to cost	1. Relating "drivers" to cost
2. Responsibility accounting—unit focus	2. Process accounting—Value Chain focus
3. Inventory driven—reporting and control	3. No inventory reporting
4. Labor reporting	4. Indirect cost reporting

Lean production workers do several tasks and cooperate with other workers in their cell to achieve desired outputs. Accountants typically calculate the costs of processes performed within cells rather than trying to calculate the labor cost component of individual products.

Exhibit 9 illustrates some of the many different types of information that may be available under different production systems.

▲ TECHNICAL ATTRIBUTES—MASS AND LEAN MANAGEMENT ACCOUNTING SYSTEMS

A management accounting system must possess two important technical properties. It must lead to better decisions and provide a good understanding of the production process.

Decision Relevance.

The accounting systems developed to support mass and lean production processes both strive for decision relevance. However, these systems reflect different structural elements, work processes, and cost structures. A mass system is efficiency oriented, emphasizes department level decision impacts, and concentrates on decisions internal to the firm. In contrast, a lean system is process focused, emphasizes cross function decision impacts, and concentrates on decisions across the value chain.

Focus on variable costs versus cost drivers.

Mass producers rely on contribution margin analysis for most decisions they make. Contribution margin is the selling price of a product minus the variable cost of producing a unit. A key element of the model is that it treats fixed costs as not relevant for short-term decisions. Most traditional managerial models are based on contribution margin analysis because the models are so easy to apply. This is also the models' downfall. Because of being easy to use and yielding good short-term results, managers forget to focus on the long-run issues of cost management. Many CEOs today find the term "fixed cost" unacceptable. They reprimand managers who describe costs as fixed because they recognize that all costs can be changed over relatively short time periods.

Lean producers recognize that cost structures are more complex. They focus on identifying and managing their major cost drivers. Accounting procedures analyze activities,

identify resource usage, and determine the drivers. Attention is paid to properly pricing the use of activities and products which consume activities and to managing activities to cost less.

Internal versus external orientation.
Mass production is suited for environments where product variety level is low, product life cycles are long, and identifying the most efficient and cost effective ways to produce large volumes of identical products is an appropriate decision focus. Since the external market is stable, it is appropriate to focus on internal efficiencies.

When the environment changes quickly and product variety, quality, and delivery time demands are more sophisticated, lean production becomes important. Lean producers have to look outward and carefully assess customers' needs so they do not waste resources producing something customers do not want. Lean producers have to focus not only on internal efficiency but also maintain focus on the external environment. They rely on target cost systems to manage costs.

Individual or unit responsibility versus cross functional and value chain emphasis.
In mass production, decision models try to optimize the performance of the individual, department, or firm. Control and coordination of internal operations is considered critical. The decision rule is that by optimizing the performance of each individual and department the firm's results will be maximized.

Lean producers emphasize a broader set of relationships across the product's life cycle and the value chain. Their emphasis is on accounting for product costs across all organizations whose activities affect the product's lifetime cost to consumers. To minimize life cycle costs, lean producers believe that decisions must include all organizations involved with the product over its life. They use a decision rule of optimizing team effort and minimizing costs over a product's life.

Process Understanding.

Mass production accounting systems focus solely on volume as a cost driver. Very little knowledge of process is required to use this simple model. It can have pitfalls, however. At *Sports Action* the management accounting system did not have a process focus. This was one of the reasons that management did not understand the implications of the existing cost structure on the QCT choices being made.

Enhancing process understanding is at the heart of lean production accounting systems. As this module shows, the lean producer must understand work processes to manage costs. Understanding the production process relationships and how these drive costs, helps managers identify and exploit cost advantages. Further it illuminates how production methods create cost structures. As was demonstrated with the *Sports Action* example, when changes in the production process are possible, the opportunity to compete without increasing volume exists.

Exhibit 10 summarizes the differences in technical attributes of a mass production and a lean production process. Many firms today have accounting systems that have characteristics of both mass and lean systems.

Exhibit 10
Mass versus Lean—Technical Attributes

Mass	*Lean*
Decision Relevance	*Decision Relevance*
1. Short run decisions	1. Long run cost structures
2. Internal efficiency	2 External environment focus
3. Single responsibility unit focus	3 Cross functional and value chain focus
Process Understanding	*Process Understanding*
1. Not emphasized	1. Primary emphasis

▲ BEHAVIORAL ATTRIBUTES—MASS AND LEAN MANAGEMENT ACCOUNTING SYSTEMS

Management accounting systems developed for mass and lean production processes differ on behavioral dimensions as well. Underlying assumptions imbedded in each lead to different behavioral consequences. Because many of the assumptions are implicit, rather than explicit, it is easy to overlook the behavioral effects.

Behavioral Assumptions—Mass and Lean.

Many existing management accounting systems, particularly those supporting mass production methods, include assumptions that emphasize: individual accountability, a monetary motivation focus, and the accountant as a control agent. In contrast, lean production systems attempt to incorporate a different set of assumptions into the organizational reporting structure. These include emphasis on team responsibility, a focus on multiple motivational factors, and the accountant as a team player.

Individual accountability versus team responsibility.
A foundation of mass production is the separation of work leading to individual responsibility and accountability for results. In contrast, lean production systems rely on flexible work teams cooperating to produce output. Responsibility is process and team based, as are performance evaluation and rewards.

Monetary versus multiple motivational factors.
Performance measures used in mass production assume that people are primarily motivated by monetary rewards that are provided for meeting short-run, preset performance targets. Lean systems are more likely to explicitly recognize that a wide variety of factors can motivate people. Money remains an important reward, but other factors such as pride in quality, achieving targets, and developing new ideas take on prominence. Communicating and celebrating achievements is used as an additional way to reward performance.

Accountant as control agent versus accountant as team player.
Mass production systems often regard the accountant and the accounting system primarily as a way of ensuring that the actions dictated by top management occur. The accountant

takes the role of the corporate police officer. A lean system makes the assumption that the accountant is a team player. Accountants become business advisors who provide valuable inputs to team decision making.

Behavioral Consequences—Mass and Lean.

The different assumptions of management accounting systems under mass and lean also explain the different behavioral consequences observed in these systems. For example, mass systems are more likely to lead to quality problems and budget games but create a lower level of employee burnout. Conversely a lean accounting system can help a firm produce higher quality products and better utilize self directed work teams, but often leads to more employee burnout. Exhibit 11 summarizes the differences discussed below.

Quality problems or quality commitment.

Management accounting systems in mass production traditionally rely on tight standards to control workers. These standards are usually tied to a reward system. Behaviorally the message is: meet standards and be rewarded. This means that the accounting system encourages workers to be more interested in output quantity than quality. Quality typically suffers. Also, quality inspections are performed by inspectors and not workers. Since quality is not their responsibility, workers often allow a defective process to continue operating. A lean production manufacturer relies on workers and not inspectors for quality. Consequently a greater commitment to quality exists and fewer quality problems arise.

Local versus global optimization.

Because mass production accounting systems hold individuals or departments responsible and accountable, they are motivated to meet their own goals regardless of the consequences on the entire organization. Several research studies document this type of suboptimal behavior. For example, one department of an aircraft manufacturer preferred to produce wings because these could be produced in less than the standard time allowed. The department stockpiled wings so performance reports would look good, and didn't produce planes which were on backorder from customers. Lean production accounting systems tie responsibility and accountability to team efforts. This typically leads to less local optimization.

Low versus high pressure and burnout.

Both U.S. and Japanese companies report high pressure and employee burnout in lean manufacturing. Empowering employees places heavy responsibility on them. There is intense pressure to support the team or organization, search for improvement opportunities, and perform at optimal levels at all times, because of the reliance of other employees. If a mistake is made that impacts quality the work stops for everyone, not just the area where the problem exists. Employees understand the consequences of their actions on others. This causes stress, and employee burnout is often high.

Mass production systems are less likely to result in employee burnout because decisions and control rest with upper management, and because inventories build slack into the system. If there is a problem at a workstation, the next station has sufficient inventory available to keep working. The responsibility of shutting the assembly line is with the supervisor and not the worker. Many workers prefer this less stressful work environment.

Exhibit 11
Mass versus Lean—Behavioral Attributes

Mass	*Lean*
Assumptions	*Assumptions*
1. Strong control of workers, suppliers	1. Empowered responsible workers, suppliers
2. Individual accountability	2. Team responsibility
3. Monetary motivation	3. Multiple motivational factors
4. Accountant as control agent	4. Accountant as team player
Consequences	*Consequences*
1. Quality problems	1. Quality commitment
2. Local optimization	2. Global optimization
3. Less employee burnout	3. Pressure and employee burnout

▲ CULTURAL ATTRIBUTES—MASS AND LEAN MANAGEMENT ACCOUNTING SYSTEMS

Mass and lean production systems represent fundamentally different cultural values, beliefs, mindsets, and power relationships. Consequently the management accounting systems that support these production methods reflect these differences. Often cultural assumptions are accepted without questioning or even explicitly recognizing their existence. These assumptions become part of the shared framework that organizations and societies use to think about accounting systems.

Key Point

When accounting methods have been in use for a long time, the embedded cultural assumptions often become so ingrained that organizations and societies take these for granted.

The rise of mass production occurred in an era when the economy was expanding, and consumers desired low cost, mass produced goods such as cars, televisions, telephones, and washers. Accounting systems developed during this era typically reflected the cultural values of individual responsibility, competition and market efficiency, pro-capital and management bias, and hierarchical power relations. Lean production developed after World War II, in Japan, where the economy was weak and capital limited. The hierarchical power of the emperor had been shaken by world events. Economic success for the nation depended on pooling resources and joint problem solving. The accounting system developed for lean production focused on cultural beliefs in teamwork, cooperation, common benefit of all participants, as well as knowledge based power.

Individual responsibility versus team responsibility.
A fundamental characteristic of Western culture, particularly in the United States, has always been individual responsibility and accountability. Consider, for example, one of the most enduring symbols of U.S. culture—western movies. The major image in most minds is of John Wayne, a rugged individualist, riding out alone to eliminate the bad guys.[7]

[7] It is interesting to note that the only western movie in which a team cleaned a town of bad guys was "The Magnificent Seven." This was a remake of the Japanese film "The Seven Samurai."

Accounting systems reflect this cultural belief in individual responsibility; individuals take charge and get things done. Budgeting for individual departments, setting standards for specific individual tasks, and holding individuals and departments accountable for results reflects this belief.

Lean production systems are built on teamwork and reflect a cultural belief that individuals working together are better problem solvers. They have more ways of viewing issues, and are more likely to generate nontraditional solutions than individuals working alone. Accounting systems of lean producers should reflect these beliefs when joint efforts of cell members are measured and reported. Standards are established for costs of a process, which involves tasks by many individuals. Rewards are often based on the joint performance of all production workers. As organizations become more team oriented, accounting systems have to be modified to support this cultural change.

Competition and market efficiency versus cooperation.
Mass production accounting systems reflect a strong belief that competition is healthy, and markets assure that capital flows to the most efficient and effective producers. Accounting measures encourage individuals and departments to compete, rather than cooperate. Often the prices at which one department will "sell" its output to another department are based on market price and each subunit is measured by its own profits. Capital investments are made in departments and units which yield a high return compared to other units of the same organization. This competition is viewed as healthy and will eliminate those too weak to survive in business.

Lean production accounting systems reflect a belief that cooperation is better for achieving results than competition. The cooperation that is expected includes not only cooperation inside departments, but also extends to suppliers, dealers, and others in the value chain. Accounting systems present information about sales, costs, and production schedules throughout the organization and share this information with "outsiders" who are part of the organization's cooperative network *(Keirtzu).*

Pro-capital and management versus common good.
Mass production accounting systems privilege the rights of capital and top management and provide those groups with more information and protect their privacy rights. Reports generated shows profits earned accruing to capital owners. Managers are often offered a percent of profits in bonus arrangements. Workers are often treated as "variable costs" which can be eliminated during business downturns.

Lean production accounting systems share information across impacted groups. This works when cultural beliefs support working together for the common good of the group. Work processes, requiring cooperative relationships, guarantee a fair sharing of rewards with all. Suppliers are not squeezed, but are guaranteed adequate returns on parts supplied. Workers are often guaranteed life time employment. Rewards from working for the common good of the group are shared.

Hierarchical versus knowledge based power.
In a mass accounting system, power rests with upper and middle management. They control the organization, determine performance standards, and have access to the information needed to enforce this control. This kind of system works best in cultures which believe strongly in hierarchical control structures.

The culture of a lean production system is quite different. The locus of power is increasingly with the knowledgable worker who can manipulate information and technology. Top management remains in control, but yields it to those whose command of technology

Exhibit 12
Mass versus Lean—Cultural Attributes

Mass	*Lean*
Beliefs and Values	*Beliefs and Values*
1. Individual responsibility	1. Team responsibility
2. Competition and market efficiency	2. Cooperation
3. Pro-capital and management	3. Work for common good
4. Managerial power	4. Knowledge based power

and information allow them to solve problems for the organization. This system works best in cultures which respect knowledge and problem solving talent.

Exhibit 12 lists some of the beliefs, values, and mindsets that are often encountered in the two systems. The characterization of these as due entirely to the culture of mass or lean production methods is a significant overstatement. It may be appropriate to think of the items described as resulting from mass production as the cultural values embedded in traditional accounting systems and those resulting from lean production as the cultural values embedded in a modern accounting system.

▲ LESSONS LEARNED

Some of the key lessons learned from this module are:

- ▲ The economic, technological, cultural, and political factors in a society influence a firm's choice of how to compete on quality, cost, and time.
- ▲ A firm's decisions about how to compete influences the way it uses factors of production and organizes work processes.
- ▲ A change in structure and process of the production method can lead to a fundamentally different cost structure for a firm. An existing production model's cost structure is reflected in the accounting reports.
- ▲ A management accounting system is shaped by the production process it supports. Managers need to understand this or they will be limited in their thinking about available alternatives.
- ▲ To be effective, a management accounting system's technical, behavioral, and cultural attributes must fit the needs of the production process in place.

▲ SOLUTION—COST WHEN PRODUCTION VOLUME IS 100,000 UNITS

Calculations should have yielded the following:

Costs incurred proportionally (or almost) on a unit basis:

Paper	.2885	
Ink and cleaners	.0961	
Pressroom	.2885	(approximately, this is not exactly proportional)
Subtotal	.6731	per unit

Costs incurred to support production in total:

Labor cost, subtotal	$25,000,000	
Less pressroom	9,000,000	(these were incurred on a per unit basis)
Subtotal, labor	$16,000,000	
Other costs, subtotal	4,500,000	
	$20,500,000	divided by 5,200,000 issues/year = $3.94

Total magazine cost

Costs incurred proportionally	$0.6731
Costs incurred to support production	3.9400
Total per unit magazine cost	$4.6131

Given the existing cost structure, producing 100,000 magazines per week would drive the cost up to $4.6131 per unit. This is a very simplistic assumption, because with such a large reduction in production (from 600,000 to 100,000 magazines), management would find ways to reduce the costs incurred to support total production. However, these reductions will not be the same as the reduction in volume. That is, the reductions are unlikely to be one-eighth of $20,500,000.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

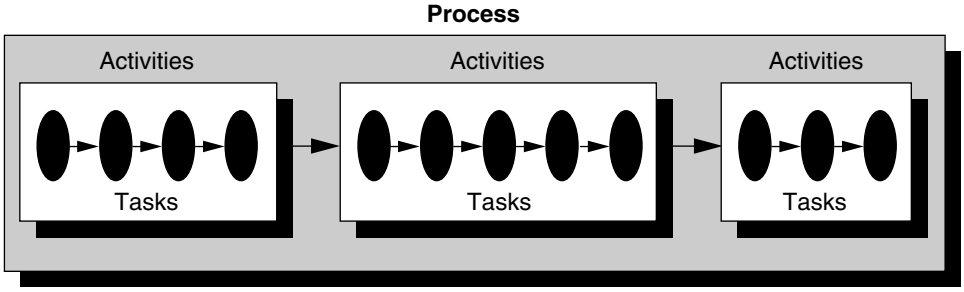
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. What is a production process?
b. Through an example, illustrate how an information system may provide information that is technically correct but not decision relevant.
c. What are the determinants of cost structures and management accounting systems?
d. Environmental factors are critical in determining how a firm chooses to compete and what production methods it uses. List three major *resource factors* and three major *environmental factors* that influence a company's QCT and production choices.
e. List three key factors that helped make mass production the primary production method in the world by the 1950s.
f. Provide a brief explanation of the craft, mass, and lean production processes.
g. List three major environmental factors that influenced the development of lean production methods.
h. What structural differences exist between mass and lean production?
i. What work process differences exist between mass and lean production?
j. Identify three reasons why volume lowers cost in a mass production environment.
k. Why is volume less important in a lean production environment?
l. Summarize the four key differences in accounting systems between mass and lean production.
m. List three differences in the decision focus of mass and lean production systems.
n. Identify three differences in the behavioral assumptions made by mass producers and lean producers.
o. List two behavioral consequences of an accounting system built on a lean production model.
p. What types of dysfunctional behaviors may a mass production system encourage?
q. How can a lean production system help overcome the behaviors identified in item (p)?
r. Does a mass production system have to involve these behaviors?
s. What is one of the most serious negative impacts of a lean production system?
t. What is a natural consequence of an accounting system that has been in use for a long period of time?
u. Why is making a change to lean production so difficult?

2. In a mass production automobile facility, aisles are crammed with repairers, housekeepers, and inventory runners. There are piles of inventory next to each station. Work is not evenly divided, and problems exist with defective parts. A large area is set aside for cars with defects. In a lean production facility there is almost no one in the narrow aisles. There is no room for extra inventory around work stations and less than one hour worth of inventory is available in the plant. There is no rework area.

Required:

a. Discuss the reasons behind these differences.
b. Discuss how these differences impact the cost structure at each of the two plants.

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* A number of problems and cases for this module were contributed by Reba Cunningham of the University of Texas at Dallas.

3. For each of the following production methods, identify a product which would be produced using the method and explain why the method makes the most sense for this product: (a) craft production, (b) mass production, (c) lean production.

4. A company rents a machine for $500,000 a year. The machine produces a standard product that requires $5 of material per unit and one hour of direct labor. The company currently pays $12 an hour for labor (including benefits).

Required:

a. What is the total cost incurred if the company produces and sells 25,000 units? 35,000 units?
b. What is the cost per unit at the two volumes?

5. Identify three important environmental factors that would influence the types of organizations listed below to move toward a lean production system. Explain how these factors influence the strategic quality, cost, and time choices the firm makes.

a. An independent clothing manufacturer that contracts to make a variety of national and regional brands.
b. A claims process function in a large national health insurance company that must deal with widely varying legal and local requirements.

Required:

a. An independent clothing manufacturer.
b. A claims process function in a large national health insurance company.

6. For more than 50 years after telephones were introduced, almost every telephone in the United States was black, used a rotary dial, and came in only a few styles. Today telephones are available in almost any size, shape, and color. Most use touch tone dial systems but rotary dials are still available.

Required:

a. What type of production system was best suited for production of primarily black rotary telephones? Why?
b. Is that same production system appropriate for producing telephones today? Why?
c. List some of the changes in quality, cost, and time strategies that a telephone producer faces in today's environment.

7. Identify the production process for which the following management accounting information techniques are most commonly used.

Required:

a. Relationship of volume to cost.
b. Value chain focus.
c. Inventory costing focus.
d. Indirect cost allocations.
e. Indirect cost driver analysis.
f. Responsibility center focus.

8. Consider the following products or types of organizations and indicate whether it is likely that craft, mass, or lean production method is used to produce output.

Required:

a. Passport office.
b. Soda pop bottler.
c. A cake bakery that produces specialty cakes.
d. Contract clothing manufacturer.
e. Manufacturer of detergent.
f. Manufacturer of collectable quality porcelain plates.
g. Fruit punch manufacturer.
h. Organic vegetable farm.
i. Publication of this modular text series that you are using.
j. Leaded crystal stemware.
k. Nascar racing car.

9. The PlastiGlass Company has to replace the equipment it is currently using to make its 14-ounce plastic drink glass. The firm identified two alternative ways of producing these glasses. The first option is to buy a $2 million dollar machine that can produce eight million, 14-ounce glasses a year. This machine will last four years and require two equipment operators at an annual cost of $60,000 a year for each. The second option is to lease four machines at a yearly cost of $150,000 a machine. Each of these machines requires one $40,000 a year operator and can make two million, 14-ounce glasses a year. The company is currently making seven million plastic glasses. Assume material and other costs are the same under either option. (Ignore taxes and time value of money.)

Required:

a. Based on the above information, which of these options results in a lower cost per unit for the glasses?
b. Assume the company sees an opportunity to enter the market with several different size and color plastic glasses. Would this influence the choice of equipment to purchase? Why?

10. Accounting reports (see Exhibit 8) at *Sports Action* show the importance of labor under the existing production system. Assume that Sarah Green asked the accounting group to study the effects on cost, quality, and time that moving production operations to a low wage country might have on the company. This step recently was taken by several other magazines. You are the individual designated to prepare this report. For calculation purposes assume that an equivalent overseas labor force would be paid only 40 percent of what *Sports Action* is paying workers in the United States. Assume a volume of 800,000 magazines a week.

Required:

a. Calculate the new cost per magazine assuming no other cost or process changes except those related to labor.
b. What other costs would you expect to change with the shift of production to another country? Why?
c. How do the cost savings of shifting labor overseas compare to the cost savings associated with a shift to lean production?

d. Suggest some ways that changing the production location might affect the quality of the magazine. In your response consider factors associated with production, such as typesetters, suppliers, and others.
e. Suggest some ways that this change in production location may influence how the magazine competes on time.
f. Identify some of the behavioral and cultural issues that *Sports Action* would need to consider in choosing between a lean production approach and shifting labor overseas.
g. If the competitive threat of custom editions did not exist, but cost pressure was severe, what actions would you recommend to further reduce costs? Explain.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

11. The NPSC is a not-for-profit agency established by a city to provide transportation for senior citizens in a large suburb of a major metropolitan area. City leaders recruited a retired bus company executive to head NPSC. The city also has a grant writing expert working closely with NPSC.

NPSC uses three, 40-passenger buses that continually circle on a 20-mile fixed route. Buses stop at major shopping centers, hospitals, and other locations senior citizens frequently use. A bus covers the route once each hour. NPSC executives feel that frequent service is important to keeping ridership high and making the bus operation economical. Working with the grant writer they were able to get a new grant to acquire a fourth, 40-passenger bus costing $100,000. This allows the buses to provide service every 15 minutes rather than every 20 minutes. Bus service is available 10 hours each day.

The NPSC accounting report shows that these buses have operating costs that average $1 a mile (excluding the acquisition cost but including repairs, driver's salary, fuel, insurance, etc.). The executive team is quite concerned because the addition of the fourth bus increased the total average ridership only slightly, from 30 people an hour to 32 people an hour. This is a major issue because a stipulation in the new grant requires NPSC to cover at least one-half of the total (four buses) operating costs with rider fees, which are currently $1 per ride. Failure to satisfy this requirement would require the agency to return the grant money.

Required:

a. How much must NPSC charge to avoid returning the grant money if the ridership remains at the current level? What are the possible impacts of the change in fee?
b. Explain why the accounting reports use an average per mile charge. Do miles driven drive costs in this situation?
c. Do you believe the accounting system for NPSC provides adequate information for making stategic decisions regarding pricing, changing routes, and investing in equipment? Explain briefly.
d. What options are available for the NPSC under its current cost structure? Describe and discuss your ideas.

12. Refer to problem 11. At a recent NPSC advisory board meeting, a senior advocacy group argued that fixed bus routes do not adequately serve a large portion of the senior population. This group suggested that NPSC use only three buses on the fixed route and use the fourth bus to provide door-to-door transportation for individual riders at a cost of $4 a ride. Door-to-door service would only be offered 5 days a week.

To provide this service the NPSC would need a scheduling service. A schedule maker would cost $500 per week. Many seniors would establish standing ride appointments, such as for regular visits to the doctor or for shopping trips. Others would call the day before a ride is needed. The advocacy group provided the NPCS advisory board with a study showing that the bus would travel an average of five miles for each rider and could provide service for six passengers an hour. While this would not be sufficient to meet anticipated demand, the group argued that limited service would be better than no door-to-door service.

Required:

a. Is this a feasible alternative for NPSC at this time? Explain why with both numbers and commentary on the strategic QCT decisions facing the firm.

b. Given the purpose of the NPSC, why might the executive team not have considered providing door-to-door service? Assume for this answer that the cost analysis (part a) shows that this option is feasible. (Hint: for your discussion consider factors related to mass production discussed in the module text.)

c. Discuss some of the environmental factors that may influence the ability of NPSC to provide improved transportation service.

d. Assume that NPSC decides to provide seniors with appointment driven transportation. It is considering using a fleet of minivans that cost $25,000 each. Identify specific structural and work process differences that would exist using minivans compared to a 40-passenger bus. What are some of the cost structure differences?

e. Discuss some of the cultural and behavioral changes that would probably occur at NPSC if it provides door-to-door transportation.

13. The Pill Box Company makes a wide variety of over-the-counter and prescription drugs. MiniCap daily vitamins is one of its basic products. This product has remained unchanged for the past decade, and the firm anticipates that demand will remain in the hundreds of millions worldwide for the foreseeable future. The Pill Box Company has dedicated production cells that make nothing but MiniCaps. The equipment could easily make other types of pills with some minor modifications and simple setups, but the firm sees no immediate need for changes in the equipment. The equipment on a typical MiniCap line costs the firm $900,000 and lasts for six years. Expenses relating to maintaining and operating the equipment average about $200,000 a year.

A traditional production cell requires five workers. Each worker gets two 10-minute breaks and a 40-minute lunch. A relief worker, who earns $14 an hour and is trained on each production cell function, takes the regular worker's place during these breaks. (This means a relief worker is in a production cell five hours each shift.) There are four different wage scales associated with regular cell employees. A materials loader earns $10 an hour, an operator earns $11, two visual inspectors each earn $8, and a product loader earns $7. The material loader gets the necessary materials from a nearby materials feed area that serves eight identical production cells and feeds it into the machine. The operator makes certain the machine is working properly. The visual inspectors use powerful magnification devices to scan rows of pills for leaks that become visible on special paper. The product loader makes certain that pills are bottled properly and periodically test counts the vitamins in a bottle. Each production cell is expected to produce a predetermined amount of pills. Accounting reports carefully track costs associated with each cell and each type of worker.

A new labor agreement initiated by a group of production workers allows the company to operate each machine cell with only the five workers, each cross trained to do every job in the production cell. This means that the firm no longer uses a relief worker as part of the production process. Instead every worker in the cell rotates and is paid a $10 an hour wage. In addition they receive a bonus based on production levels and quality. This bonus is expected to average $1 an hour per worker. As part of the new contract, workers have been guaranteed a life-time employment contract.

Required:

a. Is this new approach more or less costly? Support your answer with calculations.
b. Assume (without regard to your answer in part a) that the cost is higher. Why would Pill Box accept this new arrangement?
c. Discuss the types of environmental changes that might make such a shift in production feasible.
d. How would the production change affect the accounting information that the company accumulates? Explain.
e. What are the quality and time implications implicit in this type of change?
f. What are the behavioral and cultural implications of this type of change in the production process?

14. Spiral Consulting has an aggressive training program for the entire consulting staff. The objective of this training is to make certain that there is a solid understanding of the client's strategy and competitive environment. Consultants are trained to specifically identify what quality, cost, and time means to each client, and consider not only technical needs for information but also its behavioral and cultural uses. Two situations that the firm is considering including in training sessions on production methods follow.

Situation 1

The company manager in an old-line manufacturing company recently bought equipment that has limited flexibility but can make large traffic sign bolts very efficiently. The manager explicitly rejected a suggestion, made by a young Spiral consultant, that the company buy several smaller flexible pieces of equipment. Smaller flexible pieces of equipment can make the same quality of large traffic sign bolts, but also can make other types of bolts. The manager's comment was, "Doesn't that idiot consultant understand that my equipment is cheaper to buy and cheaper to run?"

Required:

a. Discuss why the manager may be correct in making the decision to buy the large, inflexible equipment.
b. Assume the manager's decision is not correct. Discuss why the manager may make this incorrect decision.
c. How does the decision to buy the large, inflexible equipment influence the firm in future periods?
d. What would be the impact of a sudden technology change that modified how signs are attached?

Situation 2

A company that is using all of the leading edge management tools and production methods in assembly plants throughout North America recently acquired a plant in Western Europe.

The purchased plant currently operates as a mass production facility. The plant's existing union contract severely limits the ability of management to shift workers to different functions, require overtime, or lay off unneeded employees. The plant, along with many others in this European country, also shuts down for holiday three weeks each summer. Currently the plant assembles large quantities of five standard telecommunication products. However, the market for products in this area will fragment as the level of global competition increases.

Required:

a. Identify some difficulties the acquiring company may have in converting the new plant to a lean manufacturing environment.
b. Assume that you determine a conversion is essential. Develop a strategy to make the conversion from mass to lean production.

15. Outside or Team Project. Visit a local company, explain its products and markets, and diagram its production process. Summarize the strategic choices that cause the firm to use its production method. Describe how the production process is suitable (or unsuitable) to the firm's environment. Have key environmental factors changed and created a need for a change in the production process?

Case 1: Ingot Can Company.

Part I

Ingot Can Company manufactures a variety of steel cans. These include 16-ounce cans, 28-ounce cans, large institutional-size cans, small 5-ounce (individual serving size) cans, and other odd-size cans. For decades the 16- and 28-ounce sizes were the most popular. Larger institutional sizes and small five-ounce cans were a distant third and fourth in demand. There is also a much smaller demand for odd-size cans.

The manufacturing process is highly automated but fairly low tech. The cans begin as steel sheets. Production equipment cuts and rolls the sheet steel into cylinders and seals the side seam and one end. The cans are then packaged with the material cut to seal the can entirely. The final sealing step, of course, is done after a cannery fills the can.

Specialists manually adjust equipment whenever there is a change in the can size the line makes. As part of the adjustment process several test batches of unusable cans are produced. These cans are sealed at both ends to insure that the equipment produces the proper size. Each set of tests uses about $2,000 worth of material and an average of two hours and 24 minutes (2.4 hours). Salaries for the specialists are $25 an hour. The processing equipment owned by Ingot is old but very functional. The equipment is fully depreciated, but Ingot incurs significant maintenance costs that average $150,000 a month. Utilities and insurance on the plant are running at $600,000 per month.

Production reports show that Ingot produces 16-ounce and 28-ounce size cans in continuous runs of 800,000 cases using parallel production lines. Each line has a capacity of 150,000 cases of cans per day. Ingot produces the smaller cans, institutional-size cans, and odd-size cans on the same production lines. Each size other than the 16- and 28-ounce sizes are produced only once per month.

Each production line averages three million cases a month working 24 hours a day, seven days a week. Five-sixths of the total production of three million cases (on each line) is for 16- and 28-ounce size cans. The average setups per month on each production line is 10. The table below shows a partial analysis of the average cost per 100,000 cases.

Material cost, excluding setup, is constant at $117,000 per 100,000 cases for each different size of can because the number of cans per case varies.

Cost Category	Cost per 100,000 Cases
Materials	
Steel	$115,000
Coating	2,000
Material subtotal	117,000
Labor	
Supervisors	$10,800
Operators	14,400
Packers	15,600
Warehouse	18,800
Janitorial salaries	7,200
Labor subtotal	66,800
Maintenance	?
Utilities and insurance	?
Other supplies	36,000
Subtotal other production costs	?
Total costs	?

Required:

a. Diagram the production process for the existing can production line.

b. Identify what costs and resources logically relate to each of the steps in the production flow process. What drives the costs identified and why do you think this is the cost driver for that cost?

c. What is the average cost per case assuming that maintenance, setup, and similar costs are spread evenly to each 100,000 cases? Show computations. (Hint: Find any missing amounts from the problem facts.)

d. Compute the total cost per case for a 20,000 can production run.

e. Assume management considered the cost of producing 20,000 cans too high (based on part d). What actions would management be likely to take (given the information available from your analysis)?

Part II

Refer to the data in Part I of this case. As growing numbers of elderly persons live alone and young people remain single longer or do less cooking, food packaging demands change. As a result, Ingot is receiving purchase orders for a wider variety of can sizes. Marketing estimates that customers will want food in 40 different can sizes within two years and that the demand for some sizes will be as low as 10,000 cases a month. The demand for the five ounce, one-serving size can should reach 1.5 million cases a month by next year, an increase of 1.2 million cases over historic order levels. This growth, along with the increasing number of sizes, cuts into production time available for standard sizes. Marketing expects demand for 16- and 28-ounce cans to decline and then level out at two million cases a month (for each size). Orders for the 37 other can sizes should total 800,000 cases a month.

Management is considering three options for reacting to this change in the market. Option 1 is making all the cans on the existing production lines. Any breakdowns would

make it difficult to fill anticipated orders so preventive maintenance costs would increase by $6,000 a month. Options 2 and 3 both require Ingot to set up a third production line (with the same capacity as the old lines) to accommodate the growth in single serving five-ounce cans and to help produce the growing variety of additional can sizes. Option 2 is to lease a machine like the existing ones at a cost of $14,000 a month, including maintenance. This would allow Ingot to schedule production over three, rather than two, can production lines.

Option 3 is to lease flexible equipment that allows quick and simple switches in can sizes. The lease cost is $30,000 a month (with maintenance) but this would reduce setup labor cost by 90 percent and the time needed for a setup to 10 minutes. There would also be no need to run test batches of the new cans. No additional supervisors are needed with the flexible equipment because it requires only half the current operator time and only one third of the packaging personnel. The flexible equipment would also allow Ingot to pack and immediately ship an order, eliminating the need for any additional warehousing space.

Required:

a. Which option has the lowest cost per 100,000 cases? Explain your assumptions about what drives the costs and show your computations. (Hint: You might find it helpful to diagram the process implied by your assumptions.)
b. Are there additional options that the firm might consider? Explain.
c. How would the production method choice influence the strategic cost, quality, and time choices that Ingot could make?
d. What type of structural and work process changes would you expect to occur if Ingot leases the flexible equipment? Explain.
e. What behavioral and/or cultural consequences are likely to occur if Ingot leases the flexible equipment and shifts to a different production process? Explain.

Case 2: Freedom Jeans Inc.

Freedom Jeans is a major manufacturer of medium to high quality jeans for men, women, and children. These products are sold in department stores throughout the U.S. While Freedom Jeans enjoyed success for many years, its share of the jean market and its profits have been sliding in recent years due to increased pressure from overseas suppliers. Foreign jeans are of the same quality and are sold at a price approximately 25 percent below Freedom Jeans' price.

Until five years ago, Freedom Jeans had a policy of not selling its products through discount outlets. Because of the cost of reworking poor quality products and carrying excess inventory of overstocked items, the company established outlet stores in several discount outlet malls throughout the country. With the recession and constant "sales" in normal department stores, these outlets have not enjoyed the profitability which was originally envisioned.

Manufacturing process.

The manufacturing of Freedom Jeans is much the same as it has been for the last 40 years. Each factory keeps one month's supply of raw material on hand at all times. The factories each have a warehouse which houses jean fabric, buttons, zippers, thread, and so on as well as finished products. An average factory would have approximately 50,000 yards of jean fabric on hand at any time.

Raw materials are purchased by reviewing the master production budget for the upcoming month (updated quarterly) and comparing raw materials needed for budgeted production (determined by the bill of materials) with the existing supply of raw materials. This comparison requires the purchasing department manager to physically visit the warehouse and check supplies of materials with the warehouse personnel. Items to be purchased are noted and passed to a purchasing agent to select a vendor and place a purchase order.

When items appear on the production schedule, fabric, zippers, and fasteners are requisitioned from the warehouse with a one week lead time. These items are delivered to the cutting area of the factory, where the fabric is cut in layers of 100 with a mechanical cutting knife. Batches of 500 of each pattern are cut before the pattern size is changed. The cutting area has a large holding space for the other raw materials (zippers, fasteners) which are temporarily held and then moved to the appropriate areas by factory material handlers.

After cutting, the fronts and backs go to two separate sewing areas where pockets are applied, then proceed to two rows of machines where the two halves of the front or the two halves of the back are sewn together. The fronts then proceed to an area where zippers or other fasteners are attached, while the backs wait in stacks in a temporary storage area in sewing. Finally the fronts and backs are transported to sequential sewing lines and sewn together, waistbands and loops are attached, and hemming is done. Some jeans require additional steps which involve trimming or topstitching.

Each time an item is completed through a process, it is stacked beside the operator's machine for collection in bundles of a specified quantity (e.g., 10 pairs). When the items are moved by the materials handlers, each direct laborer is given a ticket for each bundle collected. The tickets are turned in at the end of the day by the worker to indicate the quantity completed for an incentive pay scheme. Bundles not collected by the end of the day or incomplete bundles stay at the worker's station until the subsequent day and are counted in the next day's production quota.

When completed in the sewing areas, the jeans move to a packing area where they are inspected for quality, steam pressed and folded, and placed in storage boxes suitable for shipment. The items which are rejected are marked as seconds, occasionally reworked, or scrapped as necessary. (Reworking at this stage is generally too costly.) Tickets handed in by workers in the packing area indicate the quantity of boxes packed as well as size, style number, and quality. Material handlers move the boxed jeans to the finished goods warehouse to be held until sold. Seconds or items which do not turn over in one year are shipped to the company's outlet stores.

A rate is established for each factory task indicating how many bundles should be produced or boxes should be packed in the day to earn minimum wage. Quantities over the established rate yield increased pay with a scale which rewards increasing output. For example, if a person sewing in zippers is supposed to produce five bundles of 10 in an eight hour shift to earn $4.25 an hour, then the incentive system might look like:

5 bundles	@.68/pair	$34.00/day
6 bundles	@.70/pair	42.00/day
7 bundles	@.75/pair	52.50/day
8 bundles	@.82/pair	65.50/day

Supervisors pass through assigned portions of the factory overseeing sewing, materials movement, packing, and machine downtime. They spot-inspect stacks of completed products at work stations as they pass through each area. If they notice a defect, they require the workers to correct the problem if it originated in their assigned area. If it did not, they may return it to the supervisor of the prior process. (They have no real incentive

to do this, and often an item that is defective continues through the factory receiving additional processing.)

In the event that a machine is malfunctioning, a supervisor can authorize machine repairs, and determine whether the employee waits (downtime) or is sent home while the machine is repaired. Because of the cost of the machines, workers are not allowed to repair or maintain them, although almost all workers secretly do simple tasks like adjusting tension and cleaning lint. When demand for the product is down, the factory is shut down and laborers are laid off. During this period most maintenance is performed. This traditionally occurs every January and February.

Factories are specialized; that is, only certain style numbers carried by the organization are produced. This practice was initiated to allow the use of specialized machinery and minimally trained employees thereby lessening overall production costs. Over the years, the customers' demand for different styles has increased and each factory has had to increase the number of styles it can produce.

To overcome the problems of increased variety, a factory dedicates itself to one style number (and produces various sizes of the style) at a time. In fact, some factory managers produce the entire yearly budgeted demand for a given jean style before converting to a new style. The run of a style is costed as a batch and factory managers count on producing large volumes to drive the unit cost of the product down. The factory manager is primarily rewarded on minimizing these product costs.

Because factories produce only a limited variety of styles, shipments are virtually made to locations throughout the U.S. from each factory. This makes delivery times as long as 10 days to some locations and makes delivery a significant cost component. This cost is not directly attributed to the factory however, but accumulated at corporate and allocated to all factories based on sales.

Cost accounting system.

The existing cost accounting system was developed by the original controller, whose background included experience as an auditor in a international accounting firm. Accordingly, the external reporting requirements of the organization greatly influenced the cost system's design. As the current controller described it:

". . . our system focuses on determining accurate cost of raw materials, work-in-process and finished goods inventories per generally accepted accounting principles for reliable reporting to our shareholders. For cost control in our factories, we use standard costing for materials, labor, and overhead."

Corporate headquarters books and assigns sales to the appropriate factory. Corporate-wide costs are allocated to factories based on sales or headcount. While each factory measures profits, factory managers are held responsible for achieving standard costs for products.

Standards are established for materials and labor price and quantity. Budgeted factory overhead is assigned to the major areas of the factory and applied to the product based on standard direct labor or machine hours. This year's budgeted volume included in the master production budget is used to develop the overhead rate. A weekly factory variance report for materials and labor and a monthly overhead variance report are reviewed by headquarters. Standards are revised annually, and hence there is not a material difference between actual inventory costs and standard costs. Any differences (variances) are closed to cost of goods sold.

A perpetual inventory of raw material and finished goods is maintained by each factory. An accounting clerk updates a computerized database by inputting multiple manual

records (e.g., requisitions, receiving reports, work tickets, and shipping documents). Frequently the physical count reveals differences between the physical and book inventory. While some of this may be due to theft, the controller believes that the larger portion is due to inaccuracies in manual records used to update the database.

The work-in-process inventory must be determined by physical count or estimated at each reporting period. Because of the many locations in a factory where it is kept, counting the inventory requires many man-hours. When the inventory is counted, it is considered a time for general cleaning of the factory as well, since partially completed units and raw materials are stacked in locations beside each work area at all other times.

Management's strategy.

Because of pressure from competition, the management of Freedom Jeans concluded they must rethink their product and processes. After a lengthy strategic planning session, management decided that to compete in the future, they must go beyond the traditional focus on production cost. They feel it will be necessary to focus on cost, quality, and customer desires simultaneously. Further, they want to implement concepts from "lean" production. They recently hired a new corporate controller who had experience in his previous job with just-in-time inventory and redesigned factory work flows resulting in economical, high quality, small batch sizes.

In addition, the marketing vice president has been pushing for adding a "custom" jeans product line. He recently attended a trade association show where a pattern software program was demonstrated. Requiring only a microcomputer, a person's key measurements can be input into the program along with the desired style of jeans. The program generates a pattern which can then be used to manufacture the jeans. The program's developer indicated that in a lean production environment, lot sizes of one were being economically produced by other manufacturers of clothing.

The company has decided to convert one factory in Atlanta to lean production and learn from the implementation before carrying the techniques to all locations. That site was selected because its plant manager volunteered. He has just completed his MBA degree and learned quite a bit about principles of lean production that he thinks would apply to this situation.

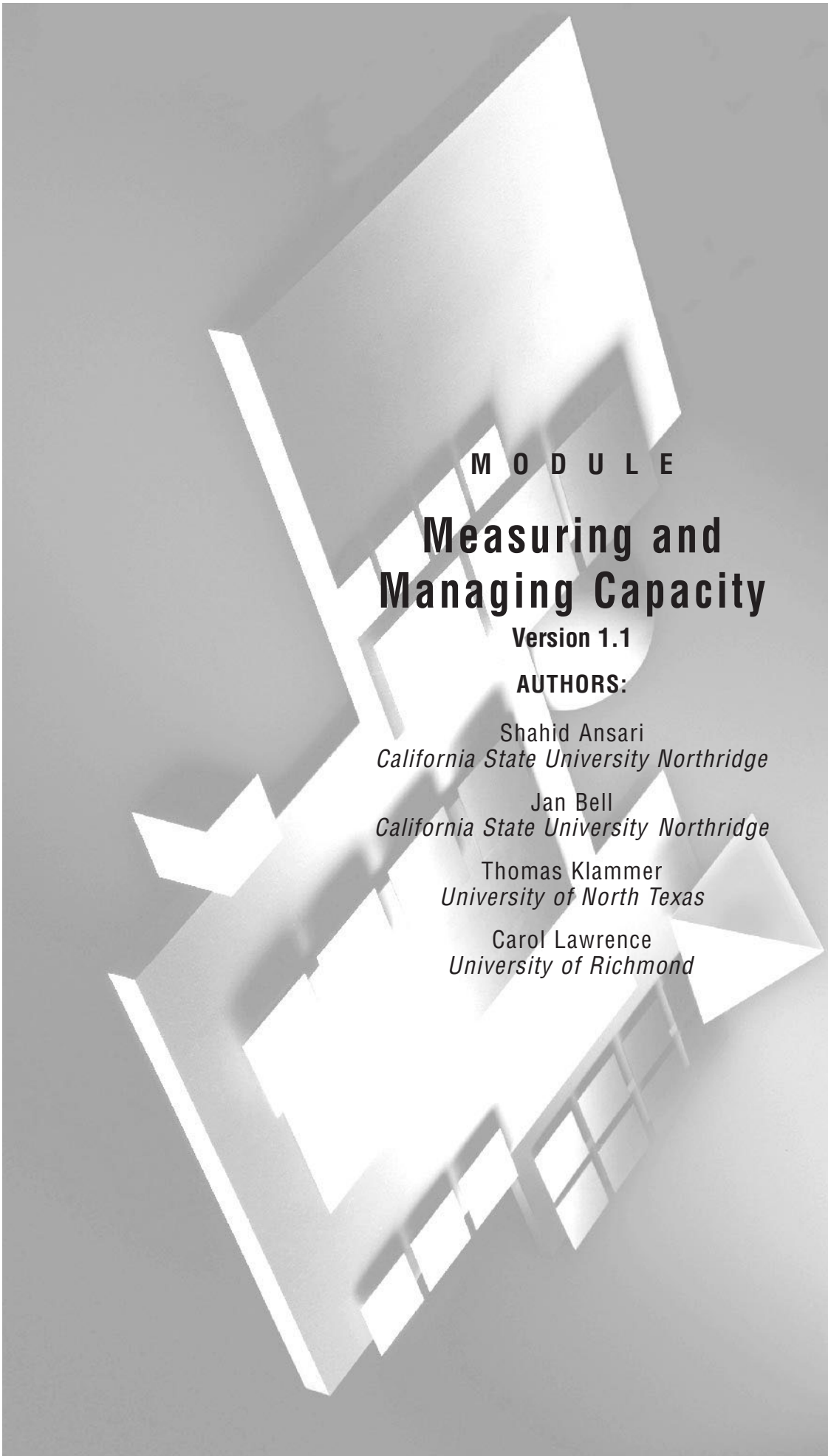
In addition, after further researching the pattern software program and the claims of its developer, management has agreed to test the custom jean line with all store locations of one of the company's major customers (a large well-known department store) in the Atlanta area. The department store's management is excited about the exclusive relationship with Freedom Jeans and the potential market for the product. They feel that fast turnaround and reliable sizing are extremely important to marketability. Accordingly, they want their own store personnel to input orders (including the customer's measurements) for the product directly into a Freedom Jeans' computer. Further, the department store's management feels that a week delivery time and a price around $50–60 a pair would enhance product sales.

Required:

a. Diagram the production process for Freedom Jeans.
b. Identify which mass production characteristics Freedom Jeans has and discuss why each one arose.
c. What problems do you identify in Freedom Jeans?
d. Prepare a brief memo outlining how lean manufacturing might solve the problems identified at Freedom Jeans.

e. What changes will be necessary if lean production methods are applied?
f. Diagram a proposed lean manufacturing process for Freedom and discuss its characteristics.
g. Describe briefly how you would change the accounting system to support the changes needed to move from the traditional to a lean manufacturing environment.
h. What behavioral and cultural changes are needed to achieve the company's new goals? How can the company implement these changes?

NOTES



M O D U L E

Measuring and Managing Capacity

Version 1.1

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Measuring and Managing Capacity

Measuring and Management Capacity

RIDDING THE RED AT TEXAS INSTRUMENT

"When we are spending hundreds of millions of dollars building new wafer fab facilities the discovery that we have large amounts of nonproductive capacity is a real attention grabber! We need a capacity cost management system…that influences our ability to productively use capacity."

This statement was made by Alan Vercio, former operations finance strategy manager for the semiconductor group at Texas Instruments, during a recent discussion about why TI had played an active role in the development and field testing of a new capacity measurement and management model.

Like other semiconductor manufacturers, TI had responded to the strong demand for sophisticated computer chips in the 1980s and 1990s by investing in new wafer fab (chip making) facilities. Investments in new wafer fab capacity are extremely costly and often have a very short life.

"Unfortunately," continued Vercio, "when we tried to measure how we were using existing capacity, we found that our measures of capacity focused primarily on product costing and provided little operational information to management. Analysis of activities in TI's semiconductor group revealed that a significant amount of the firm's existing chip making capacity was being used ***nonproductively.*** This was our motivation to work with other companies to develop a better measure of capacity. Working together under the aegis of the Consortium for Advanced Manufacturing International (CAM-I), we developed a model (described later in the module) that is allowing us to define and measure capacity in our wafer fabs. We started a campaign to *get the red out* since red is the color the model uses for nonproductive uses of capacity. We believe that our new capacity measures will help us to better utilize capacity, improve communication between operations and finance people, and allow us to make better strategic decisions."

▲ STRATEGIC IMPLICATIONS OF CAPACITY MEASUREMENT

Capacity refers to the physical facilities, personnel, and processes available to meet the product or service needs of customers. It includes both in-house as well as supplier capabilities. Providing and maintaining capacity is costly for a firm. This makes it critical to understand the amount of capacity needed to execute strategy. A firm's available capacity influences its ability to compete on the three dimensions of quality, cost, and time (the strategic QCT triangle).

- ▲ **Quality.** A firm's investment in capacity influences how it can compete in terms of quality. Capacity measurement highlights the existence and types of capacity available to fulfill demands for product features. If TI's customers want chips with certain features (such as the ability to carry out multiple instructions at the same time) and greater reliability, then TI's capacity measurement system needs to

identify whether idle capacity is sufficient for producing chips according to those specifications.

- ▲ **Cost.** Capacity measures capture and reflect the impact of capacity decisions on a firm's cost structure. Investments in capacity create a *cost structure* that determines what can be produced cost effectively. If TI were to invest in a several hundred million dollar chip making plant (wafer fab) and then utilize only a portion of it, TI's production cost per chip is likely to be higher than those of other semiconductor manufacturers that utilize capacity fully.
- ▲ **Time.** Capacity affects how a firm can compete in terms of time. Measurement of output rates and available capacity helps managers understand what can be produced in a given time period. The capacity of TI's wafer fab facilities determines the speed with which the company can produce and market products. Machines with slower rate of output or less flexibility will increase time to market.

▲ PURPOSE OF THIS MODULE

This module describes two methods of measuring capacity and demonstrates how each helps in managing capacity. When you complete this module you should understand:

- ▲ The nature and types of capacity.
- ▲ Traditional ways of measuring and assigning capacity costs.
- ▲ A new approach to measuring capacity developed by CAM-I.[1]
- ▲ Technical, behavioral, and cultural attributes of capacity measures.
- ▲ Some of the practical complexities of implementing capacity measures in organizations.

▲ WHAT IS CAPACITY?

In everyday use, the term *capacity* refers to the ability of an object to contain, absorb, or hold. For example, the capacity of milk containers is defined by volume, such as one quart, one gallon, or two liters. *In a business context, capacity refers to the maximum output or producing ability of a machine, person, plant, division, or company.* A firm has adequate capacity when it has the ability to meet the product or service needs of customers. For example, assume that Sanderson Farms has a plant that can process 1.2 million chickens per week. If the demand is one million chickens per week, there is adequate capacity.

Four key ideas help in understanding capacity: (1) capacity is a physical measure; (2) capacity is a measure of a maximum amount; (3) capacity depends on the parameters of rate and time; and (4) capacity is costly.

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[1] CAM-I is short for Consortium for Advanced Manufacturing International. The material on the CAM-I model is based on *Capacity Measurement and Improvement: A Manager's Guide to Evaluating and Optimizing Capacity Productivity, The CAM-I Capacity Interest Group,* Thomas Klammer, editor; Irwin Professional Publishing, Chicago, 1996.

Capacity is a physical measure.
Boxes moved, gallons of gas, or number of hours worked per week are capacity measures expressed in physical terms. The information systems of most organizations provide a wide variety of physical measures of capacity.

Capacity includes a measure of a maximum amount per use or occurrence.
A typical Boeing 767-200 can carry 200 passengers per trip. This is the maximum output this airplane can produce on any given trip.

Measures of capacity depend on two parameters—rate and time.
Rate is the amount of activity or number of uses or occurrences that can happen in a given amount of time. A typical Boeing 767-200 travels at an average rate (ground speed equivalent) of 500 miles per hour. In terms of passengers, its rate is 100,000 passenger miles per hour (200 people $\times$ 500 miles). The Airbus Concorde carries 100 passengers but is capable of traveling at 1,000 miles per hour. Because the Concorde can transport a passenger twice as far in an hour or can make two trips within the same hour, its rate is also 100,000 passenger miles per hour (100 people $\times$ 1,000 miles) even though its seating capacity is half that of the 767.

Generically the following equation measures maximum capacity for a given time period:

$$C = R \times T$$

where

C = The physical measure of maximum output capability.
R = The maximum rate of output that can be produced in a unit of time.
T = The maximum time available.

Capacity has a cost.
Assume that an airplane is rented for $1,000,000 a year. The rent is only one part of the total capacity cost. Other capacity costs would include items such as the crew's salary and training, repairs and maintenance, and fuel.

▲ MEASURING AND ASSIGNING CAPACITY COST

To produce a product or service at a low cost and in a timely manner, an organization must measure and manage its physical and human resource capacity effectively. There are different approaches to measuring capacity. In this module, two different approaches to capacity measurement are demonstrated—**traditional** and **modern.** The traditional approach was originally developed for determining the cost of inventory in financial statements; CAM-I has developed the modern approach to capacity measurement.

To illustrate the two methods, the example of a robot that moves finished goods off Crunch Cereal's production line and places them in storage will be used.

Exhibit 1
Illustration—Crunch Cereal

Crunch Cereal Inc. makes a breakfast cereal for various grocery store chains. They use a robot to move cereal boxes from their filling line into storage. Crunch rents the robot at an annual cost of $600,000. Analysis shows how Crunch makes use of the robot during the year. This information is summarized below.

1. The robot can move 500 boxes an hour from the filling machine to the storage room.
2. Except for 21 holidays, the factory works 7 days a week, 24 hours a day.
3. Crunch does not use the robot for the equivalent of 19 days each year because of variability in production caused by the timing of suppliers' delivery and customer order pickups.
4. There is the equivalent of 10 days of waste because the boxes are spoiled or require rework.
5. The robot is shut down to change machine settings between products (setups) and for routine maintenance. These two activities shut down the robot for a total of 25 days each year.
6. During the next five years, Crunch expects sales to average 2,750,000 boxes each year.
7. Marketing has bid on a contract for cereal for a major grocery chain. If they are successful, sales would increase to 3,120,000 boxes a year. This would keep the robot busy 260 days each year.
8. The budgeted sales level for this year was 2,600,000 boxes. The actual sales level was 2,700,000 boxes. It took the robot 225 days to move the boxes sold.

How many different measures of capacity can you calculate for this robot? For each measure, what is the cost of the robot that should be charged to each box of cereal?

Traditional Ways of Measuring Capacity.

As previously mentioned, traditional measures of capacity were developed to help management spread common costs, such as the robot's rent, to determine inventory costs for external financial reporting. These measures were not designed as management tools. However, managers frequently use these financial capacity measures for internal performance measurement, particularly when comparing budget (planned) to actual costs.

The traditional model uses five categories or partitions in measuring capacity:

1. **Theoretical**
2. **Practical**
3. **Average**

4. **Budgeted**
5. **Actual**

*Theoretical (*also known as *ideal, maximum,* or *rated) capacity* is the maximum quantity of output a single piece of equipment, an equipment group, people, or a plant can process when operating continuously at peak efficiency. For Crunch Cereal it is the number of cereal boxes that the robot can move if it operates at peak efficiency. This measure makes no allowances for any problems in the production process. The $C = R \times T$ equation is an expression of theoretical capacity. Using the information in Exhibit 1 for Crunch Cereal, the robot's theoretical capacity is 4,380,000 boxes a year (500 boxes moved per hour $\times$ 24 hours $\times$ 365 days).

Practical capacity is the attainable level of output under current operating conditions. The practical capacity measure omits from theoretical capacity the limits on production imposed by the need for vacations, holidays, maintenance, setups, scheduling, and similar items. Practical capacity is always less than theoretical capacity. For the Crunch Cereal example the robot's practical capacity is 3,600,000 boxes a year. The robot is available 300 days a year (365 $-$ 21 holidays $-$ 19 standby days $-$ 25 setup and maintenance days $=$ 300) and could move 3,600,000 boxes (300 days $\times$ 500 boxes per hour $\times$ 24 hours $=$ 3,600,000).

*Normal (*sometimes referred to as *average) capacity* is the average production anticipated over several years for a piece of equipment or a factory. For example, consider the number of boxes that the robot is expected to move during the next five years. This measure is generally tied to the sales level. Crunch Cereal expects sales during the next five years to average 2,750,000 boxes. It is assumed this will be the number of boxes the robot successfully moves and thus is a measure of the normal capacity of the robot.

*Budget (*or *expected actual) capacity* is the production anticipated in the next period based on the sales forecast. For example, Crunch Cereal planned to sell and move 2.6 million boxes during this budget year. This is the budgeted capacity of the robot.

Actual capacity is the same as the actual production in a given period. It is the actual number of boxes moved in a given period. This information only becomes available after the fact. Actual information, for the current period, is not available for planning. Crunch Cereal's actual sales were 2,700,000 boxes, so the robot moved 2,700,000 boxes (assuming that production and sales are equal). This is their actual capacity.

Think Along

Can you think of how these measures of capacity might be applied to processes or people? What might be the capacity of a shipping clerk who processes only shipping orders and can process an order in 5 minutes?

Effect of Traditional Capacity Measures on Product Cost.

The primary use of the traditional model is to determine how much capacity cost to add to a product. From this product costing perspective, the key issue is, how much does it cost Crunch to move a box of cereal? Firms also use these traditional measures for valuing inventory, for product pricing, and in budgeting or planning.

Exhibit 2
Traditional Measures of Capacity and Costs Assigned

Capacity Measure	*Cost*	*Volume (in units)*	*Cost Per Move (2 ÷ 3)*
Theoretical	$600,000	4,380,000	$0.137
Practical	600,000	3,600,000	0.167
Normal	600,000	2,750,000	0.218
Budget	600,000	2,600,000	0.231
Actual	600,000	2,700,000	0.222

Exhibit 2 summarizes the translation of the physical capacity measures (boxes moved) into the cost of moving the boxes. To keep this example simple, capacity cost is defined as the rent for the robot. Ignore other costs associated with providing box moving capacity such as the robot operator, power, supplies, and space. All of these costs are part of the total capacity cost. Exhibit 2 shows that if theoretical capacity is used in the calculation of product cost, the cost per box is $.137 ($600,000 divided by 4,380,000 boxes). At the other extreme, if budgeted capacity is used the cost to move each box increases to $.231 ($600,000 divided by 2,600,000 boxes).

Assume that the budgeted amount for product costing ($.231 per move) is used, and then the company produced and sold more than the budgeted number of boxes of cereal (2,700,000 actual production in Exhibit 2). This lowers the cost per box moved to $.222, leaving the impression that capacity cost is managed properly. As a result, it is unlikely that capacity utilization will be studied further.

Managers often focus extensively on financial information available from the accounting system. One study showed that the majority of firms surveyed used expected actual capacity (the budget) for measuring and assigning the cost of capacity.[2]

A Modern Approach—The CAM-I Capacity Model.

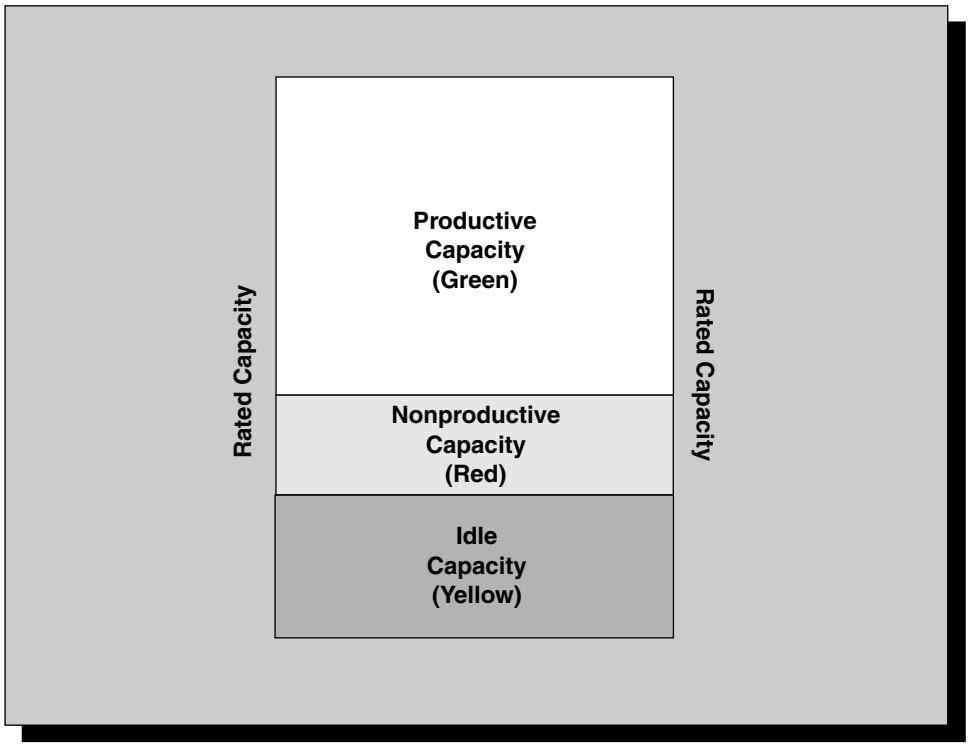
There is growing recognition of the importance of managing capacity. Several new measurement models focus on managing capacity rather than on product costing. This section draws upon the model developed by CAM-I. This approach is demonstrated using the same information from Crunch Cereal. The model classifies available capacity into four major classes.

1. **Rated**
2. **Idle**
3. **Nonproductive**
4. **Productive**

Rated capacity is the same as theoretical capacity in the traditional model. It assumes the robot operates 24 hours a day, 7 days a week, 365 days a year and therefore is available for 4,380,000 box moves.

[2] J.S. Chiu and Y. Lee. "A Survey of Current Practice in Overhead Accounting and Analysis," *Proceedings of the 1980 Regional Meeting of the American Accounting Association.*

Exhibit 3
CAM-I Capacity Model—Basic Version



Productive capacity is the time available capacity is used to produce products or services for customers. It may also include the time capacity is used for essential production-related activities such as product testing. Crunch Cereal's robot moved 2,700,000 boxes that were sold. This productive use of the robot's capacity is equivalent to 225 days of operation (2,700,000 ÷ 500 boxes ÷ 24 hours).

Nonproductive capacity is capacity that does not result in goods that can be sold. It occurs because of the nature of the production process. During production setups or maintenance, equipment does not produce goods. Other times machinery is in a standby mode waiting for actions to be performed in other parts of the manufacturing process. This can happen if other parts of the production process cannot keep pace with the robot's ability to move boxes. Some productive time is also lost due to waste, scrap, and rework. For example, the robot can damage items or move packages which are defective. Setups, maintenance, waste, standby, or buffer capacity are all nonproductive uses of available capacity.

Idle capacity is the time available capacity is not used because of policy decisions or market reasons. Holidays, contractual obligations, and lack of orders all result in idle capacity. If the factory closes for a holiday or the robot does not operate because orders are insufficient, idle capacity exists.

Exhibit 3 shows the relationship of these four capacity categories. Note that productive, nonproductive, and idle capacity are partitions of rated capacity.

A key purpose of the CAM-I Capacity Model is to communicate the state of capacity use to operational management and upper management. The use of color (or some other unique coding) is an effective way of drawing attention to the opportunities presented by

various states of capacity. As shown in Exhibit 3, productive capacity is green, nonproductive capacity is red, and idle capacity is yellow.

Expanded Version—CAM-I Model.

The basic version of the CAM-I Capacity Model provides a quick summary of capacity usage in a business, plant, or a single machine. To effectively manage capacity the reasons behind *nonproductive* and *idle* capacity must be understood. This requires breaking down these categories by the underlying causes.

Causal breakdown of nonproductive capacity.

As discussed above, nonproductive capacity arises from the nature of the production process. There are four primary causes for nonproductive capacity in manufacturing environments. These are: setups, maintenance, standby, and waste. In Crunch Cereal's case, these causes prevented 648,000 boxes from being moved. The breakdown of this 648,000 is shown below.

- ▲ **Setup and maintenance** refers to time lost in setting up machines for new production batches or for routine maintenance. Crunch's robot does not operate for 25 days because of setups and maintenance. This translates into 300,000 boxes (25 days × 24 hours × 500 boxes).
- ▲ **Standby** is a capacity buffer that helps the firm deal with variability caused by suppliers, customers, or internal operations. Crunch does not use its robot the equivalent of 19 days because the warehouse is already full with prior orders. This costs 228,000 boxes (19 days × 24 hours × 500 boxes).
- ▲ **Waste** may be scrap, rework, or other losses. Crunch lost 10 days of the robot's work which translates into 120,000 boxes (10 days × 24 hours × 500 boxes).

The robot, therefore, is nonproductive for a total of 54 days; 25 for setup and maintenance, 19 for standby, and 10 for waste. This equates to 648,000 boxes of nonproductive capacity (54 days × 24 hours × 500 boxes).

Causal breakdown of idle capacity.

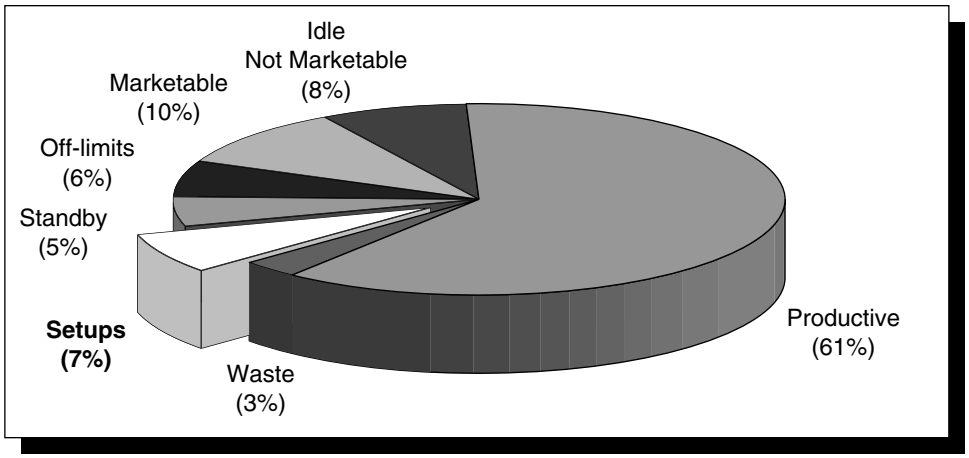
Unlike nonproductive capacity, the causes for idle capacity are rooted in policy decisions or market related constraints. There are three major types of idle capacity: idle off-limits, idle marketable, and idle not marketable.

- ▲ **Idle off-limits** represents capacity not used because of holidays, contractual agreements or management policies. It remains off-limits until management changes policies or modifies contract terms. In the example, the plant has 21 holidays that result in lost production of 252,000 boxes (21 days × 24 hours × 500 boxes).
- ▲ **Idle marketable** results from the inability of the firm to exploit the existing market for a product. It represents capacity from lost market share. To understand the calculation of idle marketable capacity, refer to the data in Exhibit 1. Item 7 shows that Crunch Cereal can sell 3,120,000 boxes. To sell 3,120,000 boxes, Crunch Cereal needs to use the robot for 260 days per year (3,120,000 boxes ÷ 24 hours ÷ 500 boxes). Item 8 specifies that the robot is currently in use for 225 days to move boxes. This means an increase of 35 productive days of robot use (260 days − 225 current productively used days). These 35 days or 420,000 boxes (35 days × 24 hours × 500 boxes), represent idle marketable capacity.

Exhibit 4
CAM-I Capacity Measures—Expanded Version

	Capacity Measure	*Time (in days)*		*Capacity In Boxes Moved (Column 2 × 24 hrs × 500/hr)*	
A.	Rated		365		4,380,000
B.	Productive		225		2,700,000
C.	Nonproductive				
	Setups	25		300,000	
	Standby	19		228,000	
	Waste	10		120,000	
	Subtotal nonproductive		54		648,000
D.	Idle				
	Off-limits	21		252,000	
	Marketable	35		420,000	
	Not marketable	30		360,000	
	Subtotal idle		86		1,032,000
	Total (B + C + D)		**365**		**4,380,000**

Exhibit 5
Visual Presentation of Capacity Measures



▲ **Idle not marketable** is physical capacity that cannot be used because there is no market for the product or because management chooses not to enter a market. Crunch Cereal's idle not marketable capacity is 30 days. This is obtained by adding the productive, nonproductive, and other idle (off-limits and marketable) days and subtracting the total from 365 or [365 − (225 + 54 + 56)]. This difference of 30 days results in 360,000 boxes of idle not marketable capacity.

The robot is **idle** for a total of 86 days; 21 days of idle off-limits, 35 days of idle marketable, and 30 days of idle not marketable. This equals 1,032,000 boxes of idle capacity (86 days × 24 hours × 500 boxes). Exhibit 4 summarizes these measures.

Exhibit 5 presents this breakdown in a chart that can be used as a factory visual to encourage continuous improvement among line workers. For example, if setups are of

interest, this segment of the chart could be separated from the other types of capacity. More importantly, operations can use this information to show upper management the capacity that is idle due to corporate policy, marketing, and procurement.

The CAM-I model uses a color coding scheme to visually draw attention to problems and opportunities. Recall that productive capacity is green, idle capacity is yellow, and nonproductive capacity is red.

- ▲ Green sends a positive signal. The message is: *green capacity is how much existing capacity is producing good product*. Productive capacity is capacity used for its intended purpose.
- ▲ Yellow sends a caution signal. The message is: *yellow capacity is the amount that is idle and offers an opportunity to grow the business or change policies that create this capacity.* Management should strive to convert idle capacity, other than that held for strategic or legal reasons, to productive capacity. It may also show the need to eliminate excess capacity.
- ▲ Red sends a warning signal. The message is: *red capacity is that portion of time which results in capacity use, but not good products*. Nonproductive capacity offers opportunities for improvement in factory operations. A prominent chart or graph in a factory showing that nonproductive capacity exists can spur efforts to reduce waste, eliminate setups, and decrease standby time.

Cost Management Implications of the CAM-I Model.

The CAM-I capacity measures offer quantitative information to assist operational personnel make daily operational decisions. To communicate capacity issues to management and business teams, these operational measures need to be converted to financial measures. Financial measures can be generated using the CAM-I model's operational measures coupled with the cost of moving a box at the robot's rated capacity ($.137). Exhibit 6 illustrates how the capacity cost of the robot (the rent) is measured for each of the capacity classifications.

Exhibit 6
Financial Cost of Capacity

[1]	*Capacity Measure [2]*	*Time (in days) [3]*	*Capacity (Col. 3 × 24 hrs × 500/hr) [4]*	*Cost per Box* [5]*	*Capacity Cost by Category (Col. 4 × 5) [6]*
	Rated	**365**	**4,380,000**	**$.137**	**$600,000**
A.	Productive	225	2,700,000	$.137	$369,900
B.	Nonproductive				
	Setups	25	300,000	.137	41,100
	Standby	19	228,000	.137	31,236
	Waste	10	120,000	.137	16,440
	Subtotal (B)	54	648,000	.137	88,776
C.	Idle				
	Off-limits	21	252,000	.137	34,524
	Marketable	35	420,000	.137	57,540
	Not marketable	30	360,000	.137	49,320
	Subtotal (C)	86	1,032,000	.137	141,384
	Total (A + B + C)	**365**	**4,380,000**	**$.137**	**$600,000**

*This is the lowest possible capacity cost per box moved and is calculated by dividing the total capacity cost ($600,000) by the rated capacity (4,380,000 boxes).

Think Along

How would management and business teams use the financial information provided in Exhibit 6? What conclusions might be drawn about the costs associated with the various uses (non-uses) of capacity?

Management can use the financial information in Exhibit 6 to understand the financial impact of not producing at the rated capacity of 4,380,000 boxes. The cost calculations show that only $369,900 worth of capacity out of an investment of $600,000 is being used productively. Nonproductive capacity has a cost of $88,776 which includes $41,100 for setups. Idle capacity is consuming $141,384 of the rent paid for the robot. As shown in column five, these calculations are based on a capacity cost per unit of $.137 per box. This is the lowest possible capacity cost which occurs when capacity is fully utilized.

The translation of capacity into cost measures is particularly useful for cost planning, an essential part of profit planning and target costing.[3] Establishing target costs for products requires calculating **unit product costs based on a projected level of capacity use.** If the actual capacity used is less than planned capacity use, actual product costs will be higher than the target cost. Exhibit 7 shows how nonproductive and idle capacity can increase the cost of moving boxes. Because of nonproductive capacity, the box moving cost increases from $.179 to $.222. The presence of idle capacity increases the cost from $.161 to $.222. If both sources could be eliminated, the lowest unit price of $.137 could be achieved.

Exhibit 7
Using CAM-I Capacity Measures for Cost Planning

Capacity Use Category	*Cost [2]*	*Volume (In Units) [3]*	*Cost Per Move (2 ÷ 3) [4]*
Productive (actual boxes moved)	**$600,000**	**2,700,000**	**$0.222**
Nonproductive:			
Setup		300,000	
Standby		228,000	
Waste		120,000	
Without nonproductive capacity		**3,348,000**	**$0.179**
Idle:			
Off-limits		252,000	
Marketable		420,000	
Not marketable		360,000	
Without idle capacity		**3,732,000**	**$0.161**
Without any unused capacity	**$600,000**	**4,380,000**	**$0.137**

Think Along

Since the robot's cost is a one time expenditure, and its total cost does not vary with boxes moved, is it misleading to report its cost on a per unit basis, for example, $.222 as shown in Exhibit 7?

[3] For a more detailed discussion of profit planning and target costing see the module on Target Costing.

Note that the terms profit planning and target costing were used when discussing unit capacity cost calculations of the type shown in Exhibit 7. Calculations of product cost for external reporting purposes is governed by financial reporting rules. For internal use, however, the per unit cost information is useful for *cost planning and cost management*. Although the robot's cost is a one time expenditure which does not vary with boxes moved, the cost must be managed. Cost planning typically establishes a per unit product cost based on some level of capacity utilization. If the total product cost for Crunch Cereal is based upon a projected cost of $.161 for box moving, then an actual cost of $.222 tells management that it has failed to achieve the planned cost because of nonproductive or idle capacity. The comparison forces managers to plan capacity use carefully and makes them aware that capacity planning is closely linked with cost planning. Management can meet the planned cost target by eliminating nonproductive or idle capacity. For example, they may divest excess capacity and buy smaller or more flexible robots that can be fully utilized.

Key Point

While capacity costs are fixed once acquired, all can be *managed* by eliminating the causes of nonproductive or idle capacity, or by selling or renting unused capacity.

There are several ways to manage capacity costs. Reducing setup times is one way to eliminate nonproductive capacity. Another way is to design products that share a common set of manufacturing steps. This eliminates standby capacity. Crunch can use their robot to move other items when there are no cereal boxes to be moved. Information on standby capacity also can be used to decide whether to invest in new robots or to share existing robot capacity.[4] Large corporations with several different product divisions often use similar equipment. It is not unusual to find each division having the same equipment and not utilizing it fully. The equipment can be better utilized if divisions are willing to share capacity rather than build their own.

Another way to manage capacity costs is to sell the existing robot and purchase a smaller robot that can be fully utilized for the work to be done. This is what airlines do when smaller planes are used on routes that have less traffic. This allows the elimination of empty seats by using planes that are smaller and more fuel efficient per passenger seat.

Note Pad

Stretching the Model. Assume that the expected demand is 4,056,000 boxes. How should idle marketable and idle not marketable capacity of the robot be reported? (For answer see the end of the module.)

▲ ATTRIBUTES OF CAPACITY MEASUREMENT APPROACHES

Like any other management accounting measure, a good capacity measure must have technical, behavioral, and cultural attributes that lead to attaining the objectives of quality,

[4] For example, Procter and Gamble was considering a proposal to spend a billion dollars to expand its available productive capacity. While considering this proposal, management discovered they were only using the existing capacity 50 percent of the time because of how they were operating the production facilities. This caused them to question the need for building additional capacity.

cost, and time. A capacity measure that works well on one core attribute, but performs poorly on the others, should be avoided.

Think Along

Which capacity measurement system do you prefer? Why?

Technical Attributes.

A good management accounting system provides information that allows managers to further an organization's strategic objectives. To do this managers must have relevant information that informs decisions and helps them to understand the underlying causes of capacity costs. Therefore, capacity measures should provide *relevant information* for making decisions about using capacity productively. Further it should improve managers' *process understanding* of the causes that lead to unused capacity. Some of the issues which should be addressed by the capacity measures are:

- ▲ What portion of the available capacity is being used? What portion of available capacity is currently not being used? Why?
- ▲ Of the capacity in use, how much capacity is used productively?
- ▲ How can the productive use of capacity be increased?
- ▲ Can unused capacity be eliminated?

Decision relevance.

When evaluating the traditional and CAM-I capacity models on their decision relevance, it is found that the traditional measures focus on assigning the cost of capacity ($600,000) to boxes produced. It provides a different cost per box for each capacity measure. Product costing is a secondary focus for the CAM-I model. However, it can provide similar information about the cost of moving boxes. For example, using the information in Exhibit 7, the rated capacity was 4,380,000 boxes of cereal. Since capacity costs are $600,000, if rated capacity was fully utilized by production, the cost per box would be $.137. Because actual production is much lower (2,700,000) the cost has gone up to $.222 per box produced. This information is vital for cost planning since it makes clear the consequences of improper capacity planning or usage.

The CAM-I model better addresses the strategic concerns of management. The model highlights reasons for nonproductive or idle capacity. In the Crunch Cereal example, the breakdown helps communicate to the various operational personnel where improvements can be made. A visual, such as Exhibit 5, along with a numerical presentation shows shop floor supervisors the capacity lost due to setups and waste. Similar exhibits can make logistics managers aware of capacity lost due to nonproductive standby days.

The CAM-I model also provides information to help management prioritize capacity improvement efforts. In our robot example, if Crunch eliminates the need for setups, this will free up enough days to move an additional 300,000 boxes (25 days $\times$ 24 hours $\times$ 500 boxes per hour). In contrast, eliminating waste provides only 120,000 boxes of capacity (10 days $\times$ 24 hours $\times$ 500 boxes per hour). There is more opportunity to reduce nonproductive capacity if Crunch focuses on reducing setup time first.

Process understanding.

The traditional capacity model provides management with little information about the actions and causes which create unused capacity. The use of practical capacity does not

make visible capacity lost due to waste, scrap, and rework. The CAM-I measures contain information to help management understand the underlying causes of unused capacity. Marketing management can graphically see the under utilization of capacity because of failure to exploit market opportunities. Human resource managers can understand the impact of bargained holidays on capacity utilization. Upper management can assess the relative size of each of the nonproductive and idle categories, and thus prioritize improvement programs.

Japanese manufacturing firms are good examples of how this process understanding leads to creation of additional capacity. Information on the causes of nonproductive and idle capacity have been used to successfully reduce these problems. For instance, in the 1970s, Toyota was able to reduce setup times for lathing operations to three minutes. General Motors was taking eight hours to perform these same operations.[5] Toyota was also able to eliminate standby capacity by forging strategic alliances with customers and suppliers. These agreements decreased nonproductive idle capacity. Finally, Toyota's emphasis on Total Quality Management freed additional capacity by eliminating waste.

Behavioral Attributes.

What behaviors does each approach to capacity measurement motivate? Remember that desired behaviors are those that lead to the achievement of the strategic objectives—quality, cost, and time.

The traditional and CAM-I models can lead to different behavioral consequences in five areas:

1. **Cost planning activities**
2. **Inventory decisions**
3. **Continuous improvement**
4. **Accountability**
5. **Communication**

Cost planning.

Cost planning is a fundamental part of cost management. Good cost planning, in turn, requires good capacity planning. The traditional capacity model does not link the capacity use plan which justified the original capacity expenditure to budgeted capacity use. The budget is an annual number, typically based on current sales forecast, that is not linked to planned capacity use. This disconnection between planned and actual use of capacity breaks down discipline and can lead to building excessive or duplicate capacity. In fact, in the 1990–91 recession, many firms that used traditional capacity measures discovered that they had built tremendous excess capacity from overly optimistic sales forecasts.

Inventory decisions.

The traditional model is used for product costing. It creates a lower per unit cost when capacity is fully utilized. This can lead to inventory build-up since lower product cost results from producing more without selling more. The CAM-I model is not for product costing purposes. It is an operational measure of capacity. Therefore, it does not create an

[5] See J.P. Womack, D.T. Jones, and D. Roos. *The Machine That Changed the World,* New York: McMillan, 1990.

incentive for lowering unit cost through overproduction. As long as the model is **not used** for product costing, it will not be susceptible to the same behavioral phenomenon as the traditional model.

Continuous improvement.
Management must seek ways to continuously improve operations and to increase productive capacity utilization. Traditional measures do not provide this focus because management uses practical capacity and views theoretical capacity as unattainable. Because practical capacity is considerably less and therefore easier to achieve, there is little motivation to improve capacity use. By providing detailed diagnostic information on capacity use, the CAM-I model encourages searching for inefficiencies and striving for continuous improvement. Highlighting nonproductive capacity can cause managers to ask why setups take so long, and why waste is higher than last period. It shows how waiting for supplies disrupts the production process and reinforces the need to stabilize supplier relationships.

Accountability.
Failure to analyze the amount and components of nonproductive capacity can seriously undermine accountability. While manufacturing is often held responsible for capacity use, many other functions, including marketing, product development, human resource management, and facilities management, contribute to the existence of nonproductive and idle capacity. By breaking out the components of nonproductive and idle capacity by functions, the CAM-I model makes accountability visible. For example, the idle marketable shows the responsibility of the marketing department in creating unused capacity. However, the color scheme chosen for the CAM-I model may lead to an inappropriate amount of attention paid to the production function. Red is used to denote nonproductive capacity, which is typically under the control of production. Yellow is used for idle capacity, which is under the control of marketing or upper management. Red means "eliminate;" yellow means "caution." The size and controllability of these two capacity categories should determine the priority of each in elimination efforts. Also, by using the color "red" for nonproductive capacity, production personnel may feel they have a higher level of accountability for capacity use than marketing does.

Communication.
Unlike the traditional model, the CAM-I Capacity Model is a strategic communication tool. It helps make visible the processes, activities, and people who use capacity. This helps operating departments and managers in different functions, such as marketing, production, or finance communicate with each other. Comprehensive capacity measurement also provides information to both operations and business management about how a firm is using capacity. This shared information facilitates communication between these two levels of management.

Cultural Attributes.

The traditional and CAM-I approaches reflect different cultural values. The modern capacity measures of CAM-I are an attempt to influence changes in organizational cultural values in three ways. First, each contains a message to *actively manage fixed costs.* Second, each instills the belief that *continuous improvement* is desirable in organizations. Finally, each encourages *managing* underlying cost structures and *business processes,* rather than managing information reported in financial statements.

Actively manage fixed costs.
Managers often assume that capacity, once acquired, is a given that cannot be managed. This creates an organizational mindset of "use it or lose it." Traditional measures encourage this mindset by focusing on contribution margins which treat capacity costs as unmanageable, fixed costs. The CAM-I model is designed to encourage **capacity management.** It emphasizes eliminating or reducing nonproductive capacity uses under an area's control. This encourages a change in the *mindset toward actively managing fixed cost items,* not simply accepting these items as given.

Continuous improvement.
This is a value that many organizations are trying to build and foster in their employees and suppliers. By incorporating inefficiencies into cost calculations and not highlighting them, the traditional model supports an organizational culture that is accepting of the status quo. The CAM-I model facilitates a culture of continuous improvement by searching for and eliminating nonproductive and idle capacity.

Manage processes, not financial statements.
In society, people focus on and accept as important those items which are measured and reported to those in positions of authority. The traditional model measures cost per unit and shows it is decreasing when production increases. The message conveyed by the traditional model is that financial statements measures cannot be controlled and a detailed understanding of the underlying processes is not needed. The CAM-I model measures operational causes for unused capacity and encourages elimination of those causes. Its message emphasizes the *importance of understanding the detailed processes* under a manager's control. It encourages managing the way business is organized, thus affecting long run cost structures. The CAM-I capacity model is an attempt to change management culture toward understanding processes, and away from managing by financial statements alone.

The technical, behavioral, and cultural properties provide criteria for choosing a capacity measurement method. We believe the CAM-I approach has better technical, behavioral, and cultural properties. Technically, the CAM-I model provides information for increasing quality, reducing cost, and planning for timely production of products. Behaviorally, it encourages problem solving and links cost planning to capacity planning. Culturally, it reinforces the values of managing costs, understanding processes, and striving for continuous improvement.

▲ COMPLICATIONS IN MEASURING CAPACITY

The information in the prior sections may have left the impression that capacity is easy to measure. In practice, measuring actual capacity is quite complex. The simplified robot example has avoided several issues that must be addressed in implementing capacity meas-urement in a complex real-world organization. These topics are addressed in detail in other modules, but are briefly introduced here.

One issue in designing a capacity measurement system is defining the level of analysis. Measuring and managing capacity requires an answer to the question: *the capacity of what?* Is it the capacity of the machine, the process, the plant, or the firm? There are different answers to the capacity question depending on the level of capacity aggregation being considered. In the robot example, discussion was restricted to measuring the

capacity of a single piece of equipment. There are major differences when there are capacity measures that relate to a single asset rather than an entire process or plant. Joint (plant) capacity and individual (machine) capacity are different. The analysis of joint capacity requires constraint analysis. The lowest individual capacity determines the overall capacity.[6]

A related issue is what to bundle with the capacity of an item. Machines are operated and maintained by people. Part of the overall capacity management question is the available capacity of people. Measuring the capacity of people, particularly knowledge workers, is difficult. Yet any effort to manage capacity will require some consideration of this issue. The capacity of people to maintain and use the robot would influence how much nonproductive capacity exists.

Another consideration is that capacity changes over time. The amount of rated capacity varies over time with technology changes or because of quality issues. The box-moving robot had a theoretical or rated capacity of 500 boxes an hour. However, by adding a part to the robot it might be possible to move two boxes rather than one box. This fundamentally changes available capacity.

Capacity may depend on product mix. For example, what if the robot can move 600 of one type of box and 300 of another type of box. To measure capacity information would be needed on how much of the total time would be spent for each product. This product mix may change each year. This is one reason for the focus on available time, rather than output.

▲ LESSONS LEARNED

Capacity measurement is an important area. In this module two approaches to measuring capacity were demonstrated. The key lessons learned from this module are:

- ▲ The traditional approach to capacity measurement focuses primarily on product costing for external financial reporting. It divides theoretical capacity into practical, normal, budgeted, and actual.
- ▲ While developed for external reporting purposes, traditional measures of capacity are often used for internal performance evaluation.
- ▲ Traditional measures provide inadequate information for managerial decision making and process understanding, lead to undesirable behaviors, and reinforce operating as usual without stimulating the search for ways to use capacity more productively.
- ▲ The modern (CAM-I) capacity model described in this module focuses on managing and communicating capacity from an operational and strategic perspective. It divides rated capacity into idle, nonproductive, and productive.
- ▲ The modern capacity measure provides information for decision making and process understanding, motivates management of capacity, and encourages an attitude of searching for ways to improve capacity utilization.

[6] A capacity model known as Theory of Constraints focuses extensively on the identification of the bottleneck in a joint capacity situation. This is one of several capacity models that firms use for certain types of measurements.

▲ ANSWER TO THINK ALONG

What happens if expected demand for cereals is 4,056,000 boxes?

- ▲ Moving 4,056,000 boxes requires 338 days of box-moving capacity from the robot (4,056,000 boxes ÷ 500 boxes per hour ÷ 24 hours).
- ▲ This means an additional 113 productive days (338 days − 225 productive days currently) is needed.
- ▲ There are only 65 incremental days available under current operating conditions (338 days − 225 productive days − 54 nonproductive days − 21 idle off-limit days). See Exhibit 3. This means there are 48 days short (113 days needed − 65 days available).
- ▲ There are two ways to report this information.
- ▲ One way to report existing idle marketable capacity is to report only the 65 days since a robot cannot work more than 365 days. This is not very informative.
- ▲ The other way is to report that 113 days of capacity are needed and that 65 days are available under current conditions. The remaining 48 days of productive capacity have to come from the use of (a) nonproductive [54 days], (b) idle off-limits [21 days], or from a new robot that increases available capacity.
- ▲ Under either reporting method the idle not marketable capacity is zero.
- ▲ It is believed that identifying the full 113 days as *idle marketable* would be more informative. This focuses attention on the cost of nonproductive and idle off-limits capacity. This approach clearly shows the relationship among capacity categories. However, it may give the appearance of violating the maximum time available (365 days) assumption.
- ▲ Practically, if focusing on how to meet increased demand, a way must be found to highlight the need for 48 additional productive days. What this Think Along shows is why a good management accounting system must be capable of reporting the same information in multiple ways to serve specific decision needs.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

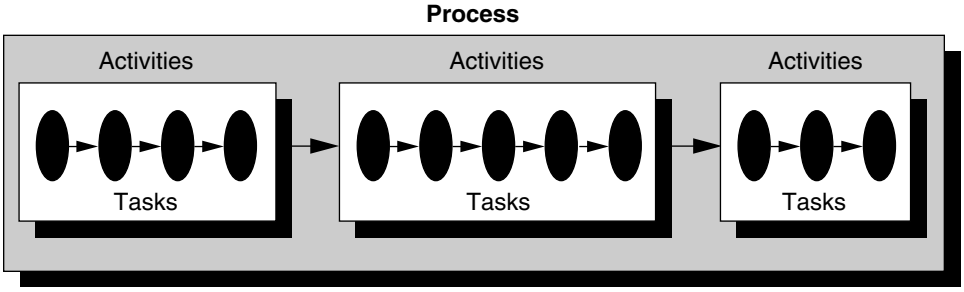
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. What are the four key ideas that help to understand capacity?
b. What is the equation to measure theoretical or rated capacity?
c. What is the difference between:
   i. Rated and theoretical capacity?
   ii. Theoretical and practical capacity?
   iii. Practical and current budget capacity?
   iv. Idle and non-productive capacity?
d. Identify three types of idle capacity and briefly explain each type.
e. Explain the difference between waste and standby capacity. Why does each type of capacity exist?
f. Why does productive capacity not automatically increase when nonproductive capacity is eliminated?
g. Explain the meaning of the colors green, yellow, and red as used in the CAM-I capacity model. Is there any behavioral difficulty with the color scheme?
h. Why is it essential to translate operating measures in the modern capacity model into cost measures?
i. List two technical attributes of a good capacity measurement model.
j. Traditional capacity measures can lead to dysfunctional behavior. List and briefly explain five different dysfunctional behaviors that may result.
k. Briefly explain how the modern capacity model can motivate different behavior on two of the five items listed in question j.
l. Identify three cultural attributes of a good capacity measure.

2. Specify how to measure the theoretical or rated capacity for each of the situations described below.

Required:

a. Mechanical Company manufactures a standard part that requires two bolts. The company uses a robot that can insert 14 bolts a minute. Mechanical Company is considering purchasing a $30,000 attachment for the robot that will allow it to insert both bolts into five parts simultaneously. The modified robot could make this insertion in 20 seconds.
b. A startup airline plans to fly older planes on short flights. The company can configure the plane to seat 180 passengers and fly the plane at 550 miles per hour. An alternative configuration is to seat 150 passengers and fly at 600 miles per hour.
c. A payroll clerk is working on a check processing machine. The clerk can enter payroll information for an employee in two minutes. The machine is capable of processing the data and preparing a check in 40 seconds.

3. You are perzforming a comprehensive capacity review for New Plastic Assembly Company. Your boss would like answers to the following questions as part of this analysis.

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* A number of problems and cases for this module were contributed by Reba Cunningham of the University of Texas at Dallas.

Required:

a. An analysis of the machine shop shows 15 percent of the time is spent on maintenance. What type of capacity is this? Since maintenance is essential for quality machining operations, why measure and report this use of capacity?

b. Analysis shows that 50 percent of the time the plant is idle because New Plastic does not work 24 hours a day. Does the capacity analysis suggest that the plant should operate around the clock? If not, why report information about idle capacity?

c. Analysis shows that one copy machine in the administrative offices is in use only 20 percent of the time the office is open. What type(s) of capacity does the other 80 percent represent? Are there ways to manage the capacity cost of this copy machine more effectively?

4. The Reso Company does contract reservations for a group of hotels in the Atlanta area. Reso has a $2.5 million annual contract with Bell South for telephone service. The contract includes telephone equipment and a multiple line 800 number. With the number of phones Reso has in place they are theoretically capable of answering 10.5 million, two minute calls a year. Realistically Reso only expects to answer 6.4 million calls. The firm answered an average of 4.3 million calls the past three years. The current year budget is for 4.4 million calls to be answered. At the end of the year records show that Reso actually answered 4.6 million calls.

Required:

a. Compute the cost per call for each of the traditional measures discussed in the module: (i) theoretical; (ii) practical; (iii) budgeted; (iv) average; and (v) actual.

b. You are the manager of the telephone operation. Is the cost per call higher or lower than anticipated? What does this cost per call measure tell you about how well you managed your telephone costs?

c. A senior executive wonders if Reso has more telephone answering capacity than necessary, because of the disparity between the theoretical number of calls the equipment can handle and the number of calls the firm reasonably expects to answer. Why might Reso be unable to answer the theoretical number of calls?

5. CupCo produces a line of special purpose coffee cups. The cup shaping equipment is flexible and with proper setup can make any possible cup shape and size. The equipment is capable of producing 4,000 good cups an hour. The plant currently operates two eight-hour shifts, five days a week. The cup shaping equipment is quite sensitive, and if improperly set up, quality problems arise. During an average week the company discards 5,000 cups due to quality problems.

The setup process takes about 30 minutes, and the firm typically performs 900 setups each year. The plant completely shuts down for 12 vacation days and 10 holidays per year. Equipment also shuts down one day every two months for regular maintenance. The company is currently selling every cup it makes.

Required:

a. What is the rated capacity of CupCo?

b. Identify (by name) two types of nonproductive capacity that exist in CupCo.

c. What type(s) of idle capacity exist?

d. How much idle capacity does CupCo have? Show computations.

6. CupCo (see exercise 5) has never done an analysis of capacity using a model similar to the modern capacity model. CupCo does have a budgetary system in place. Plant managers are evaluated on actual cost per cup compared to budgeted cost per cup.

Required:

a. If excess capacity existed what action might the present system encourage a manager to take to improve performance?

b. Given that the plant is currently selling every cup made, would the modern capacity measures help the firm manage capacity? How? In your response include a discussion of how these measures may influence continuous improvement, accountability, and communication.

7. Examine your accounting classroom and answer the following questions:

Required:

a. Identify four different measures of classroom capacity.

b. What measure of capacity is most useful to a college administrator?

c. Is there ever any idle capacity in your classroom? What measures do administrators take to use this idle capacity?

8. A Small Time top maker machine can produce 200 tops an hour. Small Time has sold an average of 900,000 tops each year for the past four years. Small Time operates its plant 220 days a year. This year 950,000 tops were budgeted to be sold, and one million were sold. The top maker machine cost $100,000 and has a five-year life. The machine also costs $400 per day to operate when the plant is open.

Required:

a. Determine the theoretical, practical, normal, budget, and actual volume.

b. Determine the cost per top under each of these measures.

c. Specify the additional information necessary to perform an analysis using the CAM-I capacity model.

9. Answer each of the following independent questions.

Required:

a. Northwest Airlines decided not to purchase new airplanes in 1996 but expects its capacity to increase by eight percent. Discuss how Northwest might be able to achieve this capacity increase.

b. Assume you manage a large auto repair shop.
   i. How can you reduce idle capacity?
   ii. Will this reduction of idle capacity make you more productive?
   iii. Why might it be logical to have idle capacity?

c. Respond briefly to the following questions about capacity:
   i. Why is theoretical capacity not used as a cost measure?
   ii. Why do costs go down as volume increases?
   iii. Why is budgeted capacity used more often in decision making than actual capacity?

10. American Airlines is substituting smaller jets and even smaller propeller planes as a replacement for larger equipment used on the same nonstop routes. One reason is to make better use of the firm's existing capacity.

Required:

a. Comment on the cost implications of this decision.
b. What are some of the quality implications of this decision?
c. Are there time implications implicit in this substitution?

11. Fiberform Industries produces a line of motor boats. The assembly department programs computerized equipment to shape and bend the metal railings for each boat. This equipment is capable of producing 40 railings per hour. The department typically produces only 30 railings per hour. The plant operates two (eight-hour) shifts, six days a week. The shape and bend of the railings are critical, and the firm currently discards 9,600 completed railings a year because of poor shape and bend. The plant is closed for 12 vacation days and 10 holidays per year. The equipment is also shut down for one day every two months for regular maintenance. The assembly department's average production of good railings for the past five years is 130,000 a year. The department expected to produce 120,000 good boat railings this year. However, the actual production was 105,000 railings. For this problem, assume the 365th day is a Sunday. Further assume any difference between actual sales and production under current conditions is idle marketable capacity.

Required:

a. Assume that the total equipment related cost for the assembly department was $2,400,000. Determine the volume and capacity cost for each of the following traditional measures: (i) theoretical; (ii) normal; (iii) budget; and (iv) actual.
b. Using the CAM-I model, determine the amount of equipment time that falls into each of the following categories: (i) rated; (ii) idle; (iii) nonproductive; and (iv) productive. As part of your solution attempt to determine what types of idle and nonproductive capacity exists. (Note: You may have to back into one type of idle capacity.)
c. Assume that the equipment used in the plant rents for $1,200,000 a year. In addition, there is a daily cost of $1,000 whether or not the plant operates. An additional $835,000 of cost is incurred on the days the plant is operating or undergoing maintenance. Estimate the cost that should be assigned for: (i) idle; (ii) nonproductive; and (iii) productive capacity.

12. The Bean Pole company rents a truck for $30,000 a year. The truck costs $2 a mile to operate (without considering the rental cost). The truck can cruise at 60 miles an hour. Bean Pole employs three drivers each of whom can drive (or wait with the truck) 40 hours a week.

The truck was driven 82,000 miles last year. While the truck was in use, it averaged 40 miles an hour. In an average week the truck was loaded for six hours while a driver was on duty. Bean Pole does not work on Sundays and each driver receives two weeks vacation and 11 paid holidays. During the year the truck was being repaired for four days and spent another three days in normal maintenance. Miles budgeted for this year were 94,000; further each driver was budgeted for 30 hours a week. In the last four years the truck averaged 90,000 miles, and the drivers worked 29 hours a week.

Required:

a. Respond to the following questions about Bean Pole using traditional capacity measures.
   i. What is the theoretical capacity of this truck in miles?
   ii. What is the practical capacity of this truck in miles?
   iii. What is the normal capacity of this truck in miles?
   iv. What is the budget capacity in miles?
   v. Bean Pole budgeted $210,000 ($2.234 per mile) for the truck (excluding drivers) this year. Actual costs were $194,000 ($2.366 a mile). You are responsible for the trucking operation, should you be praised for saving money or questioned about why actual costs per mile are higher?
   vi. Comment on the value of this information for managing Bean Pole's use of the truck.

b. Focus on the truck and answer the following questions within the context of the CAM-I capacity model. (List any assumptions you make.)
   i. What portion of the truck capacity is productive?
   ii. What portion of the truck capacity is idle? Identify, to the extent possible, the idle capacity by type.
   iii. What portion of the truck capacity is nonproductive? Identify, to the extent possible, this capacity by type.
   iv. What is the cost of the various types of capacity?

c. Focus on truck drivers and answer the following questions within the context of the CAM-I capacity model.
   i. What portion of the driver's capacity is productive?
   ii. What portion is idle? Identify by type to the extent possible.
   iii. What portion is nonproductive? Identify by type to the extent possible.
   iv. If each driver is paid a salary of $30,000 a year, what is the cost of each type of capacity?
   v. Can you devise a suggestion for making the drivers more productive?

d. In Bean Pole explain how using a traditional capacity measure might:
   i. Legitimize inefficiencies.
   ii. Fail to generate continual improvement.
   iii. Not provide adequate accountability.

e. For each of the situations in part d above, discuss how the CAM-I model might help eliminate these problems.

13. The Wind Blown Manufacturing Company has plants located on five continents. The controller is constantly looking for ways to sensitize new members of the accounting staff to the unexpected consequences of management accounting information. At today's seminar several past incidents related to capacity measures, from Wind Blown and other firms, are under discussion. Briefly comment on the possible causes for each of the following situations.

Required:

a. An automated facility in Canada was built to meet rising demand for one of Wind Blown's standard products. After the first quarter of operations, the accounting reports showed that the product cost was 30 percent over the standard cost used throughout

the firm. A manager at the home office offered the plant manager and workers a bonus if they could get production costs within 10 percent of standard the next quarter. The next quarterly report showed the plant's production cost was only three percent above standard. The capital committee also received a request for a new warehouse facility for this plant.

i. Explain what probably happened at this plant.
ii. Did the bonus generate the type of behavior the firm desired? Why?
iii. Comment on some of the reasons, related to capacity, that this new facility might not initially meet a budgeted cost level.
iv. Discuss how the modern capacity model might help the company avoid this situation.

b. A major effort by management to highlight the different types of productive, idle, and nonproductive capacity with large color posters caused a brief wildcat strike in one plant. Workers complained that they were being singled out and blamed for marketing's sale of small quantities of nonstandard products and management's choice of suppliers and work policies.

i. What information shown on the displays might cause workers to take this position?
ii. Assume that workers were correct in their concern. How could the modern capacity model highlight who is responsible and help these groups understand the consequences of their actions?

c. One of the firm's most innovative plant managers had great success with a "Get the Red Out" campaign in a West Texas facility and convinced the firm to make this a company wide slogan. Shortly thereafter the manager of a plant in Eastern Europe was jailed and released only when the company agreed that the plant would stop this campaign. What did the firm fail to consider when using this slogan in the Eastern European environment?

14. The General Service Agency has an accounts payable department that provides bill paying services to several other agencies of the state government. The department works two shifts, five days per week. Only the accounts payable department uses its space and computer equipment.[7]

A time analysis shows that employees are idle 10% of the time. When they are working the employees time is spent as follows:

1. The department spends 45 percent of the time issuing 30,000 checks.
2. Opening mail takes five percent of the time. This is analogous to a setup in a manufacturing environment.
3. Resolving problems with suppliers takes 30 percent of the time.
4. Errors require clerks to rework 6,000 checks and consume 20 percent of the time.
5. The last three activities are currently necessary, but do not add to the department's output.

The total budget for the department is $372,000. The budget detail is as follows:

1. $100,000 for continually available space and computers.
2. $200,000 for people for two shifts.
3. $72,000 for consumables ($2 per check for paper costs).

[7] Case facts abstracted from: Klammer, Thomas, Capacity Measurement and Improvement: A Manager's Guide to Evaluating and Optimizing Capacity, Irwin Professional Publishing, 1996.

Required:

a. Compute the percentage of time accounts payable department personnel are productive, nonproductive, and idle. Where information is available, identify the capacity measures in more detail.

b. Compute the percentage of time the accounts payable space and equipment are productive, nonproductive, and idle. Where information is available, identify the capacity measures in more detail.

c. Transform the time analysis completed in parts one and two into a financial analysis.

d. Comment briefly on how operations could use this capacity analysis to communicate proposals for process changes to management.

e. Independent of part d, comment briefly on what management might learn if they received this type of capacity analysis.

15. A packaging department services the retail distribution operations of Sending Company. Salaried workers (cost $300,000) use dedicated space and packaging machines (cost $150,000) to prepare shipments. The budgeted cost per package for the current year is $7.50, including $1.50 for materials used in each parcel. The basis of this budget is 75,000 packages. Sending Company managers pay special attention to unit costs, and the department manager was ecstatic when the unit cost figures showed that the parcel cost was only $6.86 last period. He commented: "Pushing hard for quicker packaging really has paid off."

Required:

a. Assuming the materials cost for every package was constant at $1.50, how many packages did the packaging department process? (Hint: Processed not delivered.)

b. You are reviewing the budget and actual numbers and discover that the delivery company accepted only 70,000 parcels from the packaging department. A quick analysis suggests that the cost per parcel should be $7.93. How did you get this cost?

c. Comment on how well the packaging manager did this week.

16. To better understand the capacity of the packaging department discussed in problem 16, you decide to test the modern capacity model. An analysis (shown below) of the department provides additional information needed for that model.

The packaging department works three shifts, five days per week. Only the packaging department uses its space and equipment. A time analysis shows that a lack of demand keeps workers idle 7% of the time. When they are working the employees' time is spent as follows:[8]

1. The department spends 65 percent of its time packaging 70,000 items.
2. Preparing for different products takes 15 percent of the time. This is a form of setup.
3. Resolving problems with packaging suppliers takes eight percent of the time.
4. Errors that require the associates to repackage 14,000 products take 12 percent of the time.
5. The last three activities are currently necessary, but they do not add to the number of packages completed.

[8] Modified case facts abstracted from: Klammer, Thomas, Capacity Measurement and Improvement: A Manager's Guide to Evaluating and Optimizing Capacity, Irwin Professional Publishing, 1996.

The total weekly budget for the department is $576,000. The budget detail is as follows:

1. $150,000 for continually available space and packaging machines.
2. $300,000 for people for three shifts.
3. $126,000 for consumables ($1.50 per package for materials).

Required:

a. Compute the percentage of time packaging department personnel are productive, nonproductive, and idle. Where information is available, identify the capacity measures in more detail.
b. Compute the percentage of time packaging space and equipment are productive, nonproductive, and idle. Where information is available, identify the capacity measures in more detail.
c. Transform the time analysis completed in parts a and b into a financial analysis.
d. Comment briefly on how operational personnel could use this capacity analysis to communicate proposals for process changes to management.
e. Independent of part d, comment briefly on what management might learn from this type of capacity analysis.

Team Projects.

17. Select a single asset used by a small business such as a copy machine, a delivery truck, or even a soft drink machine. In cooperation with the business owner or an employee, evaluate the operational capacity of this asset. Use this evaluation to make recommendations for action. (Note: An extension of this assignment would be to identify the capacity cost related to this asset and assign this cost to each category of capacity.)

18. Yosemite National Park has been overcrowded for several years. It is not uncommon to close the lower valley when tourist and camper capacity is reached. Some policy makers want to reduce the stress on the park by further limiting its use. Others want to expand use by increasing available lodging facilities.

Use library and computer resources to obtain details about the existing size, facilities, and other features of Yosemite. From this information make estimates of the capacity available at Yosemite. Develop suggestions that explicitly take into account the behavioral and cultural attributes of different capacity decisions about the park.

19. The freeways and streets of most major cities are frequently overrun with automobiles. A major loop freeway in Dallas at peak times carries 180 percent more cars than the road's designed capacity. Select a major freeway or road near your location and analyze its capacity using the CAM-I model. Information about traffic, repairs, and other features should be available from government resources.

20. Select any small segment of your college and university and work with the segment to analyze its capacity. Gather information about costs and activities within the segment. Find out what type of capacity related information the segment currently uses, and how this information is used. After developing the analysis, discuss what actions, if any, the analysis suggests.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

Case 1: Special Purpose Theme Park.

Dare Devil Adventure Park is a Texas theme park designed to offer the young adult (and the young at heart) a continuing series of adventures and thrills. The park offers a variety of thrill rides, games, food, and other concessions. The park does not cater to children under the age of 10, because they can not ride the basic thrill rides safely. However, the management of Dare Devil is aware that only about 40 percent of the people who come to the park actually ride the major thrill rides. Many people, including children, come simply to see if others in their group have the "guts" to ride. These spectators are a significant source of park revenue, because many of them buy photos of their friends on the rides and buy food, caps, or other park items. There is a $5 admission charge for each individual but this admission is taken off the first major ride that a guest takes.

Management wishes to perform a capacity analysis for the major rides in the park, ignoring concessions and other park-related activities. The park has three major rides.

- ▲ One ride is the Skyshooter. It can fly a total of 20 flights an hour with up to three people per flight. There are two stations on the Skyshooter and it takes about one minute to load and unload passengers. A single ticket for a Skyshooter ride costs $10.
- ▲ The second major ride is Texas Blast-Up which can shoot 25 times an hour with two people per thrill. This ride also has two loading stations and takes 48 seconds to load. This ride costs a passenger $10 for a single ticket.
- ▲ The third thrill is the bungee tower which allows six people an hour to bungee jump on each of its ten stations. A single bungee jump costs $20. The actual jump takes only three of the 10 minutes; the remaining time is used to attach and inspect jump equipment.

An individual can purchase a three-ride ticket for $25 or buy a second ride on each activity at half-price. There is also an unlimited $100 day pass available.

Each of the major rides requires two operators at all times. There is always one additional operator rotating among the rides and a ride supervisor, who is trained to do basic maintenance on the rides. A trained nurse is on duty to service the entire park and provides thrill seekers with a feeling of security because they know medical help is readily available. About half of the nurse's contacts with clients relate to minor complaints after people participate on major rides.

First shift operators and the ride supervisor arrive an hour prior to the time the park opens. They are available to help with maintenance and spend 40 percent of this hour doing maintenance. Operators also stay 30 minutes after the park closes to help shut down the rides and clean the area around the rides.

The park operates on three different schedules during the year.

- ▲ An analysis shows that the park is open 10:00 AM to 12:00 PM on Fridays and Saturdays (31 weekends and 215 days) and from 10:00 AM to 10:00 PM other days from April through October. This is the summer season.
- ▲ November through January (13 weekends and 91 days) is the late fall season. During this time frame the park is open from 10:00 AM to 10:00 PM on Friday and Saturday and from 11:00 AM to 8:00 PM on Thursday and Sunday. The park is closed Monday, Tuesday, and Wednesday. The park is closed on Christmas.

▲ During the winter season months of February and March (8 weekends and 59 days) the park is only open Fridays, Saturdays, and Sundays from 10:00 AM to 6:00 PM.

Inclement weather may close rides temporarily. Dare Devil budgets park rides to close three percent of the time during the summer season. For the late fall and winter this budget percentage rises to 10 percent of the time. High winds are also common in the area and these winds close the bungee ride about 20 percent of the time that other rides are open.

Major maintenance on the rides is essential. As previously discussed, there is a regular maintenance check that takes an average of one hour each day. This is performed prior to the opening of the park. In addition, unscheduled maintenance typically stops the rides for about 15 minutes twice each day.

The park is always busiest on warm sunny days and weekend evenings, particularly in the summer. Analysis shows that an average of 30 people (total for the three rides together) ride the rides each hour the park is open during the summer season. This average drops to 20 per hour (total) during the fall and winter seasons. The firm budgets using an estimate of 25 riders (total) on the three rides throughout the year.

A spot review of warm weekends shows there are typically lines at the Skyshooter and Texas Blast-Up. During the busiest times the Skyshooter averages 55 people an hour while the Texas Blast-Up averages 46. During this same periods, the bungee jump does about 40 jumps per hour, but there are seldom any lines. These totals assume a full hour of operation (no weather or maintenance related shutdown). These demand factors are also reasonably representative of the proportional demand for these rides throughout the year.

The budget for equipment and space is $4,800,000 per year. The consumable supplies budget totals $120,000. Each ride operator, including the rotating operator, is paid $10 per hour. The ride supervisor is paid $15 per hour while nurses earn $30 per hour. Contract maintenance costs the firm $40,000 a year.

Required:

Part A

a. Explain how you would make an operational analysis of the capacity of each of the three major Dare Devil rides using the CAM-I capacity model. Specifically identify the assumptions you make as part of this analysis. To the extent feasible, do that analysis using your assumptions.
b. What does this partial capacity analysis information tell the management of Dare Devil? What additional analyses would be helpful? What are the most critical assumptions made in your analysis? How would a change in assumptions modify your responses?
c. Explain how you would convert a time analysis to an economic analysis for the rides.

Case 2: INFO Department—Capacity Analysis.

You just finished gathering data for a capacity analysis of a small government agency, the INFO Department, as part of a consulting assignment. This agency's primary function is to provide the public with forms and direct individuals to an appropriate government office when there are specific services needs. The total government is facing tight resource constraints and is searching for ways to more effectively use resources. The results of this pilot study may influence how the government looks at capacity and cost issues. Because of your experience with capacity analysis in the private sector, government leaders are interested in your findings and recommendations.

About 15 percent of the INFO Department's current requests are handled when individuals come to the office. Another 50 percent are phone requests and the remainder are dealt with by mail or fax (often after an initial phone request). The administrator hopes to expand the scope of operations in the department and provide services for additional hours. Other agencies in the government are not yet certain they want INFO to expand its activities.

There are large amounts of idle and nonproductive capacity related to buildings and equipment used by the agency. In fact, the percentages in most areas are quite similar to what you found in your analysis of private sector offices that serve similar functions for major corporations. The government works five days a week, is closed for 12 holidays a year, and each employee gets two weeks of vacation. The INFO Department is open for phone and in-person requests only from 10:00 to 3:00 during regular government work days. This keeps the agency from referring individuals to other government offices at the beginning and at the end of the day. There is the normal amount of maintenance, waste, and standby on copy equipment, phones, and other office features. This results in the equivalent of eight days per year of equipment downtime.

Each of the agency's six employees are full-time with scheduled work hours from 8:30 to 5:00 and a rotating 1/2 hour lunch. Employees are budgeted for 2,080 hours a year before considering holidays and vacations. Each of the employees is capable of working phone lines, answering the mail, and answering walk-in requests. One of the employees is the supervisor and spends approximately 50 percent of her time doing administrative work such as payroll, statistical forms, and other types of analysis. Further analysis shows that the typical employee takes a total of eight sick and personal days a year.

Your analysis shows that the time workers need for the existing work is quite variable and depends primarily on the volume of mail and fax requests. When the walk up traffic is slow or there is only limited telephone traffic, mail requests are dealt with between 10:00 and 3:00. Walk up traffic approaches a counter which has space to serve three people. There are four phone lines into the office.

Using statistical analysis you discover that about two percent of the forms mailed or faxed are incorrect and must be sent a second time (or the recipient must return to the office). Another three percent of the telephone and in-person information send people to the wrong department. This results in their returning or having to call the department again. Dealing with errors takes twice the time as a first time request.

If a person knows exactly what they want, an INFO employee can provide the necessary information over the telephone in 30 seconds or in two minutes at the counter. However, analysis shows that the average phone call takes three minutes and the average person at the counter uses five minutes of time. Preparing mail and fax materials takes about three minutes. An analysis of a typical day shows that each employee averages speaking with 40 individuals on the phone, talking to 12 people at the counter, and responding to 28 mail or fax requests. These numbers do not reflect second requests due to errors. Mondays and Fridays are the busiest days.

Equipment costs total $120,000 per year. Consumable supplies cost $30,000, and personnel costs for the agency are $180,000. Approximately 10 percent of supply use is for counter requests and 30 percent for telephone requests. The supplies for responses to mail and fax requests represent 60 percent of the total.

Required:

a. Provide a description of how you would analyze and classify the agency's personnel time into capacity categories. A complete analysis of all available hours is not necessary, but complete or partial numbers may help in your discussion. For example:

i. How would you measure rated capacity?
ii. How much standby capacity exists?
iii. How much waste is in the existing system?

b. How would you assign costs to the various types of capacity identified?
c. How well is this department doing on quality, cost, and time goals?
d. Is sufficient capacity currently available to provide service from 8:30 AM to 5:00 PM?
e. What changes would you suggest to better manage capacity?

Case 3: Golf Course.

The Shady Hills Resort and Golf Course asked you to do a partial capacity analysis of its golf course. Your analysis will focus solely on the golf course. It ignores the practice facilities, the tennis courts, the pool, or the clubhouse food service operations.

Shady Hills is an exclusive resort that encourages serious golf. The pace of play is set at four hours for 18 holes. Nine hole play is not permitted until 3:00 in the winter months and 4:00 in the summer. Tournaments use a shotgun start (all golfers start at the same time with as many as 32 groups of four possible for a tournament). All other play begins at the first tee. The course finds it can enforce the pace of play rules by scheduling tee off times eight minutes apart and every hour reserve one "four minute starters time" (when no group is scheduled). No more than four golfers may play in a group.

The resort course is in the South and is open for play (weather permitting) year around. During the winter months (November–March) play begins at 8:00 AM and all players must be off the course by 7:00 PM. In the summer (April–October) play starts at 6:30 AM and continues until 8:30 PM. An analysis shows that weather will cause the course to close (or delay play) an average of 290 hours a year. In addition the course is physically closed for extensive maintenance one week a year during the winter season. Other regular maintenance on the greens and fairways has the effect of reducing play by 50 percent for three additional weeks a year (one week each in April, June, and August) even though the course is open. During these periods the green fees are reduced by 25 percent to encourage play. The course does not refund green fees when there is bad weather, but will allow the individual the option of playing a round for half price when less than nine holes are completed. Approximately 800 rounds a year are played under this arrangement.

Because this is a resort course, it is open to guest play. However, approximately once a week the resort pro schedules tournaments that effectively close the course. Twenty six of these tournaments start at 8:00 AM and end at 12:30. The remaining tournaments start at either 12:00 or 1:00 depending on the time of year, with regular play resuming at 4:30 or 5:30. During the winter months the course has an average of 160 players complete a round each day, exclusive of tournament play. Winter tournaments average 110 players. During the summer months of April, May, September, and October, play averages 230 players, exclusive of tournaments. During this time there are 90 players per tournament. June, July, and August are very hot, and play falls to 170 per day plus 100 players per tournament.

A typical round of golf for a resort guest costs $80, while non-resort guests must pay $100. The ratio of guest to non-guest play is 3 to 1. For a tournament the fee is typically $120 with about half the entry fee given back to participants in pro shop credit. All rounds include cart fees that average $12.50 a person at other nearby courses. The cost of maintaining the course, cart upkeep, pro shop help, marshals, and other costs for a year are

budgeted at $4 million dollars. This does not include charges for the cost of the land, but does include a facility depreciation charge of $2 million a year.

Required:

a. Analysis of capacity for this type situation is quite complex and depends on the assumptions made.
   i. Make a preliminary analysis of the hours the course is in use, idle, and non-productive. Explain your analytical assumptions.
   ii. Extend your analysis to capacity based on rounds available and played. Explain your analytical assumptions.
   iii. Comment on the difficulties of measuring capacity for this type of organization.
b. Describe and illustrate how you would analyze the cost of a round of golf under current operating conditions.
   i. How would the capacity analysis help management make decisions on needed operating changes?
   ii. Would this type of analysis help the local pro communicate useful information to corporate owners of the course?
c. What are the important strategic quality, cost, and time decisions the management of this course has apparently made? How are each different from those made by a golf course that provides golf at the lowest cost per round? How do the strategic decisions made for this course influence the behavioral and cultural attributes that are in place? (Hint: Consider the effects of various changes that might be made such as allowing five rather than four to play in some groups.)
d. Make suggestions that might reduce the amount of time the course is not used productively.
   i. How would your suggestions impact the strategy of this resort course?
   ii. Would your suggestions require any major attribute changes?

NOTES

M O D U L E

Measuring and Managing Environmental Costs

Version 1.1

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Module Contents
Measuring and Managing Environmental Costs

Measuring and Managing Environmental Costs

PENNY WISE AND ENVIRONMENTALLY FOOLISH

"Gentlemen, I don't want us to be another Allied Signal. I want you to read this story because I am scared about our own exposure to lawsuits or fines over environmental issues. Are we in compliance with the environmental regulations? Do our accounting systems help us understand and manage environmental exposure? How much are we spending on environmental costs? Do we know what we're spending this money on, or understand the decisions we make that cause us to spend this money? Do we consider potential environmental impact as part of our decision making? Are we managing environmental costs to avoid exposure or to reduce them?"

These comments were made by George Plankton, a member of the Board of Directors of Prestige Paints Inc. at a board meeting, while he circulated copies of a highly negative newspaper story about Allied Signal.

The story Mr. Plankton referred to appeared in the Kansas City Star, July 8, 1988, with the headline: "Old Bendix site needs $287 million cleanup." The story recounted that in the late 1960s, a supplier recommended a new fluid for molding parts to Bendix (owned by Allied Signal). The fluid contained polychlorinated biphenyls (PCBs). In the 1960's, the adverse environmental impact of PCBs was not understood. The piping system used to circulate the fluids through the molding machines was already weakened from years of use. Plant engineers were concerned that corrosion from the new fluids might cause leaks in the pipes and result in spills. They suggested replacing the entire system of piping at a cost of less than $30,000.

Because the plant budget was very tight, management decided to repair the old equipment instead of replacing it with new equipment. Over time, corrosion caused by the PCBs further weakened the piping. In the mid-1980s the accumulation of frequent small spills of PCBs resulted in serious soil contamination on the plant property. The firm excavated 1,300 truck loads of soil and shipped these loads to an approved disposal facility at a cost of $250 million. One truck overturned en route, creating another environmental problem and adding to the adverse publicity for the firm. Because of concern that the contamination may have seeped into groundwater, the firm installed groundwater monitoring wells, at a cost of $150,000 each.

In response to Mr. Plankton's concerns and other board members' reactions to the newspaper article, the CEO of Prestige stated that his risk management people were aware of and were probably complying with environmental regulations. However, he knew that, like most companies, Prestige's accounting system did not routinely track environmental costs or consider the costs in decisions. He agreed with Mr. Plankton that environmental costs were important and should not be taken lightly. Following the meeting, he asked his accounting staff to undertake steps that would allow him to address the issues raised by Mr. Plankton.

Environmental costs are the costs incurred to control, assess, prevent, and correct failures from actions that potentially have an adverse impact on human, animal, or plant life. It includes pollutants in the air, soil, and water. This story exemplifies the situation facing most companies with respect to environmental costs. Spending to prevent adverse environmental impacts or cleaning up after environmental failures is a significant cost for most firms. Yet few have systems to measure and manage these costs.

▲ STRATEGIC IMPLICATIONS OF ENVIRONMENTAL COSTS

Management accountants face a significant challenge providing management relevant information about environmental costs and opportunities. Environmental issues are important to meeting the strategic goals of providing a quality product to a customer at a reasonable cost and on a timely basis.

- ▲ **Quality.** Increasingly consumers consider environmental safety as an important dimension of product quality. In 1990 a study of American consumers found that 90 percent of those interviewed were willing to spend more for environmentally benign ("green") products.[1] A similar study in Great Britain in 1989 found consumers were willing to pay as much as 25 percent more for environmentally friendly products.[2]
- ▲ **Cost.** Environmental costs related to disposal or recycling of products are significant for both producers and consumers. This makes managing these costs strategically important. For example, DuPont spends over $1 billion annually on environmental protection. For one pesticide produced by DuPont, 19 percent of the manufacturing costs are environmentally related.[3]
- ▲ **Time.** Unplanned environmental activities such as hazardous waste cleanup may make it difficult for the firm to meet delivery schedules. For example, Allied Signal's Kansas City Division had to close its plant for two weeks to flush the fluids from the system, inspect the pipes, and do extensive repair work. This made it difficult to meet contract delivery deadlines.

▲ PURPOSE OF THIS MODULE

This module deals with the measurement and management of environmental costs. It is designed to address the type of questions that Mr. Plankton raised at Prestige Paints. After reading this module, you should understand:

- ▲ Why there is an increased interest in environmental management.
- ▲ Terminology used in the area of environmental costing.
- ▲ How to collect, classify, measure, and report environmental costs.
- ▲ How to manage environmental costs by making them a part of organizational decision making.
- ▲ Technical, behavioral, and cultural attributes of environmental costing.

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[1] Abst. Assoc. Inc., *Consumer Purchasing Behavior and the Environment,* Cambridge, MA, November, 1990, cited in Frances Cairncross. *Costing the Earth: The Challenge for Governments, the Opportunities for Business,* Boston, MA, Harvard Business School Press, 1991, p. 190.

[2] Mintel International, *The Green Consumer,* London, 1989, cited in Frances Cairncross. *Costing the Earth: The Challenge for Governments, the Opportunities for Business,* Boston, MA, Harvard Business School Press 1990, p. 190.

[3] David Shield, Miriam Heller, DeVaun Kite, and Beth Belopp. "Environmental Accounting Case Study: DuPont," in *Green Ledgers: Case Studies in Corporate Environmental Accounting,* Washington, DC, World Resources Institute, 1995, p. 124.

▲ HOW HAS INTEREST IN ENVIRONMENTAL COSTS DEVELOPED?

Interest in identifying, measuring, and managing environmental costs is fairly recent. Historically, firms did not have to worry about polluting, and were relatively unconcerned about whether the emissions from smokestacks reduced air quality or whether untreated waste water dumped into rivers damaged the habitat and threatened the survival of wildlife.

The historical lack of concern stems from the perception that the industrial countries of the West had abundant, or even unlimited resources. Land which became unusable because of careless disposal of hazardous waste was frequently abandoned, and the polluter was able to avoid costs of cleanup.

As long as there was little public concern over environmental damage, the legal and regulatory system allowed polluters to shift the costs of cleanup onto the public. In recent decades, however, society's expectations have changed. Awareness of limited natural resources and concern for the quality of the natural environment have increased. Society has demanded that firms manage activities to minimize adverse impact on the environment. The Resource Conservation and Recovery Act of 1976 was a major landmark in environmental regulation. This law requires extensive recordkeeping to ensure safe handling of hazardous materials from "cradle to grave." This legislation, along with others such as the Clean Water Act of 1972 and the Clean Air Act of 1980 are forcing firms to recognize responsibility for reducing pollution from current activities. In addition, the Superfund legislation of 1980 imposed liability for hazardous waste on those parties which generated the waste, based on the *'polluter pays'* principle. Firms are now recognizing their responsibility for the cost of actions that impact the environment.

The changes in legislation and catastrophic events have led to heightened interest in measuring and managing environmental costs. This interest is expressed by managers, by industry trade associations, and by government. The U.S. Environmental Protection Agency (EPA) as well as the Society of Management Accountants of Canada (SMAC) have responded by issuing preliminary guidelines on environmental concepts, terminology, and strategy. The International Organization for Standardization is planning to release a new standard called ISO 14000 in mid-1996. This new series of standards will require companies to comply with environmentally-friendly practices in all aspects of business. If the new standards are as influential as ISO 9000, the organization's current standards on quality assurance, there will be a great emphasis on incorporating environmental safety as an explicit factor in all business decisions.

Dramatic environmental accidents such as Union Carbide's spill of methyl isocyanide at its plant in Bhopal, India and the Exxon Valdez oil spill in Alaska have heightened awareness of the need for sound environmental management and caused an important shift in the corporate culture of some firms. Rather than waiting for some external factor such as public pressure or regulatory action to force a clean up of environmental damage, some firms are taking a proactive approach.

The recent interest in environmental costing is motivated partly by the financially crippling affect of an environmental cleanup. Some firms recognize that costs to avoid pollution are sound investments, well justified by the long run savings of not having to remediate environmental damage. Others are beginning to recognize that paying attention to environmental costs may be good strategically in an era of growing cultural emphasis on environmental preservation.

▲ THE NATURE OF ENVIRONMENTAL COSTS

In order to measure and manage environmental costs, management accountants must first understand what gives rise to these costs. Organizations typically incur environmental costs for three reasons: (1) legal or regulatory; (2) societal or cultural; and (3) customer or business.

Legal or regulatory reasons stem from environmental regulations imposed by regulatory bodies. Government regulations such as RCRA or Superfund Legislation that impose safety or cleanup requirements on firms in the U.S. were previously cited. In Europe and Japan government regulations require companies to take back products, such as computer equipment, for recycling or disposal. Regulations create environmental costs for businesses.

Societal or cultural reasons stem from expectations of the society and culture in which firms operate. Today, most nations are acutely aware of the need to preserve the environment and to use natural resources carefully. Firms that operate in an environmentally friendly manner incur environmental costs to generate goodwill.

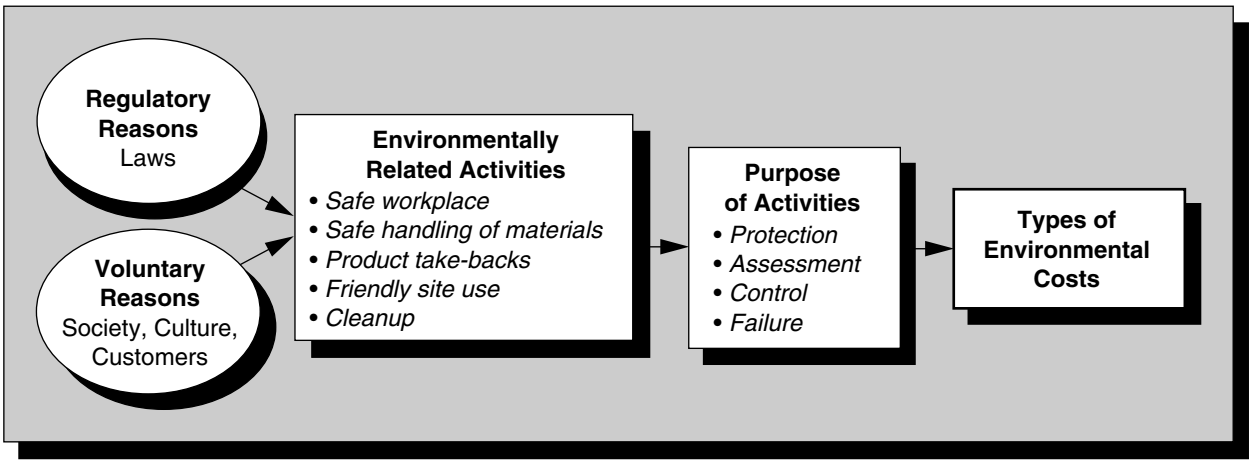
Customer or business reasons stem from customer requirements for environmentally safe products. Customers may want products that are easy to recycle or dispose. These create business reasons for incurring environmental costs.

Environmental costs incurred to comply with existing regulations are referred to as **regulatory or compliance costs.** Costs incurred by an organization on its own initiative to create goodwill or meet customer requirements are called **voluntary costs.**

Both regulatory or voluntary reasons create *environmentally-related activities* in firms. These activities, in turn, create different types of environmental costs. Exhibit 1 shows the relationship between the reasons for environmental action and the types of environmental costs.

As Exhibit 1 shows, environmental action is undertaken for regulatory or voluntary reasons. Both these reasons result in firms undertaking a wide range of environmentally-related activities. These activities, which have many tasks, include: providing workers

Exhibit 1
The Determinants of Environmental Costs



with a safe work place; safe handling of toxic or dangerous material, product take-backs for disposal or recycling, ensuring that a firm's operations do not damage the natural habitat of other species of plant or animal, and cleanup after spills or leaks.[4] These activities can be classified into four major groups according to *purpose*. Each class of activity leads to a corresponding environmental cost. The four types of environmental activities are:

- **Prevention activities** are undertaken to *eliminate* potential causes of adverse environmental impacts. Redesigning processes that create or use no hazardous materials in the first place is an example of prevention. In the case of Bendix (Allied Signal), the use of a non-toxic material instead of PCBs would be a preventive action. Costs associated with these preventive activities would be prevention costs.
- **Assessment activities** measure and *monitor* potential sources of environmental damage. Keeping track of toxic waste build-ups in plants, levels of mercury in waste emissions, paper work filed with the Environmental Protection Agency (EPA), or environmental audits are examples of assessment type actions. These create assessment costs. Throughout the 1980s Allied Signal's Kansas City Division had high assessment costs. The firm had to completely drain its piping system and use remote video cameras inserted into the piping to assess the extent of corrosion.
- **Control activities** are designed to *contain* environmentally hazardous substances that are used or produced. For example, using reinforced steel tanks to store chemicals is a way to control the chemicals to avoid damage from spills. Waste water treatment is another example of control actions. These actions create control costs.
- **Failure activities** are undertaken to *remediate* accidental environmental damage. An example of failure costs is the case of an Air Force facility which used solvents that contained ozone-depleting chemicals to clean machined parts. A six-gallon spill of the solvent eventually caused the facility to incur $6,000,000 in cleanup costs.

▲ MEASUREMENT AND REPORTING OF ENVIRONMENTAL COSTS

Assume that as a result of the board meeting Prestige Paints is interested in measuring environmental costs so the CEO can respond to the issues raised at the board meeting. (See opening story.) The following pages illustrate how to measure and report environmental costs using some hypothetical numbers from Prestige. The illustration is divided into three parts: (1) determining the total amount of environmental costs incurred; (2) classifying environmental costs into the four categories of prevention, appraisal, control, and failure; and (3) reporting environmental costs to managers.

Determining Total Environmental Costs.

To keep the example simple, take one department in Prestige and analyze its environmentally related spending. The purchasing department will be used because it is responsible for procuring and arranging for shipment and storage of hazardous materials. Further,

[4] For a detailed discussion of the various types of environmental activities being undertaken by corporations see Marc J. Epstein. *Measuring Corporate Environmental Performance,* Chicago, Ill. Irwin and IMA Foundation for Applied Research, 1996.

Exhibit 2
Prestige Paints Inc.—Purchasing Department Annual Costs

Cost Item	*Amount*
Salaries and fringe benefits—agents	$240,000
Manager salary	48,000
Facilities costs (space, desks, computers, etc.)	40,000
Supplies and materials	15,000
RCRA fine	20,000
Consultants fee	15,000
Total	**$378,000**

purchasing agents prepare and file required documentation with government agencies for these hazardous materials. Therefore, many of the department's costs are related to compliance with environmental regulations.

A traditional accounting system does not separate environmental costs as a separate cost object. The only information available for analysis is likely to be by departments and reported in traditional categories of wages, supplies, and other expenses. The costs of Prestige's purchasing department are shown in Exhibit 2.

To estimate environmental costs, the work of the purchasing department must be documented by interviewing knowledgeable personnel, observing them doing their work, and by using other data collection methods. These methods are a part of activity-based management (ABM) which is increasingly used by many organizations.[5] Exhibit 3 shows the data collected from the use of ABM data collection methods.

The data in Exhibits 2 and 3 can be used to calculate the amount spent on environmental costs. As Exhibit 3 shows, a great deal of the purchasing department's time is spent on procuring and arranging for proper transportation and storage of hazardous materials. Therefore, the total costs of $378,000 needs to be segregated into the amount spent in dealing with hazardous and nonhazardous materials. This analysis is shown in Exhibit 4. All common costs, such as purchasing agent salaries, are split between hazardous and nonhazardous materials based on the proportion of time spent by an agent in each category. These, in turn, are estimated on the basis of number of purchase orders processed multiplied by the number of steps required for each type of purchase order.

The analysis in Exhibit 4 shows that nearly three quarters (73.4 percent) of the purchasing department's costs are environmentally related. Assume that a similar analysis is performed on *all* departments of Prestige. This will give the firm-wide spending on environmental costs. Assume that approximately 15 percent of the company's *total* costs represent regulatory or voluntary environmental spending.

Think Along

Is it appropriate to conclude that Prestige's customers are paying 15 percent for environmentally related costs?

Prestige Paints is only one link in the chain of suppliers, dealers, and recyclers that service Prestige's customers. These other companies, commonly referred to as the value-chain or the extended enterprise, also incur environmental costs related to Prestige's products. Suppliers may incur costs of handling hazardous material, dealers have storage costs related to safe storage of paints, and even customers may have to dispose used paint cans safely

[5] See the module on Activity-Based Management (ABM) for a detailed discussion of how activities are documented.

Exhibit 3
Prestige Paints Inc.—Purchasing Department Activity Analysis

1. The department employs 8 purchasing agents with average salary and benefits of $30,000 each, and a manager with a salary and benefits of $48,000.
2. The department requires 20 hours of training per agent each year in hazardous materials recordkeeping procedures.
3. One of the 8 agents, with an annual salary of $30,000, spends half of her time interacting with warehouse personnel to advise and document appropriate handling of hazardous materials upon receipt. The rest of her time is spent processing purchase orders.
4. The department is expected to place 4,000 purchase orders this year.
5. Hazardous materials require 30 steps in the approval process prior to purchase; nonhazardous require 5 steps. Last year 40% of all purchased items were hazardous. This year's percentage is expected to be similar. (The total number of steps in the approval process will be used to assign salaries of agents to hazardous and nonhazardous materials.)
6. The manager of the purchasing department estimates that 25% of his time is spent in interacting with risk management personnel, studying regulations and solving problems workers encounter in purchasing hazardous materials.
7. The company paid a $20,000 fine last year because a hazardous material was stored in an improper container by the purchasing department.
8. Purchases of hazardous materials require approximately the same supplies and materials as do nonhazardous materials. (Actually, it was a little more, but the accountant did not feel the difference was worth tracking.)
9. Facilities costs will be assigned to hazardous materials based on the percent of salaries associated with handling hazardous materials.
10. During the past year the purchasing department hired an outside R&D consultant to study ways in which environmentally benign materials could replace hazardous materials. The study cost $15,000.
11. The plant operates on average 40 hours per week and 50 weeks per year or 2,000 hours per year.

imposing a cost as well. The total environmental spending in a paint can must include the amounts spent by suppliers, recyclers, dealers, and customers.

Analyzing total environmental costs incurred by all value-chain members can identify opportunities for joint efforts to reduce environmental costs. For example, Ashland Chemical learned that its customers were concerned about the disposal of spent chemicals. The company developed a "reverse distribution network" to collect spent chemicals from customers. The firm was able to create strategic advantage by developing technologies and markets for the recycled chemicals. Currently, as much as 60 percent of these chemicals are either recycled for reuse or used as fuel by the firm.[6]

Key Point

Jointly value-chain members can reduce a product's total environmental costs more than any one organization working alone.

[6] John R. Hall. "Recycling Waste into Profit," in *Business, Championing the Global Environment,* New York, The Conference Board, 1992, p. 12.

Exhibit 4
Prestige Paints Inc.—Environmental Cost for Purchasing Department

*Ref.**	*Cost Breakdown*	*Nonhazardous*	*Hazardous*	*Total*
1	Salaries and fringe benefits—agents			
4	Training (20 hrs. ÷ 2,000 hrs.) × (240,000)		$2,400	
3	Oversee storage (.5 × 30,000)		15,000	
2,3,5	Agent salaries (see Note 1 below)	44,520	178,080	$240,000
6	Manager's salary	36,000	12,000	48,000
	Subtotal before facilities	*80,520*	*207,480*	
9	Facilities cost allocated (see Note 2 below)	11,183	28,817	40,000
8	Supplies and materials (see Note 3 below)	9,000	6,000	15,000
7	RCRA fine		20,000	20,000
10	Special materials study		15,000	15,000
	Totals	**$100,703**	**$277,297**	**$378,000**
	Percentages	26.6%	73.4%	100%

*Reference numbers refer to activity numbers in Exhibit 3.

Notes

1. Of the total purchasing agent salaries of $240,000, training and storage account for $17,400. The remaining amount, $222,600 is assigned using number of steps in purchasing hazardous and nonhazardous materials. Of the 4,000 purchase orders (POs) processed, 1,600 (40%) are for hazardous items.

Number of Steps in Approval Process

	Number of POs	Steps per PO	Number of Steps	% of Total
Hazardous materials	1,600	30	48,000	80
Nonhazardous materials	2,400	5	12,000	20
Total	4,000		60,000	100

2. Facilities cost assignment is based on proportion of hazardous salaries to total salaries:

Salaries associated with hazardous materials	**$207,480**
Total salaries	**288,000**
Percent of salaries associated with hazardous materials	72.04%
Assigned facilities cost $40,000 × 72.04 =	**$28,817**

3. Supplies and materials cost: $15,000

Hazardous POs	1,600	40%
Nonhazardous POs	2,400	60%
Total	4,000	100%
Assigned supplies and materials cost:	$15,000 × 0.4 = **$6,000**	

Determining Reasons for Environmental Spending.

To determine why the purchasing department is spending $277,297 on environmental costs, Prestige must further analyze the *nature or underlying reason* for the environmental activities performed. Note that there are four basic environmental activities Prestige's employees perform. These are: (1) activities designed to remove any potential sources for environmental damage; (2) activities which monitor environmental impact; (3) activities which contain hazardous substances so environmental damage does not occur; and (4) remediation activities subsequent to an environmental accident. The accountant will need the purchasing department manager's help to classify work performed into these

activities. Once these activities are identified, the $277,297 can be assigned to the four categories of prevention, assessment, control, and failure.

Can you classify the activities listed in Exhibit 4 into these four categories using the definitions from the previous section?

Prevention costs.
Examining the activities identified in Exhibit 3, note that Prestige spent $15,000 (item #10) on a study to eliminate the use of hazardous materials. This is the only activity aimed at prevention.

Assessment costs.
Prestige's cost of training employees to be knowledgeable of environmental laws impacting the company, filling forms, and monitoring are assessment activities. Prestige spends $2,400 on training (item #4), and another one-half time agent (salary $30,000) for monitoring and reporting on storage of hazardous materials (item #5). The firm's assessment costs, therefore, are $17,400.

Control costs.
Most of the remaining costs of handling hazardous substances in Prestige (item #'s 1,2,3,6,8,9) are control costs. These costs relate to shipping, handling, and storing hazardous materials correctly and total $224,897.

Failure costs.
In Prestige's case, the $20,000 fine (item #7) represents a failure cost.

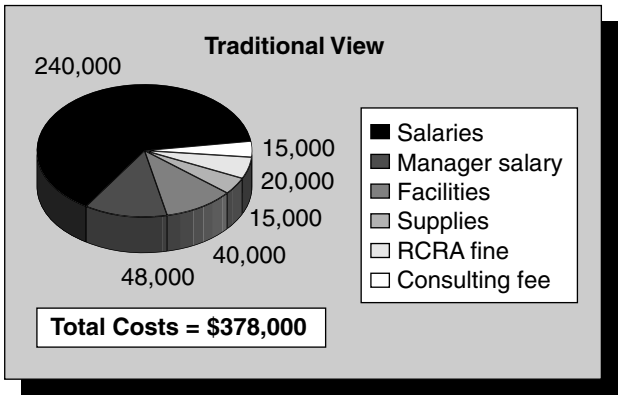
Exhibit 5 summarizes the classification of the purchasing department's environmental costs.

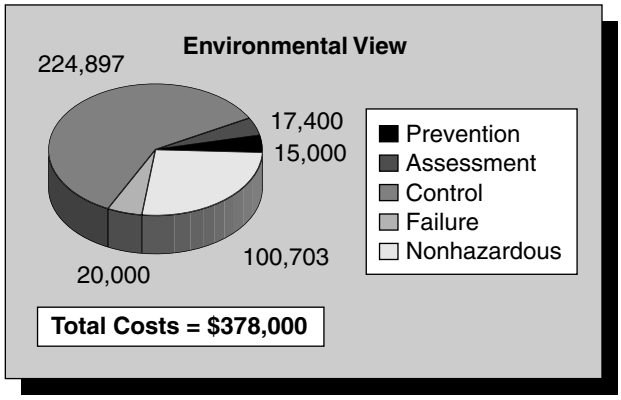
The same process can be used for all other departments. The distribution of costs across these four categories may differ in other departments. For example, in process engineering and R&D departments, the largest component of environmental costs probably will be for prevention. Inspectors from quality control may be used for monitoring related to environmental concerns. The environmental costs incurred in quality control probably will be primarily in the assessment category. Almost all cost incurred in the waste management department would be control costs. The maintenance department's costs of cleaning up spills will be failure costs.

Exhibit 5
Prestige's Purchasing Department—Environmental Costs by Environmental Activity

Environmental Activity	*Cost*	*Percent*
Prevention	$ 15,000	5.4
Assessment	17,400	6.4
Control	224,897	81.0
Failure	20,000	7.2
Total hazardous materials cost	**$277,297**	**100**

Exhibit 6
Prestige Paint—Purchasing Department Cost Two Views Through a Kaleidoscope





Key Point

> Environmental cost analysis represents an example of the kaleidoscopic nature of costs in today's complex organizations. It is a way to arrange the basic cost elements into a pattern that provides insights about the impact of environmental issues on an organization.

For example, in the purchasing department at Prestige, the total costs of $378,000 were originally classified into wages, supplies and materials, and facilities costs. This is a useful classification for the purchasing department manager to use in budgeting. To report on the cost of compliance, these same costs of $378,000 were reclassified as relating to purchasing hazardous or nonhazardous materials and further categorized as prevention, assessment, control, or failure costs. Exhibit 6 depicts these two views of the $378,000 total purchasing costs.

Think Along

> Assume that the result of a company-wide analysis results in a distribution similar to that shown in Exhibit 6 above. What conclusions can you draw about how Prestige is managing their environmental costs? How can they better manage these costs?

Using the results from Prestige's purchasing department, it is possible to address the questions raised at the firm's board meeting. Two things are apparent from the analysis. First, the company is approaching environmental costs as a necessary evil. This is reflected by the fact that most of its spending is for control and assessment. Second, environmental costs are not part of routine reporting to management and hence there is no way for managers to incorporate environmental issues in decision making.

Reporting Environmental Costs.

Environmental cost management has to go beyond occasional special studies of the type demonstrated for Prestige. Managing environmental costs requires a *routine reporting system* and an understanding of the *organizational decisions which cause environmental costs*.

Exhibit 7a
A Sample Environmental Cost Report

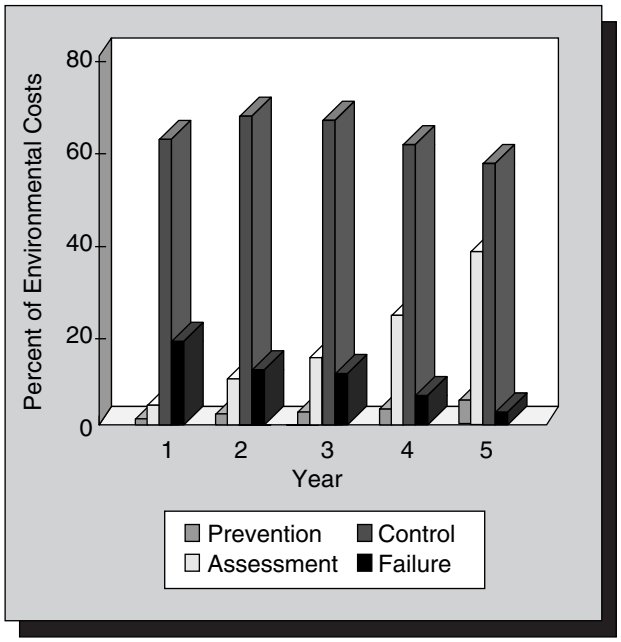
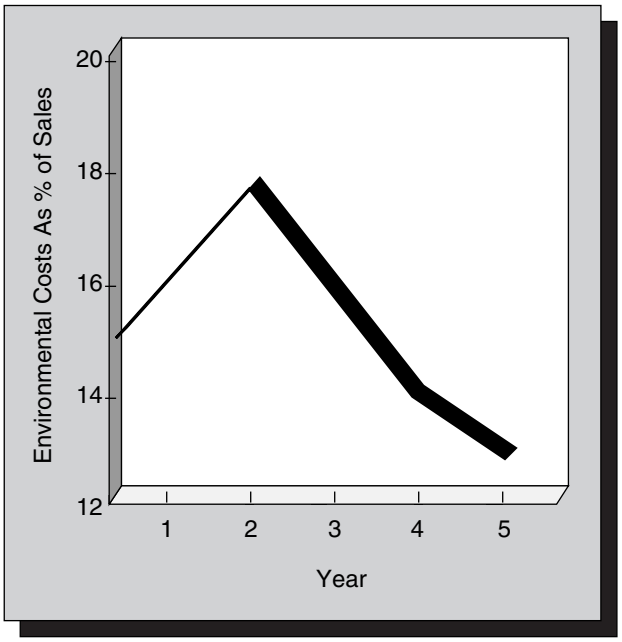


Exhibit 7b
Environmental Cost As Percent of Sales Revenue



Routine reporting of firm-wide environmental costs can be achieved through regular capture and disclosure of spending in the four cost categories in Prestige: prevention, assessment, control, and failure. Consider the presentation of these costs shown in Exhibits 7a and 7b.

The bar chart report in Exhibit 7a shows the environmental spending by categories as percent of total environmental costs. It allows assessment of tradeoffs. As spending on prevention is going up, assessment, failure, and particularly control costs are declining. This makes sense since prevention should decrease the need for costly cleanups later. Exhibit 7b shows the relationship between environmental costs and sales revenue. Total environmental spending increases initially as more is spent on prevention. It is then assumed to decrease as the company receives the benefit from reduced control and failure. This is an anticipated relationship since there has been little empirical research on what happens to environmental spending as spending on prevention increases.

▲ MANAGING ENVIRONMENTAL COSTS

The purpose of measuring and reporting environmental costs is to allow management of these costs. Environmental costs are seldom incurred or recorded in the organizational unit that causes these costs to be incurred. Costs related to environmental activities, such as waste treatment, legal costs, environmental insurance, or emergency preparedness, are typically incurred in production and support departments. These are, however, the result of decisions about the *product or processes* to use, the type of *equipment* to buy, or the *location* of the production facility. These decisions are typically made by other organizational units such as design and manufacturing engineering and the capital budgeting committee.

Managing environmental costs, therefore, requires explicit consideration of these costs in decision making. Three decisions that are particularly important in creating environmental costs are: the design of a product and the type of processes used to produce it, acquisition and modification of capital equipment, and selection of a plant site.

Think Along

> Can you think of the environmental costs created by some of the many different business decisions that organizations typically make?

To a certain extent, environmental costs can arise from nearly all business decisions. These include decisions about where to locate the plant, what products to produce, which production processes to use, what packaging materials and transportation mode to use to ship products, how customers use products, and how to dispose of used products. Examine three decisions that are particularly important in creating environmental costs: product/process design, acquisition of capital equipment, and plant location.

Product/process design.

In many industries, as much as 70–80 percent of product costs are determined by decisions made during the product and process design phase. Accordingly, opportunities to prevent these costs are more effective during the design stage. Features to include in products and the choice of manufacturing processes can create many environmental costs. For example, a feature such as a disposable container can create cleanup costs while a manufacturing process that requires acids may create costs for safe transportation and disposition of the acids. Many firms have begun to use an approach called "target costing"[7] which considers the impact of product/process design on all costs (production, distribution, marketing, service, support, and disposition/environment). Environmental costs can be better managed if such costs are explicitly considered, estimated, and minimized during the design of products and processes.

Acquisition or modification of capital equipment.

Another key decision that creates environmental costs is the acquisition of capital equipment. Unless managers are aware of environmental costs throughout the organization, they make equipment decisions that impact environmental costs elsewhere in the organization. For example, equipment may be purchased which requires cleaning with a hazardous substance, cooling with fluids which become contaminated during the production process, or lubricating with hazardous lubricants. The equipment may emit particles into the air that must be removed for worker's health. Running the equipment may require workers to use protective masks, gloves, or other items which slow their work. The equipment could have non-recyclable parts which must be routinely replaced. These parts may contaminate groundwater and require special disposal. Without a good understanding of environmental costs, the manager requesting the equipment will likely ignore these items in his or her financial analysis.

Plant location.

The selection or abandonment of a plant location is another area in which environmental costs arise and should be managed. Measures to avoid environmental damage can add considerably to the cost of new buildings or the modification of existing ones. A firm produc-

[7] For a detailed description of target costing see S. Ansari, J. Bell, and CAM-I Target Cost Group. *Target Costing: The Next Frontier in Strategic Cost Management,* Forthcoming, 1996 and the module on Target Costing.

ing circuit boards in the Los Angeles area decided to relocate after a major earthquake because of environmental considerations. It was determined that its above ground pipes carrying acids and chemicals for bathing circuit boards could cause a catastrophic failure during a seismic event. The cost of retrofitting the plant with pipes buried underground was extremely high. An analysis showed that it was less expensive to move to a more seismically stable location.

Think Along

How can Prestige ensure that environmental costs are routinely integrated into decision making?

To assist the analysis of organization-wide environmental cost impact, a checklist of potential environmental impact is suggested as a part of each financial analysis package for every product/process design, capital equipment, or plant location decision. The checklist, tailored to each organization's particular issues, would prompt the requesting manager to consider environmental costs beyond his or her own department. The information from the checklist would be the raw data used to assess firm-wide environmental impact. A sample checklist is provided in Exhibit 8.

Further, the firm's financial analysis software should include an environmental cost section. This section would be completed by management requesting the project with the assistance of accounting personnel. To complete the cost analysis, data on cost of the impact must be collected from the impacted department. The relevant data for this purpose is the additional cost expected by each department as a result of the proposed project.

Exhibit 8
Organization-Wide Environmental Checklist

Does the Product, Process, or Equipment:	*In Your Department (Y/N) If yes, explain.*	*In Other Departments (Y/N) If yes, explain.*
1. Require the use of hazardous raw materials?		
2. Require the use of hazardous lubricants?		
3. Require hazardous cleaning agents?		
4. Create waste water?		
5. Emit any substance into the air?		
6. Generate heat or noise?		
7. Cause employees to need special clothing/equipment?		
8. Require special equipment to offset environmental impact?		
9. Require plant or equipment modification to offset environmental impact?		
10. Have non-recyclable parts?		
11. Have parts that require special disposal?		
12. Require reporting to regulatory agencies (EPA)?		
13. Require inspections by regulatory authorities?		
14. Necessitate special storage facilities?		
15. Necessitate special transportation?		

Exhibit 9
Environmental Review of Projects—Sample Form

Project Description: Replacement of boiling unit with new model.			
Department: Manufacturing Shop 012			
Environmental Cost Category	***Estimated Cost***	***Actual Cost***	***Comments***
Prevention	$30,000	$33,000	Product reformulation & personnel training
Assessment	18,000	14,000	New emissions monitoring technology
Control	6,000	2,000	Emission filter installation
Failure	1,500	800	Expected cleanup from accidents

Every project's analysis would summarize this data into the four environmental cost categories: prevention, assessment, control, and failure. A sample environmental review form is presented in Exhibit 9.

The required use of the checklist and the environmental summary form assure that environmental impact is not unintentionally overlooked. The inclusion of actual cost on the form signals that a post implementation review will be performed. If managers know that actual costs will be compared to their estimated costs after the project is implemented, then they will be more likely to produce reasonable estimates. As the new financial analysis software comes on line and people become familiar with the reporting of environmental costs, environmental awareness will gradually spread throughout the organization.

Key Point

It is important to measure environmental costs even if the measures are somewhat imprecise. The long run financial impact of environmental damage can be serious enough to threaten the survival of a firm. Because of serious long term consequences, integrating environmental considerations into organizational decision making is critical.

▲ ATTRIBUTES OF AN ENVIRONMENTAL COST SYSTEM

The previous discussion clearly indicates that attention must be devoted to measuring and reporting environmental costs. To understand why such a system is desirable, consider its technical, behavioral, and cultural attributes.

Technical Attributes.

A good management accounting system provides information that is relevant to decisions and helps managers understand the processes underlying these decisions. The measurement and analysis of environmental costs provides managers with information relevant for decision making and improves understanding of the decisions and processes that give rise to environmental issues.

Decision relevance.
Future environmental costs are largely determined by product/process design, capital equipment, and plant location decisions made by management. These costs vary across the available alternatives facing managers. Measuring and reporting these costs assures that there is a database available for future decisions. In turn, this will decrease environment-related product and process costs. Further, provision of an environmental impact checklist causes managers to think about environmental costs not only within their own department, but also across all departments of the organization. In addition, measurement provides a way of incorporating environmental issues into more traditional financial analysis.

Measurement of environmental costs also encourages fact-based decision making. In some cases, when hard data are analyzed, common beliefs are not supported. For example, there is a common perception that the use of plastics is environmentally damaging. An East German study found, however, that using paper rather than plastic packaging would quadruple the weight of packaging and double the energy requirements for production. Facts not only improve decisions, but also provide a way of explaining decisions not consistent with common beliefs. This can improve management's confidence in decisions and help gain support for decisions made.

Process understanding.
Without a measurement system managers have nothing but an intuitive feeling for the amount of environmental costs their processes generate. Rhone-Poulenc implemented a waste-accounting system to measure the waste and related disposal costs at each of its plants. The initial reaction to the waste reports was shock. No one believed how much waste was being generated. As a result, "they were jolted from blissful ignorance about their true production costs."[8]

Managers need to know which activities and processes of a firm cause environmental costs. They need to understand what drives these activities and processes. For example, most procurement staff knows that purchasing hazardous materials is more time consuming than purchasing nonhazardous material. What they may not know is that purchasing cheaper material from a supplier today can create environmental costs upstream for production, distribution, and recyclers tomorrow. Costing these process level relationships, makes it easier to communicate to decision makers the costs they can create for others. This process understanding can lead to better cost management throughout the value chain and allow decision makers to identify and eliminate the root causes for excessive environmental costs.

Behavioral Attributes.

An important purpose of management accounting is to guide and influence actions to attain a firm's quality, cost, and time objectives. Environmental accounting measurements and reports must motivate managers to adopt a long term view on environmental spending and incorporate environmental prevention efforts in decision making. Environmental costing data helps motivate desirable behavior by making environmental issues *visible* to managers. Further, the environmental costing process *empowers* workers to participate in the organization's environmental efforts.

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[8] Kathleen M. Victory. *Case Studies in Corporate Environmentalism,* Cutter Information Corp., Arlington, MA, 1993, p. 19.

Visibility of environmental costs.
Environmental accounting systems make environmental costs visible throughout the entire organization. The old adage of "what gets measured gets counted," applies here. If an item is important to management, this priority is communicated throughout the organization by requiring measurement and reporting. Most firms provide at least lip service to environmental concerns, due to the publicity which has surrounded recent environmental disasters and Superfund cleanups. Internally, many are simply trying to comply by having workers perform more tasks and document what they do. Measurement and reporting environmental costs underscores that more than lip service is expected. It means that managers will be accountable for management of environmental issues.

Incorporating company-wide environmental impact into routine financial analysis holds a project's sponsor responsible for that impact throughout the organization. This encourages managers to adopt a firm-wide perspective. Reports provide environmental spending as a percent of sales over time, and show shifts in the portion of environmental spending devoted to prevention assessment, control, and failure. These reports orient managers toward *long run* environmental cost reductions by shifting their efforts and spending toward prevention. For example, an oil firm studied by Nikolai[9] found the choice of pollution control devices for refineries (wet gas scrubbers vs. electrostatic precipitators) involved hard tradeoffs. Wet gas scrubbers were more expensive, used more energy to operate, and took longer to install, but were chosen because of long-run concerns. The scrubbers were judged to provide greater long-run reliability as well as considered more likely to meet future regulatory standards, which presumably will become more stringent. Thus future failure costs are expected to be small.

Routine measurement of control and failure costs visibly demonstrates the costs of *not* acting to minimize environmental impact. This can help management resist the temptation to cut environmental programs in response to budget pressure. Employees at Pitney Bowes found that the most serious challenge was to gain support for its environmental program when the company was increasing emphasis on careful spending and operational efficiency.[10]

Empowers workers.
Workers have a vast amount of knowledge about how hazardous substances cause additional tasks and costs for an organization. The process of environmental costing solicits information from workers about those tasks and costs, and includes that data in cost management efforts. If that environmental information is incorporated into decision making, the workers' inputs have impacted those decisions. When workers feel that managers understand how their jobs are impacted and will use that knowledge to change the organization, they become empowered to participate further.

Cultural Attributes.

Good management accounting systems reflect values, beliefs, and mindsets that are important to an organization and society. The use of environmental costing reflects three important cultural values. First, it explicitly recognizes that developed nations value protection

[9] Loren A. Nikolai, John D. Bazley, and R. Lee Brummet. *The Measurement of Corporate Environmental Activity,* Montvale, NJ, National Association of Accountants, 1977, p. 82.

[10] Kathleen M. Victory. *Case Studies in Corporate Environmentalism,* Cutter Information Corp., Arlington, MA, 1993, p. 21.

of the environment, and demonstrates that the organization *shares* those *societal values*. Second, it serves to *change* management's *mindset* away from complying with environmental laws to searching for strategic environmental opportunities. And, third, it *frames environmental issues* to be mainstreamed in the organization and become a credible part of management and decision making.

Shares societal values.

This module began by giving a brief history behind the interest in environmental accounting. There it was acknowledged that society has developed expectations that organizations will be held accountable for environmental impact—past, current, and future. In industrially developed nations, laws have been passed which reflect those changed expectations.[11]

Environmental costing is an organizational response to this change in values. It is a way of sending a message to society that its values will be shared and reinforced in the organization. It is based on the belief that when environmental costs are routinely measured and reported, minimizing environmental impact will become ingrained in organizational culture. An organization's culture must reflect the values of the society in which it operates. If values are not consistent, it may not be possible to attract good employees, get good suppliers, obtain financing in capital markets, obtain contracts for products and services, and perform operations that require societal blessing.

Changing mindsets about environmental costs.

Firms typically approach environmental costs with three mindsets. These are: compliance, cost avoidance, and strategic.

A *compliance* mindset exists if environmental spending is driven primarily by the need to meet the requirements laid down in government regulations. This approach views regulatory costs as a necessary evil. In a compliance mindset, a firm's costing efforts are directed primarily toward calculating the costs of complying with existing regulations. It views regulations as a constraint to operating the way it would like. For example, an engineer proposing a process change may be asked to analyze not only the direct costs of the new process, but also any costs the process will generate to comply with existing regulations.

Cost avoidance typically occurs after a firm has gained experience with measuring compliance costs. Managers begin to appreciate that there is a tradeoff between prevention and other categories of environmental costs. They begin to move toward thinking about "spending to save" future environmental costs. Developing a "cost avoidance" approach requires special studies since environmental costs impact many different types of decisions.

A *strategic* mindset approaches environmental costs proactively. Managers seek opportunities to capitalize from environmental knowledge. Unlike the compliance or cost avoidance mindsets which approach environmental costs as **constraints,** the strategic approach views this as a business **opportunity.** There are many examples of firms using this approach to develop a market niche for 'green' products or for the environmental expertise it has developed. Dow Chemical has created a separate business unit, Dow Environmental Services, which provides consulting services based on its experience in minimizing the environmental impact of its own products and processes. This unit is expected to become a $1 billion business within a decade.

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[11] It is important to point out that there are differences of interpretation about environmental protection. What one party may see as environmental protection can be viewed by another as unnecessary cost increase. For example, the Prime Minister of Malaysia has resisted efforts by environmentalists to force his country to conserve its rain forests. In his view, western environmentalists are using this issue to interfere with his country's attempt to better its standard of living.

In an era when consumers are becoming more environmentally aware, a strategic mindset about environmental costs puts a firm ahead of the game. As environmental awareness is being integrated into school curricula, a future generation of green consumers is being created.

Key Point

It is important that firms manage environmental costs with a strategic mindset rather than a compliance or cost avoidance mindset.

Frames environmental issues.
Accounting serves as a language for organizations. It frames issues and sets the terms of debate around these issues. Measuring environmental costs and including these costs in reports makes environmental management a mainstream issue for managers. It says that conversations will be framed around how to deal with environmental issues and costs, not around whether these should be considered. When items get included in the accounting system, it means that management has decided to consider these items in decisions and take them seriously.

▲ ROLE OF THE MANAGEMENT ACCOUNTANT

A management accountant has an important role to play in an organization's environmental management system. The prior sections discussed how a management accountant can help by measuring and reporting environmental costs. He or she is also critical in assessing the cost effectiveness of environmental programs and in ensuring that environmental management does not create additional administrative costs for a firm. To perform these roles effectively and to interact knowledgeably with other technical personnel, a management accountant must understand the basic issues and terminology in the area.

A major factor which influences environmental costs is legislation. Many environmental costs are related to legal fees, fines, penalties, and damages which result from lack of compliance with regulatory requirements. In most firms, the primary responsibility for ensuring compliance with these regulations lies with functional areas such as legal staff or the environmental safety and health department. The management accountant, however, also needs to understand the implications of the new legislation.

Perhaps the best known environmental law is the Superfund Act, officially titled the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under this law, an individual or corporation may incur liabilities for costs associated with the clean up of hazardous waste disposal sites. The liability applies to both current and past owners of the property. The liability is *strict,* which means that a liability can be imposed even if the firm is not at fault. Superfund liability is also *joint* and *several,* which means that any one party can be held liable for the entire cleanup cost, regardless of what proportion of the waste that party contributed.

The EPA may either initiate cleanup activities itself or require the *potentially responsible parties* (PRPs) to begin site investigation and design of a remedy. If the EPA conducts emergency cleanup, it may later seek reimbursement from the PRPs. The average cost of cleaning up a Superfund site is estimated to be approximately $25 million. In addition to

the site remediation costs, a firm may be responsible for monitoring the site for 30 years after cleanup is complete, which of course creates additional cost.

The management accountant should be aware of several other environmental laws. The Resource Conservation and Recovery Act (RCRA) requires extensive recordkeeping to document the handling of hazardous materials. The Clean Water Act of 1972 is the main vehicle for addressing water pollution. It establishes a permitting system which sets specific limits on discharges of various substances, monitoring requirements, and provides for fines of up to $25,000 a day for violations. The Clean Air Act of 1980, later amended by the Clean Air Act Amendments of 1990 gives the EPA authority to establish limits on permissible levels of emissions for a few common pollutants and makes the knowing violation of any requirement a felony crime.

The management accountant also is responsible for external financial reporting and auditing of environmental costs and activities. An important financial reporting issue is the disclosure of environmental liabilities. When a firm is identified as a potentially responsible party (PRP) for the cleanup of a Superfund site, it must provide disclosure of a contingent liability. The Superfund legislation may impose liability on a single PRP for the entire cleanup, even though others may have contributed to the pollution. Further, present owners may have to bear responsibility for the cleanup costs even if the pollution occurred long before they assumed ownership of the property.

Because of the risk of major environmental accidents and related costs, environmental auditing is an essential element of environmental management. Environmental auditing is a relatively new field, and many terms do not have standard definitions. The Institute of Internal Auditors defines an environmental audit as "an integral part of an environmental management system whereby management determines whether the organization's environmental control systems are adequate to ensure compliance with regulatory requirements and internal policies."

▲ LESSONS LEARNED

There are several lessons to learn about environmental accounting:

- ▲ Society is demanding greater environmental accountability. Measurement and reporting of environmental costs are being developed in response to this demand.
- ▲ Environmental costs should be classified into amounts spent on prevention, assessment, control, and failure. The costs in these categories should be reported over time to gauge if spending on prevention is reducing total environmental costs as a percent of sales.
- ▲ Employee knowledge about how activities and processes are impacted by hazardous materials or wastes should be captured and used for assessing the environmental costs of future decisions.
- ▲ Value-chain members should be encouraged to participate in environmental costing and prevention efforts to help bring down the total environmental costs customers pay for in a product.
- ▲ Decisions involving product/process design, capital equipment, and plant location or modification should require a firm-wide environmental impact assessment. The cost of environmental impact should be estimated and routinely included in decision making.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

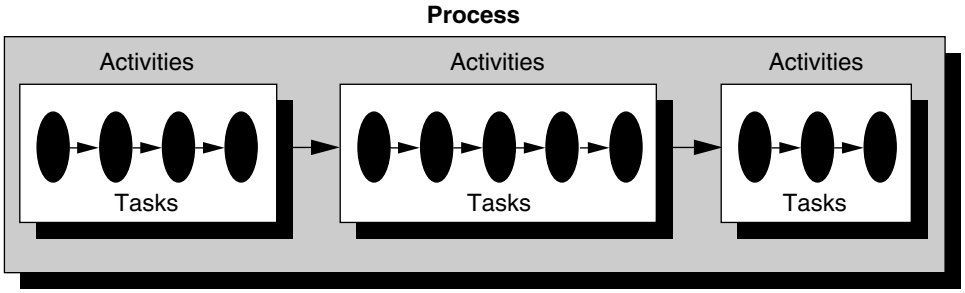
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL*

1. Self-test questions.

a. How might a product's quality be affected by the use of hazardous materials during production? Explain.
b. List three organizational costs that would be affected by the use of hazardous materials in production. Explain how these costs would be impacted.
c. How would the time taken to produce a product be affected by the use of hazardous raw materials?
d. Explain how environmental quality strategies can be used to increase the attractiveness of a product to consumers.
e. What specific types of employee training would be considered a prevention cost? An assessment cost? A control cost? A failure cost?
f. How does the kaleidoscope concept apply to environmental costs?
g. Why is the product/process design stage so important for environmental management?
h. How do decisions regarding the type of equipment used for production affect management of environmental costs?
i. If an organization is considering a location for a new plant, what should be taken into consideration from an environmental viewpoint?
j. How can technical information be used to make decisions regarding environmental costs?
k. What measurement issues are involved in gathering environmental cost information?
l. Can environmental costs be determined from an organization's traditional financial statements without a special study or reorganization of information?
m. Ideally total environmental costs decrease over time. How is this possible?
n. How can managers be made more accountable for environmental costs?
o. Explain the meaning of an environmental cost avoidance strategy. Why would a firm use this strategy?
p. Explain the meaning of a strategic environmental approach. How can a mindset of strategically managing environmental costs increase a firm's competitiveness?
q. If an organization's strategy is to be a low-cost, high-quality producer of batteries, what environmental issues must be considered?
r. Why might an increase in prevention costs cause a shareholder backlash?
s. How might managers' react to increases in prevention costs?

2. Classify the following costs as prevention, assessment, control, or failure. Also explain your classification, and whether each could be considered in more than one category.

a. Consulting fees paid for a study of damage resulting from the past use of hazardous chemicals.
b. Fees paid for an environmental assessment of land being considered for purchase.
c. Fees for an audit undertaken to determine level of compliance with regulations.
d. Damages paid to neighboring residents experiencing health problems due to emissions of a hazardous gas.

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* A number of problems and cases for this module were contributed by Cynthia Thomas of Westminster College, Missouri.

e. Chemical analysis of compounds used in the production process.
f. Medical costs to employees exposed to hazardous materials.
g. Training of new employees on the handling of a hazardous substance.
h. Maintenance costs for a waste treatment holding tank.
i. Equipment purchased to monitor a waste filtration system.
j. Equipment purchased to store hazardous waste.

3. Provide an example of an environmental cost incurred by an airline that would fall into each of the following categories.

	Regulatory	***Voluntary***
Prevention		
Assessment		
Control		
Failure		

4. Anna Co. and Brett Inc. are both manufacturers of agricultural pesticides. Due to the nature of this business, both companies experience significant environmental costs.

Anna Co. was fined two years ago following an EPA inspection of its waste disposal procedures. Because Anna does not want to incur such fines in the future, management started measuring some environmental costs. The desire was to know the magnitude of environmental costs, which were determined by first isolating obvious items. Since the cost analysis was undertaken, Anna Co. has found several areas where it can distinguish itself from other pesticide producers. The company has hired an advertising agency to develop a marketing plan for this niche.

Brett Inc. has a corporate strategy of increasing market share by being a low-cost producer. All departments have been working to reduce costs, while maintaining quality and compliance with applicable environmental regulations. Costs of complying with environmental regulations have been identified as costs that cannot be reduced. Brett Inc. has never been cited in violation of any EPA guidelines and wants to assure that this record continues.

Required:

a. What evidence can you cite to suggest Anna Co. is in a compliance mindset? Cost avoidance? Strategic? Which mindset seems to dominate?
b. What evidence can you cite to suggest Brett Inc. is in a compliance mindset? Cost avoidance? Strategic? Which mindset seems to dominate?

5. Environmental issues often involve tradeoffs between product quality, cost, and timeliness. For the following items, provide a specific example of a decision that would result in the tradeoff described. Consider each independently of the others.

a. Increase product cost but decrease environmental costs from capital equipment.
b. Decrease environmental costs from capital equipment, but increase process time.
c. Decrease product cost, but increase environmental costs.
d. Increase time of product design, but decrease environmental cost.
e. Retain plant location, but require a change in process design.

6. Davis Corporation is a manufacturer of computer monitors. It currently has five plants in various locations. Current environmental spending for each of the plants is presented below.

	Type of Cost				
Plant	***Prevention***	***Assessment***	***Control***	***Failure***	***Total***
Clark	$11,000	$14,000	$75,000	$20,000	$120,000
Tahoe	6,000	19,000	8,000	9,000	42,000
Rico	31,000	15,000	12,000	7,000	65,000
Sparta	61,000	32,000	21,000	4,000	118,000
Burrows	500	1,500	3,000	20,000	25,000

The cathode ray tubes (CRTs) used in Davis' monitors are considered a hazardous material because the glass is leaded, and heavy metals are included in the phosphors in the tubes. All plants are being encouraged to find solutions to decrease the costs of land filling the CRTs that are disposed of when Davis obtains computers and monitors through trade-in, donation, or failure to pass inspection. The Clark and Tahoe plants produce the older models of monitors. The Rico and Sparta plants were built in 1989 and 1991, respectively, and produce the newer models. The Burrows plant is the oldest in the company. While it was used for monitor production in the past, it now mainly assembles the monitor shells as a supplier to the other plants who add the "insides."

The Tahoe plant manager is concentrating on proper disposal of the CRTs in a landfill. However, the manager at the Sparta plant is very environmentally conscious and has just developed a method of handling the CRTs. He sends these to a recycler that crushes the glass for use in new CRTs.

Required:

Based on the environmental spending as presented, analyze the five plants' environmental spending and propose a solution for each of the following scenarios:

1. As controller of Davis Corporation, the president has asked you to analyze the plants' environmental performance. Which plant would you specify as an environmental leader? Which needs the most improvement? On what did you base your conclusions?
2. A broker asked whether Davis would be a good company to recommend to her clients who are interested in investing in businesses that are environmentally friendly. Would you recommend Davis Corporation? Why or why not?

7. Below is a list of obstacles that may be encountered in an organization's attempt to adopt environmentally conscious production methods.

a. Lack of objective, verifiable cost information.
b. Desire to continue familiar practices, doing things the way they have always been done.
c. Concern that product quality may be hindered due to a change in processes.
d. Concern that processing time may be extended due to a change in processes.
e. Fear that visibility of an environmental hazard could instigate additional regulations.
f. Regulatory uncertainties.

g. Concern over long-term stability of markets for recyclable products.
h. Long-term corporate commitment to recycling or waste reduction programs.

Required:
Which of these obstacles are technical, which ones are behavioral, and which ones are cultural? Explain your reasons for classifying.

8. The following information about the production division of Dade Production Co. was obtained from the accounting records.

Cost Item	*Amount*
Salaries and fringe benefits—workers	$900,000
Manager's salary	65,000
Raw material and supplies	215,000
Machinery rental	150,000
Facilities' costs (space, desk, computer, etc.)	140,000
RCRA fine	90,000
Consultant's fee	45,000
Total	**$1,605,000**

Further analysis revealed the following:

a. The department employs 30 skilled workers with average salary and benefits of $30,000 each and a manager with a salary and benefits of $65,000.
b. The department requires 30 hours of training per worker each year in hazardous materials handling and recordkeeping procedures.
c. One of the workers spends 2/3 of her time interacting with warehouse personnel to advise and document appropriate handling of hazardous materials upon receipt. The rest of her time is spent in production.
d. The department is expected to produce 3,000 finished items this year.
e. There are nine steps in the production process. Two of these involve hazardous materials, and each of these steps takes six times as long to complete as the other steps.
f. The Department Manager estimates that 30 percent of his time is spent interacting with risk management personnel, studying regulations and solving problems workers encounter in working with hazardous materials.
g. Last year the company was fined $90,000 because a hazardous material was stored improperly.
h. The use of hazardous materials require approximately the same supplies and materials as do non-hazardous materials.
i. Facilities' costs and machinery rental will be assigned to hazardous materials based on the percent of workers' salaries associated with handling hazardous materials to total salaries cost.
j. During the past year the department hired an outside research and development consultant to study ways in which environmentally benign materials could replace hazardous materials.

Required:

1. Determine the amount of environmental and nonenvironmental costs.
2. Classify the production department environmental costs into the categories of prevention, assessment, control, and failure.
3. Design a report for the environmental cost information that will allow the production department employees to understand the impact of using hazardous materials on costs. These are workers who generally do not receive accounting information and are unfamiliar with traditional accounting terminology such as facilities' costs or the process of allocation.

9. Jay Thomas runs an automobile service station. The station is housed in facilities leased for $5,800 per month which includes rent on equipment and service bays used for oil changes, tire changes, and weather checks. Approximately 25% of the rent is attributable to service bays and 75% is to gasoline sales. Jay employs 6 employees who are paid on average $8 per hour.

Jay realizes that many hazardous substances are handled on a daily basis in his station. He would like to determine the environmental cost associated with each type of service. He needs to know whether his charges are sufficient to cover those environmental costs, or whether the cost is such that the service should be discontinued. Jay has analyzed each service he provides and assembled the following information.

Oil Changes. A complete oil change generally takes a half an hour to perform. For each vehicle, the filter must be replaced, and the old oil drained and placed in a waste oil storage tank. Jay's cost for new filters averages $1.35 each. Most vehicles require 5 quarts of oil at $0.50 per quart. In addition, the oil storage tank, purchased at a cost of $3,500, holds 400 gallons of used oil. Each oil change adds 1.25 gallons of fluid to the tank. Jay estimates that the use of the oil storage tank costs $0.10 per oil change. A local waste hauler empties and disposes of the oil in the tank at a charge of $10 per month. About 10 minutes of each oil change is spent complying with EPA guidelines for oil and filter disposal.

The EPA requires Jay to charge (and show on the sales ticket) a $1.50 fee for oil and filter disposal. In the past Jay has shown this on the sales ticket, but has discounted his charge an equal amount. This practice is commonly followed by his competitors.

Tire Installation. It takes approximately one hour to install 4 new tires. Normally, Jay sells and installs 30 sets of new tires per month. Old tires are placed in a designated area for scrap tires. This area occupies 1/10 of the work bay area. Removal of scrap tires must be done by a registered disposer of scrap tires, who charges $1.00 per tire. Jay passes this cost to his customers.

Weather Checks. In the spring, air conditioning and coolant checks become a staple part of Jay's business. A weather check requires 1.5 hours to complete. Freon and coolants, drained during weather checks, are both considered hazardous substances. However, Jay is able to recycle these substances through individual filtration systems. The filtration systems were purchased for a cost of $3,850 each. Jay estimates that the cost of these systems is $1.50 per weather check. The filters in the coolant tank must be replaced once a month; this costs Jay $30.

The freon system stores freon until the tank is full and then compresses the freon to remove excess water. This drying process reduces the liquid by 50%. Jay performs the drying process 5 times per year. Each drying uses two filters which cost $15 each. The

recycled freon is stored in another container and used to fill vehicles as needed. The storage tanks for coolants and freon occupy 5% of the work bay areas.

Other. Training and certification for the handling of hazardous substances is required for all new employees. This is generally accomplished in a 6-hour course offered locally by a national automotive chain. Cost for the course is $100. Jay has an employee turnover rate that requires him to hire around 6 new employees each year. Usually 4 of these have previous experience and certification and do not require the EPA training.

Additional information about Jay's sales is provided below.

Budgeted Revenue	
Oil changes—320 per month @ $12.95	$4,144.00
Tire changes—30 per month @ $19.95	598.50
Tire sales	10,350.00
Weather checks—15 per month @ 44.95	674.25
Gasoline sales and other services	12,450.00
Total revenues	$28,216.75

Required:

a. Compute the total cost per month for each type of service: oil changes, tire changes and weather checks.

b. Develop an environmental cost analysis similar to Exhibit 3 of the module classifying the costs from requirement (a) as environmental or nonenvironmental.

c. Calculate the amount Jay spends for prevention, assessment, control and failure costs.

d. Are there any services Jay should consider discontinuing?

10. The Energy Division of the State Department of Natural Resources recently received an employee suggestion for the office to begin a recycling program. The director and other top officials agreed that the agency image would be enhanced by promoting efforts to recycle. Recycling would be beneficial to the division's employees and eventually would spread to other state agencies. Waste reduction has become more of a cost issue as well since disposal costs have risen 70 percent over the last five years. The department budget requires that office maintenance costs, which includes waste disposal, be kept flat for the next year.

As the division accountant you have been assigned the project of determining what costs are involved in implementing a recycling program. There is only a minimal amount of money available for any type of recycling program. You are also aware that as the accountant, you may influence the outcome of a decision such as this by the information you present. Should recycling not show a cost reduction or positive benefits, the program may not be instituted. The importance of linking recycling and waste reduction to the division's image will be important.

Required:

Outline the items that should be considered in a one to two page memo to the director. Be sure to include technical, behavioral, and cultural aspects of recycling.

11. Team Project. In 1995, the EPA began six new voluntary partnership programs in conjunction with its *Green Lights* efficiency and *Energy Star* programs. These programs encourage the use of energy-efficient equipment, conservation in energy usage, and reduction in air pollution. Investigate library and Internet sources to find information about instituting an *Energy Star* program in an office. What is involved in an *Energy Star* partnership? What costs or cost savings would be involved? What other advantages or disadvantages would be relevant in establishing such a partnership?

12. Team Project. Contact a local business and identify an environmental issue the firm faces. If the firm does not identify environmental costs, interview personnel and observe production processes. Prepare an environmental checklist similar to Exhibit 8. If the firm is aware of environmental issues within the operations, pick a product, group of products, or a process and prepare an Environmental Review similar to Exhibit 9. Analyze your findings. Design and prepare a report for the business explaining your results and analysis.

13. Team Project. Shell United Kingdom's plans to dispose the Brent Spar (oil platform) in the North Sea became public in January 1995, when Greenpeace discovered documentation of the plan. The plan was abandoned when several European governments protested, and Greenpeace activists landed on the platform and chained themselves to it to prevent its sinking. By fall of 1995, some news reporters were acknowledging that they may have been led by situational emotions, and the facts of the case may have been on the side of sea disposal. How to dispose of these oil platforms will be an ongoing problem; in fact in the United Kingdom approximately 50 platforms will have to be disposed in the next ten years. Research the disposal of oil platforms and prepare a report presenting information that Shell might have released to the public to gain acceptance of its plan. Consider the technical, behavioral, and cultural aspects of Shell's information.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

Case 1: Chesterfield Municipal Landfill.

"Sharon, we can't propose close to 50 percent increases in our monthly trash collection charges! It would be political suicide. I don't have to remind you that if I lose November's election we'll both be looking for new jobs." Mayor Jim North of the city of Chesterfield was meeting with the city's Director of Finance, Sharon Slater, to prepare for the upcoming budget hearing.

Sharon responded: "Jim, we're really caught here. You know we have to cleanup the old Brownsville Road Landfill. Our planned bond issue will provide the short-term cash flow for the cleanup, but trash collection fees must pay off the bonds. The Solid Waste Management Fund cannot make bond payments without this increased revenue and also comply with City Council's requirement to operate with revenues exceeding expenditures by 1.25 percent."

As Jim and Sharon concluded their meeting, Jim was discouraged. He asked Sharon to prepare a detailed cost analysis of landfill operations, including cleanup costs for the Brownsville Road Landfill.

The old Brownsville Road Landfill.

In April 1995 the EPA notified the city that the Brownsville Road Landfill, which had been closed since 1991, was being investigated as a possible hazardous waste site. Acting on

complaints from citizens about odors and rodents, the EPA had performed a preliminary Remedial Investigation and Feasibility Study (RI/FS) of the old landfill site. As a result of the study, the EPA placed the site on its National Priorities List of the most serious hazardous waste sites. As the current owner of the property, the city of Chesterfield was designated as a potentially responsible party (PRP) under the *Comprehensive Environmental Reclamation and Cleanup Liability Act,* commonly referred to as the Superfund Act.

The EPA study found that the waste at the Brownsville site contained volatile organic compounds (VOCs) which represented significant danger of explosion. As a short term safety measure, the EPA had fenced the landfill and posted warning signs. The EPA was seeking reimbursement of $2.2 million from the city for the cost of conducting the preliminary site investigation and installing the fencing.

The cleanup approach recommended by the EPA was to pump the contaminated groundwater and treat it by air stripping. This technique forces contaminated water through a pressurized air stream inside a tower filled with packing material. In this process, the contaminants are transferred to the air stream which is then collected and treated. Air stripping is proven technology, and can remove approximately 95 percent of the contaminants from the groundwater. The cost estimate for the air stripping process is $28 million.

Following the groundwater treatment, a clay cap would be constructed to prevent rain water from leaching hazardous materials into the groundwater. A multi-layer design had been proposed which would include a water-resistant layer two feet thick and a one-foot thick drainage layer. Finally, the cap would be covered with top soil and vegetation. A contractor had submitted a bid of $5.4 million for the job. Sharon had estimated that ongoing maintenance of the cap could be done by the city's Public Works Department at a cost of $240,000 per year. A bond issue was intended to fund the **one time** costs of cleaning up the landfill. However, the annual maintenance would have to be met from annual revenues. The city is obligated to pay 8% interest on these bonds and must set aside 2.7% of the total bond principal in a sinking fund for the replacement of this principal.

Sharon began her analysis by reviewing contracts the city had signed for work at the Brownsville site. These included two groundwater monitoring wells, constructed at $75,000 each, and extension of the municipal water system at a cost of $720,000, to replace drinking water wells used by residents near the site. The city also paid $85,000 in outside attorney fees related to the negotiation and litigation with other potential PRP's.

Sharon knew that in addition the city attorney's office had spent an estimated 600 hours on the case, which was costed at the rate of $150 per hour. The Director of Public Works also spent over 100 hours providing information to both attorneys' offices. His time is charged at $35 per hour.

Current trash collection charges and costs.

The city currently serves 29,270 households and 2,150 businesses. Residential customers are currently charged $12 per month and businesses $28 per month for trash services. The current operating costs for trash collection and landfill operations is $4,810,000. This does not include the one-time clean up costs or the additional maintenance costs for the landfill. The one-time clean up cost, paid by the bond issue, requires an annual transfer to a debt service fund for the principal and interest on these bonds. The bonds carry an annual interest rate of eight percent paid semiannually. The entire principal is due in 20 years.

Required:

1. What is the cost of cleanup for the old Brownsville Road Landfill?

2. What is the annual cost of the landfill cleanup, including amounts to retire the bond issue?
3. What are the net cash flows from landfill operations in the upcoming year?
4. What price increases are necessary to keep the Solid Waste Management Fund solvent and in compliance with the city council charter?
5. Should the city price hazardous and nonhazardous waste differently? If not, why? If so, what should be considered when determining the prices it should charge?
6. Assume you are a new city manager of a small city. Jim is a friend of yours and has told you about Chesterfield's experience. What lessons can you learn to help your city avoid similar problems?
7. Prepare a memo Jim might write for the City Council briefing them on the need for the increase in landfill charges. Assume that no one on the City Council has any accounting background, so the memo must explain the technical accounting issues in layman's terms. Limit the length of the memo to no more than two single-spaced typed pages.

Case 2: Bryan Aerospace Inc.

Bryan Aerospace Inc. is a large defense contractor located in the Southwestern U.S. Bryan produces safety devices for nuclear weapons systems. One of its products is the "strong link," a safety trigger used to prevent weapon systems from firing accidentally. A strong link costs $45,000 to produce, has more than 300 moveable parts, and is about the size of a pack of cigarettes. Because of its critical functionality, the production process for the "strong link" is extremely precise. Even a tiny speck of dust left in the product can impair its long run reliability.

Bryan's production facility is owned by the U.S. Government and leased to Bryan. It is known as a government-owned/company-operated (GOCO) facility. The facility is located near a river which is used both for the city water supply and for recreation. The plant is the largest employer in the area, and normally has approximately 4,500 employees. With the cutbacks in defense spending in the early 1990s, the number of employees has shrunk to 3,000.

Industrial cleaning project.

In 1995, John Beckley, Vice President of Environmental Health and Safety, convinced Bryan's president to undertake a study of alternative cleaning methods to eliminate the use of chlorinated solvents. Bryan used these solvents to clean printed circuit boards and machined parts. These are called chlorinated solvents because of containing chloroflourocarbons (CFCs) and chlorinated hydrocarbon (CHCs), both suspected to deplete the earth's ozone layer. As such both CFCs and CHCs are subject to the Montreal Protocol, an international treaty signed by the United States and several other countries, which requires the phasing out of ozone depleting chemicals by the year 2000.

A multidisciplinary project team was formed to investigate alternative cleaning methods. The project, referred to as the Industrial Cleaning Project (ICP), was formally announced at the monthly staff meeting in September 1995. One manager complained that the plant had already been through more than enough of these "spotted-owl programs," referring to the various environmental programs the company had instituted over the years. Several managers shared the reaction of the manager of Department 28, who commented,

"Sure, we need to preserve the environment, but my department uses such small amounts of CFCs that it's not a problem worth much ado about."

Beckley was perplexed. He knew plant-wide use of chlorinated solvents was substantial. He also knew that the original selection of the cleaning process was not thoroughly researched. The original choice had reflected a belief on the part of engineers that chlorinated solvents were the best technological way to clean. Beckley knew that the choice of cleaning process needed to be reconsidered, and he didn't want the ICP to die for lack of support from production people. To convince them, he asked accounting to prepare a monthly summary of CFC usage by department, based on materials requisitions. When he presented this report, which included cost figures, at the next monthly staff meeting, the department managers were surprised that the amount of CFC usage across the firm was so large. The cost and use data helped to mute some of the opposition to the project, and there was a readiness to take a harder look at the issue.

The ICP team evaluated the existing method of cleaning with chlorinated solvents against two other options—the use of alternative solvents which do not contain ozone depleting chemicals, and cleaning with water-based detergents, referred to as aqueous cleaning. While engineering and production personnel researched the technical properties of the three cleaning methods (chlorinated solvents, alternative solvents, and aqueous cleaning), Dale Johnson, the cost analyst on the ICP team, began a comprehensive cost analysis. The engineering and production people concluded that the two alternative cleaning methods were relatively safe and reliable and could be used by the firm. Dale discovered that environmental costs were not considered in the original decision to use chlorinated solvents.

Environmental cost analysis.

In performing his environmental cost analysis, Dale relied on a talk he had heard recently at a conference on environmental issues in accounting. The speaker had described a method which classified environmental costs into four categories: prevention, assessment, control, and failure. **Prevention costs** are costs incurred to prevent or avoid environmental impact. **Assessment costs** are associated with measuring and monitoring environmental impact. **Control costs** are incurred to control, or limit, environmental damage resulting from hazardous materials in use at the plant. **Failure costs** are costs associated with unplanned, accidental environmental damage.

This approach to measuring and managing environmental costs appealed to Dale because it was very similar to the quality cost analysis already used by the firm. Dale realized that the whole idea of measuring environmental costs was very new, and thought it would be more readily accepted if the methods used were familiar. Also, the firm's Total Quality Management system had been in place for several years, and a "zero defects" mindset was becoming a part of the organizational culture. The Environmental Safety & Health group was following a similar approach by adopting a slogan of "zero emissions, zero waste" program.

Through analysis of cost information, observation of the production process, and interviews with relevant employees in the production, human resources, waste management, quality control, and environmental health and safety departments, Dale accumulated the cost data needed for the project. He grouped the costs related to the cleaning process into seven categories. These categories are briefly described in the following text. The costs are summarized in Exhibit 10.

1. **Cleaning Agents.** Comparing the purchase costs for the cleaning agents for the three types of processes, Dale discovered that the $42 average price for chlorinated solvents included $20 per gallon in pollution taxes.

Exhibit 10
Cost Data for the Industrial Cleaning Project Analysis

	Chlorinated Solvents	*Alternative Solvents*	*Aqueous Cleaning*
Cleaning Agent			
Purchase price	$ 42[1]	$16	$.73
Usage (in gallons per year)	1,600	1,840	1,100
Personnel			
Time			
Cleaning operations	22,000	18,400	13,800
Cleaning related training	1,250	1,300	2,850
Studying MSDS's		62	
Waste water pH testing			2,170
Inspections	575	300	940
Chemical analysis of waste	175	135	850
Emissions monitoring	290	243	
Average hourly rate	$40	$40	$40
Equipment and Facilities			
Cost of existing equipment	$96,000		
Cost of new equipment[2]		$65,000	$18,000
Retrofitting	$126,000		
Rinse tanks			$8,000
Drying ovens			1,300
Installation		$ 3,250	4,500
Floor space (in square feet)	40	52	180
Utilities			
Electricity	$3,600	$3,550	$13,900
Water	$1,800	$1,650	$22,800
Other Operating Costs			
Special handling of shop towels[3]	$6,000	$7,500	
Special containers for waste	1,600	3,200	
Waste hauling	16,000	12,000	
Emergency preparedness[4]	5,800	12,500	
Eyewash stations	3,500	2,800	
Wastewater treatment			115,000
Disposal of residual sludge			96,000
Special Items			
Accident cleanup	$25,000		
Fines	13,500		
Overhead			
Material related (per material dollar)	$0.60	$0.60	$0.60
Personnel related (per labor dollar)	2.90	2.90	2.90
Facilities related (per square foot)	218	218	218

[1] Includes pollution tax of $20 per gallon.
[2] Depreciation method used is straight line and useful life is 3 years.
[3] Of this amount, 40% is labor cost.
[4] Of this amount, 30% is labor cost.

2. **Personnel Costs.** These costs are related to performing basic cleaning (nonenvironmentally related) and protecting the environment from hazards during cleaning (environmentally related) activities. The nonenvironmentally related cleaning process includes removal of contaminants from the surface of the circuit board. In this area Dale discovered that the aqueous cleaning process is highly dependent on the skill of the operator and has a higher training cost than other cleaning methods.

   There are also several environmentally related cleaning activities. These include purchasing cleaning solvents, inspections, emissions monitoring, and pH testing. The chemical engineers explained to Dale that alternative solvents vary considerably in chemical properties. Some are classified as Volatile Organic Compounds (VOCs) and therefore require special permits. Purchasing agents need to study carefully the Material Safety Data Sheets (MSDSs) provided by chemical suppliers to avoid purchasing cleaners which require permit applications and related recordkeeping. All of the cleaning methods would require varying levels of inspections, as well as regular analysis of the chemical content of waste generated. Both types of solvents would require emissions monitoring. Dale learned from personnel in waste management that wastewater from aqueous cleaning could only be disposed of through the city sewer system if the pH was within a specified range. Accordingly, ongoing pH testing would result in additional costs.
3. **Equipment and Facilities Costs.** Engineers estimated that modifying existing equipment to reduce emissions would cost $126,000. Even when the cost of rinse tanks and drying racks was included, the equipment cost was substantially lower for aqueous cleaning than for the other methods. Dale knew, however, that Bryan normally charged facilities costs at a rate of $225 per square foot, and the rinse tanks and drying racks used for aqueous cleaning required substantially more floor space. Installation costs were also high for aqueous cleaning due to the extensive plumbing required.
4. **Utilities.** The cost of electricity and water used in the cleaning process was estimated based on the power required to run the equipment and to wash down the baths.
5. **Other Operating Costs.** With both types of solvent cleaning, shop towels require special handling because the chemicals absorbed can cause dermatitis and are regulated by OSHA. In addition, all solvent cleaning requires special containers for waste, special procedures for hauling the waste to approved disposal sites, and extensive emergency preparedness provisions due to the risk of fires and explosions. Because all solvents can cause eye injury, production departments where these are used must have eyewash stations. With aqueous cleaning, wastewater treatment costs are substantial. In addition, the treatment process results in a residual sludge which requires special disposal methods. With aqueous cleaning, extra power for drying would increase the annual cost of electricity. Because of the plant's location in the Southwestern U.S., the cost of water for aqueous cleaning was very high.
6. **Special Items.** Last year, a spill of chlorinated solvents resulted in $25,000 in cleanup costs and a fine of $13,500. Because there are highly detailed recordkeeping and permitting requirements associated with alternative solvents, it is highly likely that some small fines will be incurred for this alternative as well, until the procedures are learned and control systems operating effectively.
7. **Overhead.** Bryan uses a conventional overhead application system that has three cost pools. The first cost pool is material-related overhead; the second is personnel-related overhead; and the last is facilities-related costs. Dale realized that many of the items identified elsewhere as part of the environmental costs of the cleaning process were

part of the current overhead rates. He therefore refined the cost pool to exclude these items and then recalculated the new overhead rates. The resulting rates were: $.60 per material dollar for the materials-related overhead; $2.90 per personnel dollar for personnel-related overhead and $218 per square foot for facilities-related overhead.

In doing his analysis Dale was aware that the credibility of the environmental cost estimates was critical. He used two techniques to enhance the credibility of the cost analysis. First, he solicited the help of the operating personnel in estimating the costs. Second, he took a consistently conservative approach. Whenever his investigation provided a range of cost estimates, he chose the lowest figure to use in the analysis. Dale knew this resulted in biased estimates, since the cost numbers were consistently understated. He realized, however, that understating the costs was less of a threat to credibility than overstating the costs.

Required:

1. Prepare a comprehensive cost analysis of the three cleaning processes. Show environmental and nonenvironmental costs separately.
2. How does the cost analysis performed in the previous requirement help you to understand what drives the costs of the cleaning process?
3. How can the analysis of environmental costs improve decision making at Bryan Aerospace?
4. How can the analysis of environmental costs encourage behaviors that are environmentally friendly?
5. How can the analysis of environmental costs help to create an environmentally conscious organizational culture at Bryan?
6. How will Bryan evaluate whether the environmental costing project is a success?

M O D U L E

Measuring and Managing Quality Costs

Version 1.1

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Measuring and Managing Quality Costs

Measuring and Managing Quality Cost

DINING IN STYLE WITH ALASKA AIRLINES

Airline passengers can be merciless in their treatment of airlines that do not deliver good service. Northwest Airlines has been called "Northworst." The now-defunct Allegheny Airlines was referred to by New Englanders as "Agony Airlines" due to its cramped seating, which made even short flights uncomfortable.

Alaska Airlines, formerly known as "Elastic Airlines" due to its unreliable, "rubbery" schedules, has successfully overcome its unfortunate label. The airline invested $12 million for guidance equipment to enable its planes to land in low visibility conditions, helping them avoid delays caused by frequent fog in the Northwestern U.S. In order to provide more leg room to passengers, Alaska outfits its planes with 135 seats, while other airlines install 142 to 155 seats in similar planes. Other airlines have reduced their food service to tiny packages of pretzels in order to reduce short-term operating costs. In contrast, Alaska spends more than twice the average of U.S. airlines on food service, serving full course meals which often include fresh salmon or venison. Fresh fruit is available on all Alaska Airlines flights. In a novel touch, the chef routinely visits passengers on board. "It's like I have a restaurant," he says.

Alaska's strategy has worked. The firm was close to bankruptcy in 1971 when new management began the quality movement in the company. By the late 1980s the customer loyalty established over the years helped to protect Alaska Airlines from the devastating profitability declines in the industry. In 1988, when industry profits decreased an average of 169 percent over 1987, Alaska's net income increased by 13 percent. The following year, when profit for air carriers declined an average of 627 percent, to a net loss of $5.122 *billion* per airline, Alaska earned a net income of $17 million.

▲ STRATEGIC IMPLICATIONS OF QUALITY COSTS

Quality costs are costs incurred to ensure that a product or service meets customers' expectations. Alaska Airlines is a good example of a company using spending for quality to gain strategic advantage. The air carrier clearly understands that quality includes not only providing the *features* customers desire, such as seats and meals, but also making certain that these features *perform* at a level expected by customers. It does not just provide a seat, it spends additional money to provide greater leg room. It does not simply serve food, it spends twice as much as other airlines to provide a restaurant-style meal. Clearly, Alaska Airlines feels that extra spending on quality is justified by the strategic benefit provided by meeting or exceeding customers' expectations.

A good system for measuring quality costs is essential for pursuing quality as a strategic goal. In addition, it helps management achieve other strategic goals of producing products at a reasonable cost and delivering a product to customers in a timely fashion.

- **Quality.** A well-designed quality costing system supports effective quality management, and so helps a firm compete on the quality dimension of the strategic triangle. As the Alaska Airlines story shows, spending on quality can be an important source of strategic advantage when spending is focused on the aspects of quality most valued by customers.
- **Cost.** The total cost of a product includes not only the cost of production, but any additional costs incurred due to quality problems. For a producer, total product cost includes not only manufacturing costs but also costs incurred to fix any defects. For a consumer, the total cost of ownership of a product includes the purchase price and all costs associated with using (owning) a product, including repair and maintenance costs.
- **Time.** Improving quality so that we *build quality in,* instead of *inspecting quality in,* avoids nonproductive time spent in inspection, rework, and product recalls. A quality costing system makes the cost of these "non-value-added" activities visible and translates the time savings from eliminating these activities into cost savings.

▲ PURPOSE OF THIS MODULE

This module discusses how to measure and report quality costs to achieve the quality goals of an organization. After reading this module, you should understand:

- Why there is greater interest in measuring quality costs today.
- The nature of and reasons for measurement of quality costs.
- The typical steps in a quality management system.
- How to measure quality costs.
- How to use cost data to manage quality in an organization.
- The technical, behavioral, and cultural properties of a quality costing system.

▲ HOW HAS INTEREST IN MEASURING QUALITY COSTS DEVELOPED?

Contemporary approaches to quality control can be traced to the work of a U.S. engineer named Walter Shewhart and a statistician named W. Edwards Deming. An important contribution of Shewhart and Deming was the use of statistical methods to explain the nature of variation in manufacturing processes. Their focus was on measuring and controlling variation to minimize production of defective units. The approach was to produce first, then check and compare the defect rate against acceptable levels of variation, and to take corrective action only if the variation was more than the prespecified "control interval." In the Shewhart-Deming approach, quality is measured by the number of defects, or products which fall outside the acceptable limits for product variation.

The narrow technical focus to quality measurement was greatly expanded after World War II by Deming, Joseph M. Juran, and Genichi Taguchi. These authors expanded the notion of quality to encompass customer expectations and societal considerations. The cost and benefits of good quality to a producer, to a customer, and to society at large became central concerns. Another important change was to introduce the idea of building quality in rather than inspecting products for defects after production.

In the 1950s, Japanese industry realized it could gain competitive advantage by implementing a modern manufacturing system with no inventory and faster time to market. To do so, however, would require extremely high standards of quality. It turned to Deming for help. His work, along with that of Juran and Taguchi, served as the foundation of the "Total Quality Management" (TQM) movement. The results were extraordinary. In twenty-five short years, Japan transformed itself from a war ravaged nation into an industrial powerhouse. Its reputation for producing quality products gained it a sizable world market share in many industries previously dominated by U.S. and European companies.

U.S. industry got a "wake up call" in the 1980s as firms in industries such as consumer electronics and autos were decimated by global competition. In searching for ways to compete, U.S. firms rediscovered and applied Deming's teachings. Since the 1980s, firms such as Motorola, Ford, Kodak, L.L. Bean, and Xerox have become world class practitioners of quality management, with quality levels of just a few defects per million units produced. The suppliers to these firms have also achieved impressively high levels of quality. For example, in 1982 Xerox suppliers were shipping 92 percent defect-free parts. By 1988 these suppliers were shipping 99.97 percent defect-free parts. The measurement and management of quality costs plays an important role in supporting quality management.

▲ THE NATURE OF QUALITY COSTS

Quality is defined as customers' satisfaction with total experience of a product or service. Quality has two dimensions—features and performance. For example, customers may want a personal computer (PC) with sound and video capability (features). If, however, the keyboard locks up or the operating system is not compatible with word processing or spreadsheet software, it is not meeting customer expectations on the performance dimension of quality. This module focuses on the ***performance*** aspect of quality.[1]

In this module, we *define* ***quality costing*** *as the measurement and management of costs related to providing a customer's required level of product or service performance.* This includes all costs incurred to monitor and prevent problems in product performance, as well as costs incurred to remedy problems that do occur.

The ***objective*** of quality costing is to help management maximize the value customers receive from a product. Failures of product performance create costs for both the firm which produced the product and for its customers. Improving product performance reduces costs for the producing firm because there is less need to spend time reworking defective units, fewer product recalls, and fewer warranty claims. Improved product performance also reduces the cost incurred by customers over the life of the product (referred to as *life-cycle cost,* or *cost of ownership*) by reducing operating, maintenance, and repair costs.

Quality costs have received little attention until fairly recently. Traditional management accounting systems do not separately identify quality costs. Instead, quality costs are subsumed within the costs recorded in many different parts of a firm. For example, the costs associated with spoiled or reworked units may be treated as part of the cost of inventory.[2] Warranty repair costs would be recorded by service departments. Costs of monitoring and preventing quality problems would be recorded by the quality control department.

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[1] A firm typically meets customer requirements for product features through a target costing system. This subject is discussed in detail in a separate module. The separation of target costing from quality costing is purely a matter of convenience. In practice the line between features and performance is not always clear.

[2] The Modules on Process Costing and Job Order Costing discuss spoilage and rework costs.

In a traditional management accounting system, there is no way to aggregate quality cost items recorded in different departments, so management cannot assess the total quality costs being incurred firm-wide.

Another reason quality costs are not visible in traditional management accounting systems is the combination with other costs. Costs of the quality control department, for instance, are typically part of indirect manufacturing costs (called overhead). However, overhead accounts also record other indirect manufacturing costs such as plant supervisors' salaries, plant payroll processing, and maintenance. The amount recorded as spoilage cost includes not only the costs associated with defective units produced, but also the cost of any units stolen or broken during handling, which are not really quality costs.

When quality costs are not separately identified, it is difficult for a firm to know what it is spending on quality. More importantly, it is not possible to assess the effectiveness of a firm's spending on quality. A firm cannot determine whether its quality spending is focused on the right items, or whether the spending on quality is yielding benefits.

Among those firms that do measure quality costs, many classify total quality costs into the categories of prevention, appraisal, internal failure, and external failure.

Prevention costs are costs incurred *to avoid quality problems from occurring*. An example is the cost of training workers so they do not produce defective units.

Appraisal costs are costs associated with *measuring and monitoring* activities related to quality. An example of appraisal costs is the time spent on inspection of output to determine the number of defective units produced.

Internal failure costs are costs incurred *to remedy defects discovered before the product is delivered to the customer.* The cost of reworking defective units is an example of an internal failure cost.

External failure costs are costs incurred *to remedy defects discovered by the customer.* Warranty repair cost is an example of an external failure cost.

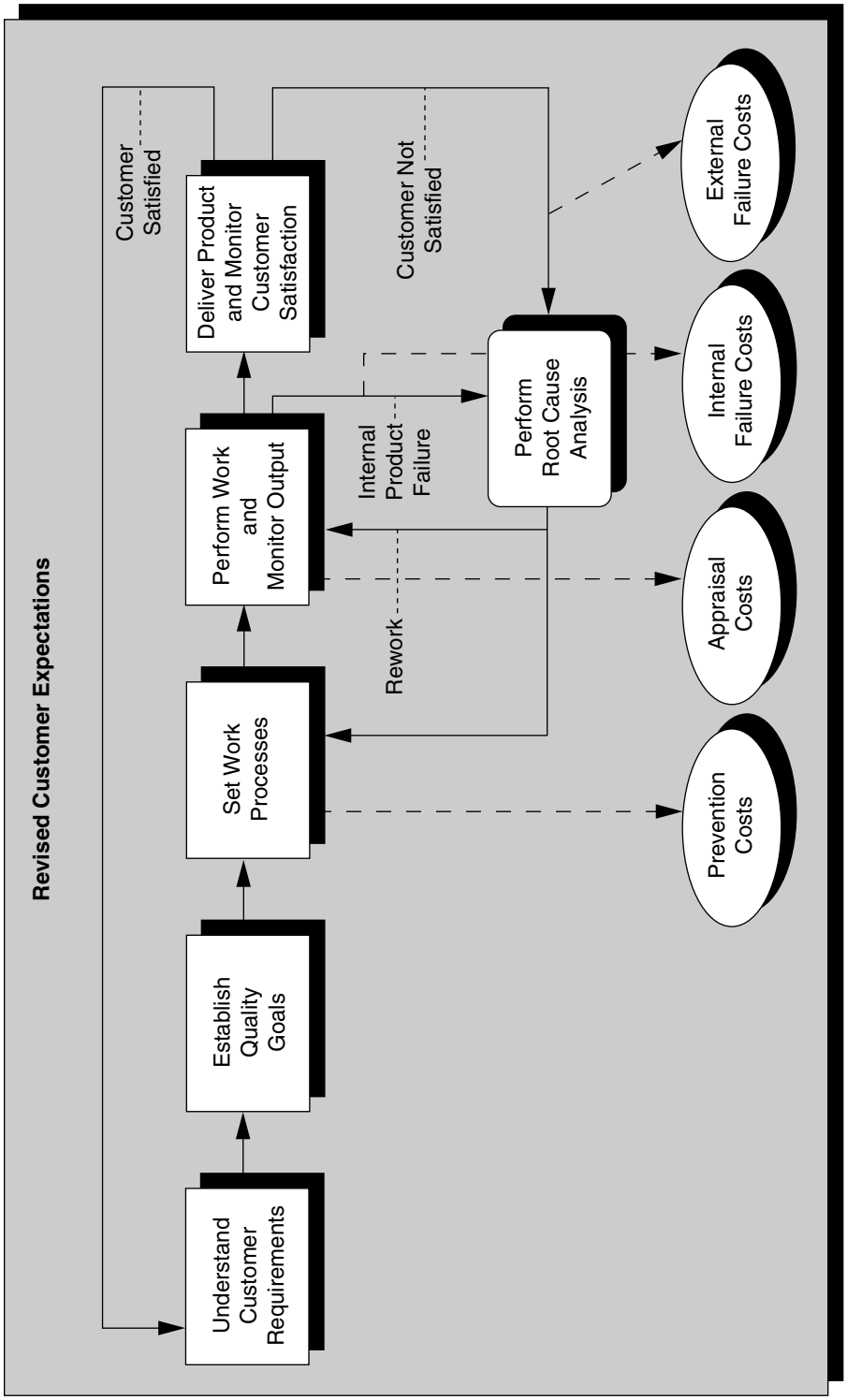
▲ THE QUALITY MANAGEMENT SYSTEM

To manage the four types of quality costs listed above, the relationship of these to the quality management system must be understood. Exhibit 1 shows this relationship. The top part of Exhibit 1 presents the six major activities in managing quality. These relations are depicted by the solid line arrows. The bottom part shows the quality costs commonly incurred at each step of the quality management process. These relations are depicted by the broken line arrows. As Exhibit 1 shows, quality management is a recursive process which begins with understanding customer requirements and ends with customer reaction to the product's delivered quality. The six steps are described in the following pages.

Step 1. Understand Customer Requirements.

The first step in managing quality is to understand customer requirements relating to quality. This requires determining what customers want with respect to performance and how important the various dimensions of performance are to the customers. The PC manufacturer must know the relative importance customers place on multi-media versus ability to run other software, the interval between repairs, and other aspects of reliability and usability. For a tax preparation service, the quality requirements may include freedom from errors in tax returns prepared. For a patient checking into a hospital for elective surgery,

Exhibit 1
Quality Management System and Quality Costs



prompt admission and friendly service may be the relevant dimensions of quality. Alaska Airlines seems to understand that customers value the quality of meals and seating comfort.

Step 2. Establish Quality Goals.

The next step is to translate customer requirements for product/service performance into an appropriate quality goal. Today most firms state quality goals as the percent of defect-free output produced. The term defect is general and applies to both manufacturing and service firms. In manufacturing a defect is any attribute of a product that does not conform to customer specifications. For example, an on-off knob on a radio that breaks off is a defect. In service industries, a defect is any customer "encounter" which does not result in a satisfied customer.

In manufacturing, quality goals are commonly set at either "three-sigma" or "six-sigma" levels. Sigma is the technical term for the standard deviation, which is a measure of variation. Most measurements have some degree of inherent variation. Statistical theory used in quality control assumes that a process in control produces output that has a normal distribution.[3] This means that 99.7 percent of the output will be within plus or minus three standard deviations of the mean (the desired value for the output). When a firm expresses its defect rate as "three sigma," it is saying that 99.7 percent of the output will be defect-free. Another way to state this is to say that for each thousand units produced, no more than three will be defective.

Today, many world-class competitors are using a "six-sigma" approach pioneered by Motorola in the 1980s.[4] Using the normal distribution, this means that 99.99966 percent of observations fall within plus or minus six standard deviations of the mean. Six-sigma quality means producing no more than 3.4 defective units per million. This is nearly perfect quality!

Think Along

Do you think six sigma is an excessively high standard that cannot be reached cost-effectively?

Motorola applies six-sigma quality standards to *individual parts and processes, not to completed products*. If individual parts are produced at the three-sigma quality level (99.7 percent defect-free output), there are three defective parts per thousand. Now assume that Motorola builds a TV set which has 1,000 different parts such as chips, resistors, power supply, picture tube, color gun, and so on. Since each part has three defective units, and 1,000 TV sets are built, the only way to produce three defective TV sets in a batch of 1,000 is if all defective parts end up on the same three TV sets—a near impossibility! As Motorola has discovered, setting quality standard for *individual parts* at three-sigma level results in more than *66,810 defective units of finished product per million units produced!* That is, with three sigma, 66.8 defective TV sets will be produced for a batch of 1,000 TV sets.

Note that the relationship of sigma level at parts to the entire product depends on the complexity of products. The more parts or processes, the higher the difference between parts level and product level defect rates. For complex products that require hundreds or thousands of parts or processes, the finished product can be defect-free only if *every single part which goes into the product is virtually defect-free*.

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[3] A more detailed explanation of sigma limits and properties of a normal distribution is contained in most basic statistics texts.

[4] Ismael Dambolena and Ashok Rao. "What is Six Sigma, Anyway?" *Quality,* Vol. 33, Issue 11, November 1994, p. 10.

Note Pad

Think of an automobile manufacturer with three-sigma quality levels for 10,000 parts or processes. How many defective cars will there be if each part or process uses a three-sigma level? What about an aircraft manufacturer that uses a million parts and processes? How can defect-free output be ensured?

Step 3. Set Work Processes to Meet Quality Goals.

The third step in managing quality is to ensure work processes are designed to produce at the required quality level. This requires adjusting machines, developing control systems, training, and supervising people so quality problems do not occur. Costs incurred on activities undertaken to prevent defects and are called **prevention costs.**

Step 4. Perform Work and Monitor Output.

The next step is to perform work and monitor the output produced to see if quality goals are being met. Quality activities undertaken in this step include inspection of output to detect errors or mistakes. The costs of these activities, which are aimed at making certain that the final output meets the established quality targets, are called **appraisal costs.** When defective units are discovered, any costs incurred for correcting the defectives, which might include rework labor and materials, defect analysis, and error correction are called **internal failure costs.**

Step 5. Deliver Product and Monitor Customer Experience.

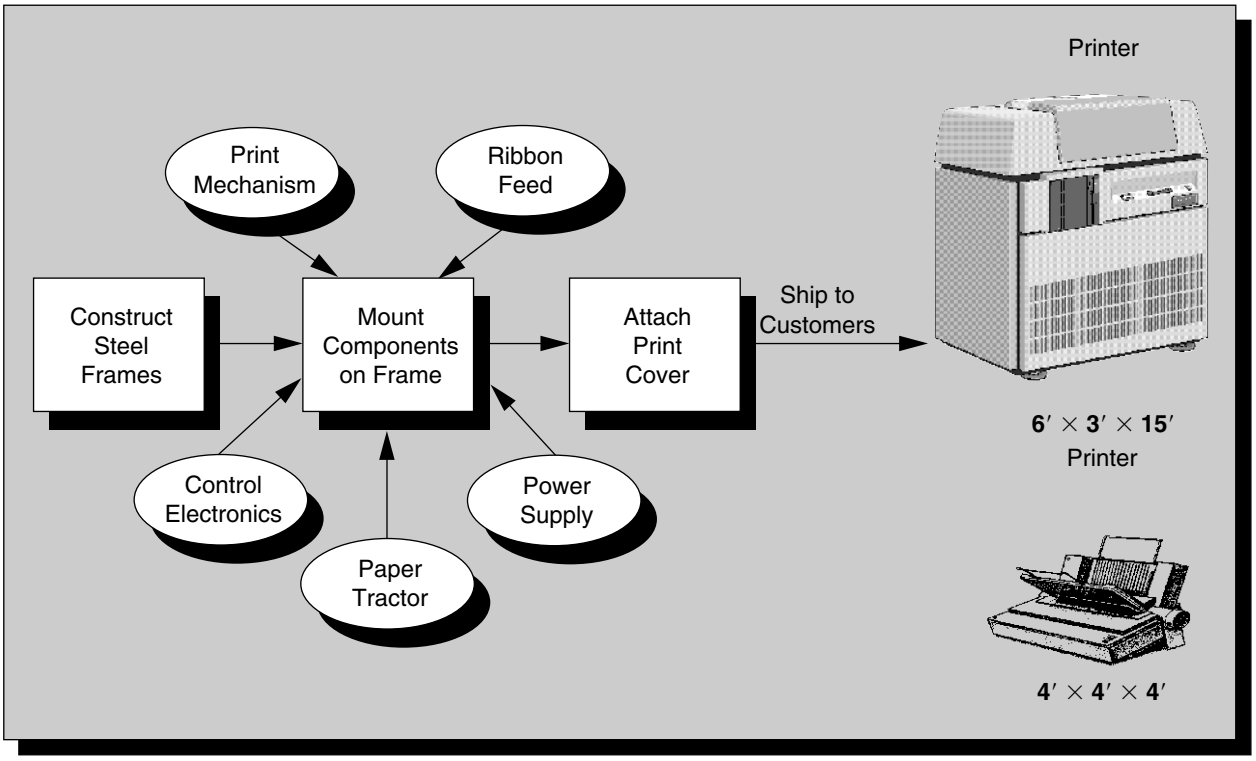
The fifth step in the quality management process is to deliver the product and monitor the customer's experience with the product. If the product fails to perform according to customer expectations, the customer may return it for repair or ask for a price adjustment. Any costs related to correcting defects discovered by customers are called **external failure costs.**

If the product does meet customers expectations, the quality management process does not end. Rather, the process begins again with a new assessment of customer expectations for future versions of the product. Most firms have discovered that when customer expectations are met, the customers come to expect even higher levels of performance from future versions of the product. Quality performance becomes a "moving target," and a firm can never become complacent, believing its quality is "good enough."

Step 6. Perform Root Cause Analysis.

The final step in the process is to perform root cause analysis for all internal and external product failures. A root cause analysis determines the underlying cause for product failure. The analysis is designed to find the underlying factors which allowed the problem to occur, and to help the firm identify what corrective measures are needed. A major purpose of the root cause analysis is to determine if certain steps in the process that are causing quality problems should be set at higher tolerance (sigma) levels. The findings of the root cause analysis may be used to redesign work processes to prevent similar problems from recurring.

Exhibit 2
DFP Technologies—Production Process



▲ MEASURING QUALITY COSTS—AN ILLUSTRATION

As the flow chart of the quality management system (Exhibit 1) shows, quality costs are incurred at the various stages of the quality management process. To manage quality, measure and report these costs. This section illustrates the measurement of quality costs through the example of a hypothetical firm called **DFP Technologies Inc.** DFP produces large scale printers for high volume applications. Its sales revenue for 1996 is $50,900,000 and its total costs are $45,800,000.

DFP's printers operate at speeds from 1,500 to 6,000 lines per minute. The smallest model is four feet tall and measures approximately four feet by four feet. The largest is six feet tall and measures three feet by 15 feet. DFP's customers are insurance companies, banks, and telephone companies who use the printers for mailings to customers, such as premium notices or bank statements, and other high volume applications such as creating a continuous log of data entry.

The production process used by DFP begins with the construction of steel printer frames. Next, the printer components are mounted on the frame. The components include print mechanisms, control electronics, ribbon feed systems, paper moving mechanisms (tractors), and power supplies. Finally, a printer cover of high grade industrial plastic is attached. The process is depicted in Exhibit 2 above.

Quality is important for DFP's customers, because when a printer is not operating a backlog of work quickly accumulates. In addition to the loss of productive time, recovering from printer downtime involves costs for customers, who may have to pay overtime to

data entry operators or hire additional temporary help. Through interaction with customers, DFP has learned that the *two* overriding quality factors most important to its customers are:

1. Minimizing downtime due to printers being out of order.
2. Maintaining high print quality.

DFP's quality goals are set at the three-sigma level for each process step and for each part supplier. This means that both in-house manufacturing and suppliers strive to attain a goal of 99.7 percent defect-free outputs, or producing less than three defective parts per thousand *parts*. Remember that each printer contains several components, including a power supply, paper tractor, control electronics, print mechanism, and ribbon feed. The defect rate for *printers* is substantially higher than three per thousand, because the only way a printer can be defect-free is if *all of the major parts in the printer are defect-free*.

DFP's spending on quality is substantial. However, these costs are not visible because they are buried within the traditional cost categories of materials, wages and salaries, equipment, rent, and utilities. The actual costs for the assembly department, as they would appear in DFP's accounting system, are shown in Exhibit 3 below.

Exhibit 3
DFP Assembly Department—Actual Costs for Year Ended December 31, 1996

Cost Item	*Total Cost*
Materials	$8,124,000
Manager's salary	64,000
Supervisors' salaries (3)	102,000
Assembly wages	3,360,000
Equipment	675,000
Rent	270,000
Utilities	90,000
Total	**$12,685,000**

To determine which costs are related to quality, the accountant must interview people in the assembly department and observe work being performed.[5] The results of this analysis are summarized in Exhibit 4.

Think Along

Can you use the information provided in Exhibit 4 to determine what part of the assembly department's spending would be classified as prevention, assessment, internal failure, and external failure costs?

[5] This is an application of activity-based management. For a more detailed discussion of that topic see the ABM Module in this series.

Exhibit 4
DFP Assembly Department—Analysis of Actual Costs for Year Ended December 31, 1996

1. **Materials.**
   a. Of the total spending on materials, approximately $194,940 was for spoiled and reworked units.
   b. Of this amount, approximately 40% is for defective units discovered internally.
   c. The remaining 60% is for defects discovered by customers.
2. **Manager's Salary.** The manager spends time in the following activities related to quality.
   a. Fifteen work days attending seminars on preventing quality problems.
   b. Two hours a week analyzing the results of quality inspections.
   c. Ten hours a week searching out causes of problems.
   d. One hour a week meeting with the sales manager to resolve quality problems identified by customers.
3. **Supervisors' Salaries.** There are three supervisors who each spend the following time on quality activities:
   a. 3 hours a week in quality training.
   b. 5 hours a week overseeing rework activities for defects found internally.
   c. 7 hours a week overseeing rework of defects found by customers.
4. **Assembly Wages.** The firm has 120 assembly workers who are paid, on average, $14 per hour. Their quality activities are:
   a. Each employee spends eight hours per year in quality training.
   b. A total of 28,800 hours per year is spent inspecting components purchased from outside suppliers.
   c. A total of 18,000 hours is spent on inspection of printers assembled in the department.
   d. 21 assembly workers spend all of their time reworking defects discovered in the department.
   e. 24 workers spend all of their time reworking defective units returned by customers.
5. **Equipment.** The assembly department's equipment-related expenses were $675,000. This includes the following quality items:
   a. Equipment used in testing—$8,500.
   b. Depreciation on equipment used to correct problems discovered within DFP—$45,000.
   c. Depreciation on equipment used to correct problems discovered by customers—$38,000.
6. **Rent.** The assembly department's share of factory rent is $270,000. Analysis reveals the following:
   a. Approximately 10% of the assembly department space is devoted to inspection.
   b. Approximately 30% of the assembly department space is occupied by area used for rework of defective units. It is estimated that approximately 60% of the units reworked are discovered internally. The rest are problems reported by customers.
7. **Utilities.** Annual utility costs are $90,000. These are assigned to the inspection and rework areas on the basis of the relative amount of space each occupies.

DFP's Assembly Department Quality Costs.

We can use the data in Exhibit 4 to classify DFP's assembly department quality costs into the four categories. The first step in this analysis is to examine each of the eight items in that exhibit and decide whether they are prevention, appraisal, internal, or external failure costs. For example, materials used for spoiled and defective units (Item 1, Exhibit 4) are failure costs. These are internal failure costs if the defective units are discovered before shipment, otherwise these are external failure costs. Similarly, the cost of the manager's time attending quality seminars (Item 2a, Exhibit 4) is a prevention cost. The other items can be similarly classified. The results are shown in Exhibit 5.

Exhibit 5
Four-Way Classification of Assembly Department Costs

	Quality Cost Element	*Classification*
1.	**Materials.**	
	a. Internal defects	Internal failure
	b. Customer discovered defects	External failure
2.	**Manager's Salary.**	
	a. Attending seminars on preventing quality problems	Prevention
	b. Analyzing the results of quality inspections	Appraisal
	c. Searching out causes of problems	Internal failure
	d. Resolving quality problems identified by customers	External failure
3.	**Supervisors' Salaries.**	
	a. Quality training	Prevention
	b. Overseeing rework of defects found internally	Internal failure
	c. Rework of defects found by customers	External failure
4.	**Assembly Workers.**	
	a. Quality training	Prevention
	b. Inspecting components purchased from suppliers	Appraisal
	c. Inspection of the printers assembled by DFP	Appraisal
	d. Reworking defects discovered in the department	Internal failure
	e. Reworking defective units returned by customers	External failure
5.	**Equipment.**	
	a. Equipment used in testing	Appraisal
	b. Depreciation—problems discovered within DFP	Internal failure
	c. Depreciation—problems discovered by customers	External failure
6.	**Rent.**	
	a. Factory space devoted to inspection	Appraisal
	b. Factory space for rework of defective units—60% internally; 40% customers	Internal failure (60%) External failure (40%)
7.	**Utilities.**	
	a. Factory space devoted to inspection	Appraisal
	b. Factory space for rework of defective units—60% internally; 40% customers	Internal failure (60%) External failure (40%)

The next step is to rearrange the items in Exhibit 5 into the four categories of prevention, appraisal, internal failure, and external failure costs. Also, the costs shown in Exhibit 3 must be assigned to each of the cost items. This provides the view of DFP's assembly department's quality costs presented in Exhibit 6.

Exhibit 6
Quality Costs—Assembly Department

Ex. 2 Ref.	*Cost Element*	*Calculation*	*Amount*
	Prevention Costs		
2 a	**Manager's Salary—**attending seminars	([15 × 8) ÷ 2000]) × 64,000	$3,840
3 a	**Supervisors' Salaries—**quality training	([3 × 50 × 3] ÷ 6,000[1]) × 102,000	7,650
4 a	**Assembly Workers—**quality training	8 × 120 × $14	13,440
	Total Prevention Costs		**$24,930**
	Appraisal Costs		
2 b	**Manager's Salary—**analyzing results	2 ÷ 40 × 64,000	$3,200
	Assembly Wages—		
4 b	Inspection of outside components	28,800 × $14	403,200
4 c	Inspection of printers assembled	18,000 × $14	252,000
5 a	**Equipment—**used in testing		8,500
6 a	**Rent—**inspection space	.10 × 270,000	27,000
7 a	**Utilities—**inspection space	.10 × 90,000	9,000
	Total Appraisal Costs		**$702,900**
	Internal Failure Costs		
1 a	**Materials—**internal defects	.40 × 194,940	$77,976
2 c	**Manager's Salary—**searching causes	10 ÷ 40 × 64,000	16,000
3 b	**Supervisors' Salaries—**overseeing rework	([3 × 50 × 3]/6,000) × 102,000	12,750
4 d	**Assembly Wages—**reworking defects	21 × 2,000 × 14	588,000
5 b	**Equipment—**internal problems		45,000
6 b	**Rent—**rework area	.30 × 270,000 × .60	48,600
7 b	**Utilities—**rework area	.30 × 90,000 × .60	16,200
	Total Internal Failure Costs		**$804,526**
	External Failure Costs		
1 a	**Materials—**external defects	.60 × 194,940	$116,964
2 d	**Manager's Salary—**sales meeting	.1 ÷ 40 × 64,000	1,600
3 c	**Supervisors' Salaries—**reworking defects	([7 × 50 × 3] ÷ 6,000) × 102,000	17,850
4 e	**Assembly Wages—**reworking defects	24 × 2,000 × 14	672,000
5 c	**Equipment—**external problems		38,000
6 b	**Rent—**rework area	.30 × 270,000 × .40	32,400
7 b	**Utilities—**rework area	.30 × 90,000 × .40	10,800
	Total External Failure Costs		**$889,614**
	Total Quality Costs		**$2,421,970**

[1] Assumes each of 3 supervisors works 40 hours per week 50 weeks a year, so 3 × 40 × 50 = 6000 hours.

The quality cost analysis for the assembly department at DFP Technologies would generate the quality cost report shown in Exhibit 7.

Exhibit 7
DFP's Assembly Department—Quality Cost Report for the Year Ended December 31, 1996

Cost Item	*Prevention*	*Appraisal*	*Internal Failure*	*External Failure*	*Total Quality Cost*	*Total Department Cost*
Materials			$77,976	$116,964	$194,940	$8,124,000
Manager's salary	3,840	3,200	16,000	1,600	24,640	64,000
Supervisors' salaries	7,650		12,750	17,850	38,250	102,000
Assembly wages	13,440	403,200	588,000	672,000	1,928,640	3,360,000
		252,000				
Equipment		8,500	45,000	38,000	91,500	675,000
Rent		27,000	48,600	32,400	108,000	270,000
Utilities		9,000	16,200	10,800	36,000	90,000
Totals	**$24,930**	**$702,900**	**$804,526**	**$889,614**	**$2,421,970**	**$12,685,000**

The quality cost analysis demonstrates the kaleidoscopic nature of cost analysis in today's complex organizations. Costs can be viewed from different perspectives, just as each turn of a kaleidoscope presents a unique pattern. The traditional cost data (Exhibit 3) is one view, while the quality cost report (Exhibit 7) presents a different view.

While the information in this exhibit provides the necessary detail for the cost analysis, the accountant will need to organize the information differently to report to management. The report shown in Exhibit 7 accomplishes this.

Firm-Wide Analysis of Quality Costs.

In order to understand the full impact of quality costs, the accountants at DFP must perform an analysis similar to that shown for the assembly department in each department of the firm. Assume this is done and the firm-wide quality cost report is as shown in Exhibit 8.

Exhibit 8
DFP Technologies—Quality Cost Report for the Year Ended December 31, 1996

	Engineering	*Purchasing*	*Assembly*	*Other Depts.*	*Totals*	*% of Total QC*
Prevention	$505,900	$8,400	$ 24,930	$ 248,520	$ 787,750	13
Appraisal	46,000	40,600	702,900	184,700	974,200	16
Internal failure	320,800	260,200	804,526	841,124	2,226,650	38
External failure	476,500	295,400	889,614	299,886	1,961,400	33
Total	$1,349,200	$604,600	$2,421,970	$1,574,230	**$5,950,000**	**100**

Based on the information presented in firm-wide quality cost report, what conclusions can you draw about how DFP is managing their spending on quality?

▲ USING QUALITY COST DATA TO MANAGE QUALITY

The quality cost information can help DFP's management address five important quality management issues:

- ▲ What is the total *amount* of spending on quality management throughout the firm? How is this amount *distributed* across different areas of the firm?
- ▲ What is the relative amount the firm is spending within each *cost category*?
- ▲ Is the spending on quality producing tangible *financial benefits* to the firm?
- ▲ Is the spending on quality *focused on customer satisfaction*?
- ▲ What are the *root causes* of quality problems and how much is being spent on eliminating them?

Firm-Wide Spending on Quality.

To manage quality costs, management must know how much it is spending on quality activities in total, and where in the firm quality costs are being incurred. The firm-wide quality cost report (Exhibit 8) shows that DFP's total quality costs are $5,950,000. This represents approximately 11.7 percent of DFP's total sales of $50,900,000 (5,950,000 ÷ 50,900,000 = .1168).

Clearly, quality costs have a substantial impact on DFP's profitability. In many industries, average firm profits are less than 10 percent of sales revenue. If this is true for DFP, eliminating quality costs *would double firm profit*.

Without the quality cost information, DFP would not have been able to evaluate the firm-wide effect of quality. Individual departments measure quality in a variety of ways. For example, engineering typically measures quality by the number of design changes. Purchasing would measure quality as billing errors. Accounts receivable might measure quality as the number of errors in customer accounts. These measurements provide useful information, but there is no way to combine them. It is meaningless to add design changes to billing errors to misstatements of customer accounts. Combination can be accomplished only when these measures are translated into dollar terms, and the total effect on the company made visible.

Another important insight from the firm-wide quality cost report is that quality costs are incurred throughout the firm. Many firms have the notion that "quality is manufacturing's job," and quality costs are incurred only in production and assembly departments. As the DFP example demonstrates, however, the assembly department is not the only area of the firm with substantial quality costs. In fact, the quality costs in assembly are only about 41 percent of the firm's total quality costs (2,421,970 ÷ 5,950,000 = .407).

Spending on Quality by Categories.

In order to manage quality effectively, the firm needs to evaluate whether spending is focused on the right quality activities. Firm-wide, DFP's spending on prevention is just 13 percent of total quality costs, and appraisal is 16 percent. Combined, prevention and appraisal are less than internal failure costs, which are 38 percent of total quality costs. In addition, the large amount of external failure costs is of particular concern because these costs represent quality problems which impact customers.

Large as it is, the measure of external failure costs underestimates the cost DFP bears because of quality problems experienced by customers. A more complete estimate would include such intangible items as lost goodwill and diminished reputation. The loss of future sales revenue is also relevant. For example, DFP might learn through sales representatives that a dissatisfied customer is planning to replace his equipment with a printer from a different vendor. The lost profit from that customer would be an external failure cost for DFP. Research has found that for consumer products, on average, every dissatisfied customer tells 19 others, and those individuals' purchasing decisions may be affected as well. Although the financial impact of lost sales is not a cost item recorded in traditional management accounting systems, it is in a very real sense a quality cost.

Another insight from DFP's firm-wide quality cost report (Exhibit 8) is that a relatively large amount is being spent on appraisal compared to prevention. You will recall that appraisal costs represent inspection and monitoring costs. The high appraisal cost suggests that DFP is relying on inspections to correct defects rather than investing in prevention activities to ensure that defective units are not produced. Inspecting quality in after-the-fact is generally more costly and is less effective in the long-run than redesigning work processes to ensure that defective output is not produced in the first place.

Financial Returns from Quality Costs.

An effective quality management program can provide a positive financial return by improving quality, reducing cost, and speeding time to market. Many firms have specific financial goals for quality programs. For example, AT&T requires all quality programs to produce at least a 10 percent financial return. One way to measure the financial impact of quality programs is to look at what happens to the categories of quality costs over time. Research shows that firms without quality costing systems frequently have quality costs between 15 and 20 percent of revenues. Firms with effective quality cost measurement systems, in contrast, normally have quality costs less than five percent of revenue. This exhibit suggests that one important financial return from the measurement of quality costs is reduction in the level of quality costs.

Key Point

The experience of many firms who have invested in quality shows that improving product quality actually reduces the total spending on quality.

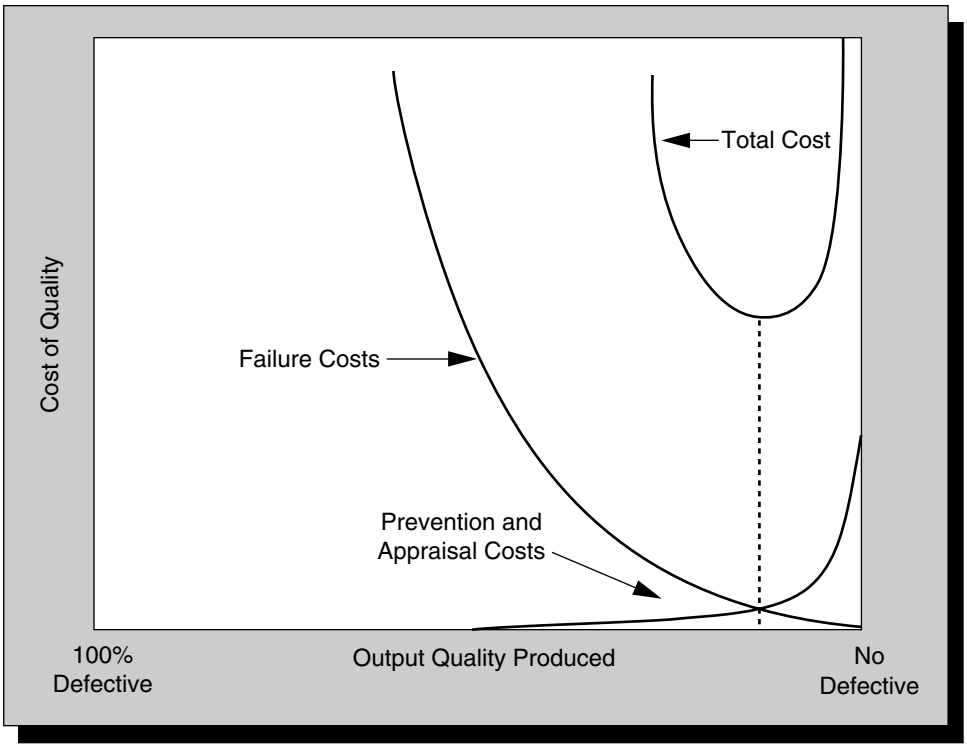
Think Along

How can improving product/service quality reduce a firm's total spending on quality?

There are two main reasons for this. First, as more is spent on prevention and appraisal to improve quality, there is a corresponding reduction in failure costs. Failure costs are much greater in magnitude than prevention and appraisal costs, however. The increased spending on prevention and appraisal needed to improve quality is more than offset by reduced failure costs, with the result that total quality costs decrease.

Consider what might happen if DFP increases spending for prevention and appraisal by 20 percent. This would require a cash outlay of \$352,390 (787,750 + 974,200 = 1,761,950 × .2 = 352,390). If this spending achieves a 20 percent reduction in failure costs, this will generate savings of \$837,610 (2,226,650 + 1,961,400 = 4,188,050 × .2 =

Exhibit 9
Relationship of Quality Costs to Defect Level[6]



837,610). The combined effect is a reduction in total quality costs of $485,220 (837,610 failure cost savings − 352,390 increased prevention/appraisal costs).

The quality tradeoff function shown in Exhibit 9 depicts this relationship between spending on prevention/appraisal, failure costs, and the level of total quality costs.

As Exhibit 9 shows, a firm which produces poor quality output is probably spending little on prevention and appraisal, and will incur high failure costs. Conversely, a firm producing close to zero defects may be spending more on prevention and appraisal, but lower failure costs will likely result in lower total quality costs. As the firm moves toward zero defects, this tradeoff between higher spending on prevention/appraisal and lower failure costs results in a total quality cost curve which is U-shaped. The lowest point on the curve, which represents the minimum total quality costs, is very close to the zero defect end of the scale.

The other way in which improved quality reduces total quality costs is through long term reduction in overall spending for prevention and appraisal activities. As quality becomes a routine part of the production process, firms frequently find there is less need for monitoring and inspecting (appraisal costs) or to redesign products/processes (prevention costs).

For strategic decision making, a firm needs a way to estimate potential cost savings from improved quality management. Remember that quality goals are commonly expressed as sigma levels, which refer to the probability of producing a defective part.

[6] This chart has been adapted from J. M. Juran, Leonard A. Seder, and Frank M. Gryna, Jr. editors. *Quality Control Handbook,* New York; McGraw-Hill, 1962.

The financial impact of improved quality on total quality costs can be illustrated by considering what would happen if DFP were to move from its current level of quality performance (three sigma) to the world class level of six sigma. Currently, the company is spending a total of $4,188,050 on failure costs ($2,226,650 in internal failure costs plus $1,961,400 in external failure costs). This amount represents 8.2 percent of its sales revenue (4,188,050 ÷ 50,900,000 = 0.082). This spending level is for three-sigma quality which yields approximately eight defective printers per 100 produced.

Motorola and other firms operating at "six-sigma"[7] quality levels have found failure costs commonly less than one percent of sales revenue. If DFP were to adopt a six-sigma strategy and to experience similar savings, its failure costs could be reduced to one percent of sales, or $509,000 (.01 × 50,900,000). This would provide failure cost savings of $3,679,050 (4,188,050 − 509,000).

If DFP needed to double spending on prevention and appraisal to achieve six-sigma quality levels, this would cost an additional $1,761,950 (787,750 + 974,200). Overall, the total quality costs would still be reduced by $1,917,100 (failure cost savings of $3,679,050 minus increased prevention/appraisal of $1,761,950). This amount would represent a savings of approximately 3.8 percent of sales revenue (1,917,950 ÷ 50,900,000 = .0377). Over time, as the six-sigma quality performance becomes a way of life in the organization, the firm may be able to reduce spending on prevention and appraisal, generating additional financial benefit.

Exhibit 10 shows the impact of improving quality on total quality costs. Cost is measured as a percent of sales revenue and quality is measured in terms of sigma level (defect rates) produced. Typical firm experience shows that as quality improves from four sigma levels to six sigma, quality costs decline from 10 percent of sales to two or three percent of total sales.

Think Along

How can DFP use its analysis of quality costs to meet its strategic objective of satisfying customers' expectations regarding product performance?

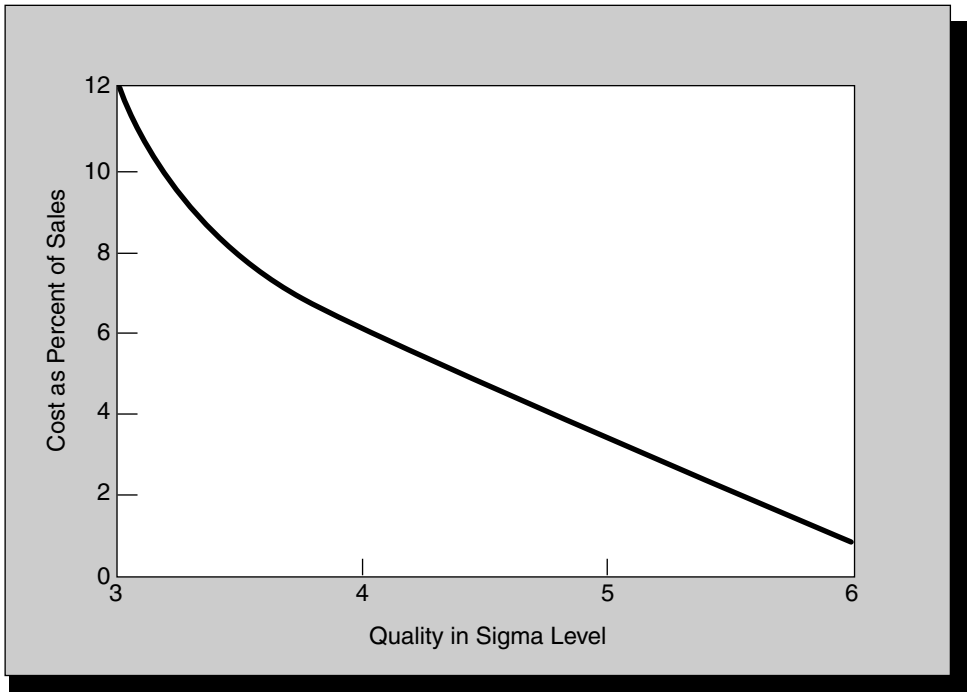
Quality Spending and Customer Satisfaction.

The ultimate test of any quality management program is how well it helps the firm meet customer expectations. DFP can use its quality cost data to determine how well the pattern of its spending on quality matches the relative importance placed on each dimension by its customers. This is accomplished by constructing a *Value Index*. A Value Index is the ratio of a customer's perceived importance of a performance dimension to a firm's spending on that dimension.

When the Value Index is greater than one, *the importance of that performance dimension to customers is relatively larger than the firm's quality spending for that dimension.* This suggests the firm may want to consider increasing quality spending for that dimension. When the Value Index is less than one, *the importance of that dimension to customers is relatively lower than the firm's quality spending for that dimension.* This suggests the firm should consider whether it may be spending too much money on that dimension.

[7] Motorola embarked on a six-sigma quality program in the early 1980s which improved its quality tenfold, reduced manufacturing costs, and decreased time to market for its products.

Exhibit 10
Impact of Improving Quality on Quality Costs



Constructing the Value Index requires a firm to complete three steps. These steps are developing a customer ranking of performance dimensions, estimating quality costs related to each performance dimension, and computing the Value Index.

Step 1. Develop customer ranking of performance dimensions.
The analysis begins with identifying the dimensions of printer performance, as defined by the customer. How important a given dimension of printer performance is to customers depends on *the costs the customer incurs* each time the problem occurs. This may be quite different from the costs incurred by the firm for that dimension of product performance. The analysis of DFP's quality costs thus far has considered only the quality costs incurred by DFP. To complete the analysis, and provide the strategic link to satisfying customer expectations, DFP will need to consider quality costs incurred by its customers.

From the customer's perspective, the quality costs associated with a specific dimension of printer performance would include costs associated with downtime while the printer is being repaired and any maintenance or service fees paid to DFP for printer repair. Assume that based on conversations and customer surveys, DFP has determined that the two quality dimensions most important to customers are downtime and print quality.

One way DFP might estimate its customers' quality costs related to the dimensions of printer performance would be to conduct a detailed activity analysis jointly with the customer. This would involve identifying the activities the customer performs whenever a given dimension of printer performance fails. For example, attempting to restore lost files or re-keying lost data entry work might be required whenever the printer goes down. Estimation of the time required for such activities can be combined with appropriate wage and salary information to provide estimates of the customer's quality costs.

The activity analysis of customer quality costs can be very time consuming and requires close cooperation, as well as considerable trust, between the firm and its customers. A simpler approach can be used to develop rough rule-of-thumb guidelines to estimate customer costs. The customer's personnel can be asked to assign 100 "importance points" to the dimensions of printer performance, based on relative importance. A dimension considered more important will be assigned more points. If DFP finds that its customers consider downtime four times as important as print quality, the customer performance ranking would appear as shown in Exhibit 11.

Exhibit 11
Customer's Importance Ranking of Printer Performance

Dimensions of Printer Performance	*Importance Ranking*
Downtime	80%
Print quality	20%

Step 2. Estimate quality costs related to each performance dimension.
The next step in the analysis is for DFP to determine what proportion of its quality cost relates to each of these two dimensions of printer performance. Assume DFP's service logs show the three causes of printer downtime are faulty ribbon motion, improper paper feed, and overheating. Similarly, assume that print quality problems result from broken print hammers or paper feed misalignment. DFP must now determine how its spending on quality relates to the five causal factors of ribbon motion faults, paper feed problems, overheating, broken print hammers, and paper feed misalignment.

Exhibit 12
Quality Costs by Customer Performance Requirements

Customer Defined Performance Dimension	*Prevention*	*Assessment*	*Internal Failure*	*External Failure*	*Total*
Customer downtime					
Ribbon motion fault	$55,200	$225,600	$583,680	$487,435	$1,351,915
Paper feed problems	343,931	685,380	665,400	716,145	2,410,856
Overheating	34,548	95,800	153,760	69,700	353,808
Subtotal					4,116,579
Print quality					
Broken print hammers	217,451	339,365	461,763	253,664	1,272,243
Paper feed misalignment	86,620	78,055	162,047	234,456	561,178
Subtotal					1,833,421
Total	$737,750	$1,424,200	$2,026,650	$1,761,400	$5,950,000

DFP can assign its total quality costs of $5,950,000 to these five causes by using an activity analysis similar to that used to develop the quality cost reports shown in Exhibits 7 and 8. DFP will have to analyze all activities and resources related to preventing, monitoring, and reworking problems related to these five causes. Assume this analysis has been done, and the result is the report shown in Exhibit 12. DFP can now see that, of its total quality spending of $5,950,000, 69 percent relates to printer downtime (4,116,579 ÷ 5,950,000 = .69). The remaining 31 percent of DFP's quality costs relate to the performance dimension of print quality (1,833,421 ÷ 5,950,000 = .308).

Step 3. Compute the Value Index.

The customer value data (Exhibit 11) can now be combined with DFP's cost data (Exhibit 12), to construct the Value Index for the two customer-defined performance dimensions of printer downtime and print quality. Exhibit 13, below, shows the calculation of the Value Index.

Exhibit 13
Value Index for DFP's Printer Performance Dimensions

Dimensions of Printer Performance	*Importance Ranking*	*Quality Cost*	*Value Index (Col. 2 ÷ 3)*	*Action Needed*
Downtime or shut-down time	80%	69%	1.16	Requires more attention/cost
Print quality and legibility	20%	31%	0.645	Requires less attention/cost

Think Along

Based on the Value Index, how would you suggest DFP adjust its spending on quality to improve customer satisfaction?

DFP appears to be spending too little on the performance dimension of printer downtime. While 69 percent of DFP's quality spending relates to this dimension, customers assigned it a value rating of 80 percent. Notice that this performance dimension has a Value Index greater than 1.00. This indicates that the firm is underspending on this performance dimension. In contrast, 31 percent of DFP's quality spending relates to print quality, which received an importance rating of only 20 percent from the customers. As a general rule, a firm can improve the effectiveness of its quality management by increasing spending on performance dimensions with a Value Index greater than one. This rule does not apply to items which have very low importance rankings or very low quality costs, however.

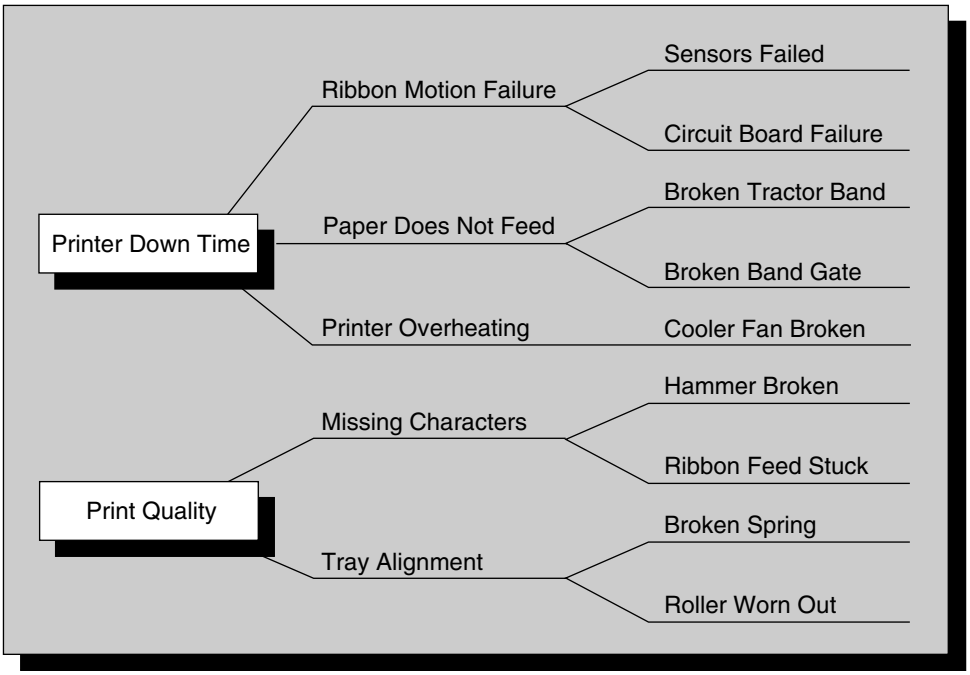
The Value Index is a powerful strategic tool because it focuses attention on customer requirements. It shows a firm how to allocate its spending on quality in order to provide the greatest value to customers. DFP now knows that it must find ways to address the causes that result in printer downtime for its customers.

Root Cause Analysis of Quality.

To eliminate downtime or improve print quality, we must address the causes behind these problems. A *root cause analysis* is a systematic method of linking a problem, as perceived by the customer, to the underlying causes in order to identify the appropriate corrective action. Exhibit 14 provides an abbreviated root cause analysis for DFP's printer problems.

As Exhibit 14 shows, downtime may result from one of three *first level causes*. These are ribbon motion failure, paper misfeed, and overheating. Ribbon motion failure, in turn, is caused by failure of either the sensors or the circuit board. These are the *second level causes*. For conciseness, the root cause analysis shown in Exhibit 14 shows only these two levels of analysis. To determine how to remedy the problem of printer downtime, however, DFP would need to carry the analysis further. For example, DFP may determine that circuit board failure is caused by either a defective chip or faulty resistor. The chip, in turn, may

Exhibit 14
A Partial Root Cause Analysis for DFP Printers



have failed because of improper specifications. When the analysis is carried through to ultimate causes in this way, DFP can see that to reduce printer downtime resulting from ribbon motion faults it must redesign the chip to correct specifications.

Most firms find it takes four or five levels of analysis to identify root causes. For this reason, Toyota, and other firms that use root cause analysis refer to this approach as the *"five why's."* The idea is that root causes can only be found by asking "why" several times to understand the multiple levels of causes of performance failures. Because of the appearance of the root cause diagram, these are often referred to as *fishbone diagrams*.

Quality cost data can be used with root cause analysis to focus quality spending on elimination of the more costly causes of product failure. DFP can assess the appropriateness of its quality spending related to ribbon motion faults by examining costs in each category (prevention, appraisal, internal, and external failure) for each of the causes of ribbon motion faults (sensor failure, faulty circuit board). For example, DFP might find that, of the $1,071,115 in failure costs for ribbon motion faults, 80 percent relates to sensor failures. The analysis might also find that sensor failures account for only 40 percent of the prevention and appraisal costs of ribbon motion faults. In that case, DFP should increase spending on prevention and appraisal related to sensor failure and monitor failure costs associated with this cause to see if it declines.

The combination of root cause analysis and quality cost data for each root cause can be a powerful tool to help management prioritize quality spending. An important contribution of root cause analysis is that it helps management to see the relative contribution of each cause to failure costs. Organizations that perform this type of analysis discover that a relatively small number of causes are responsible for most of the failure costs. A rule of thumb used by industry is the "80–20 rule." This rule asserts that root causes have a *Pareto*

distribution so that 20 percent of the root causes are responsible for 80 percent of the failure costs. By helping to identify *which root causes* are the 20 percent that cause 80 percent of costs, quality cost analysis can help management focus quality improvement efforts to achieve maximum benefit.

▲ PROPERTIES OF A QUALITY COST SYSTEM

As the prior discussion shows, a well-designed system for measuring quality costs is essential for an effective quality management system. The properties that must be present in a quality cost system if it is to be an effective strategic tool will be addressed next. In designing quality cost systems, managers must consider the technical, behavioral, and cultural attributes of these systems.

Technical Attributes of a Quality Cost System.

A well-designed quality cost system should provide information relevant to management decision making and provide a better understanding of the process that leads these costs to be incurred.

Decision relevance.
The analysis of quality costs provides information relevant to many managerial decisions related to quality. In the previous section several key decisions that require quality cost data were discussed. For instance, to make informed decisions about quality, management needs to know how much it is spending on quality, where in the firm the spending occurs, what is the purpose of the spending, and how quality impacts the firm's profitability. This information can help management balance cost and quality considerations intelligently and to focus its spending on eliminating the critical root causes that account for quality problems, resulting in improved customer satisfaction and lower total quality costs.

Process understanding.
A well-designed system for measuring quality costs can help managers understand what causes, or drives, quality costs to be incurred. Tracing quality costs to the root causes, as shown in Exhibit 14, requires a horizontal flow of information across departments. This is because root causes often are the result of decisions made in other departments than where the costs are incurred, and also because a single decision may result in quality costs being incurred in several departments. The only way to understand the firm-wide impact of each root cause is through this type of horizontal analysis. This in turn helps management understand interdependencies between departments. Process understanding can be further enhanced by extending the analysis to include other value chain members such as suppliers and customers. The focus on the entire value chain helps to make visible how the design of work relationships lead to quality problems or improvements.

Behavioral Attributes of a Quality Cost System.

A well-designed quality costing system must lead to behaviors that support an organization's strategic goals of quality, cost, and time. Three positive behavioral consequences of

measuring and reporting quality costs are: (1) greater responsiveness to customer requirements; (2) improved attitudes and aspirations about quality, and (3) better management of quality costs through visibility. A possible dysfunctional behavioral consequence is creating an incentive to pad budgets.

Focus on customer requirements.
By computing the cost and value of particular performance characteristics of a product, a quality cost system can link actions and decisions to customer requirements. This information helps people understand how their daily activities impact the product's performance in the hands of a customer and what value the customer places on these performance dimensions. The people in DFP who manufacture or assemble the paper feed can see how important it is to a customer and how much it costs DFP in failure costs when the paper feed fails. This helps them to see the importance of their actions in satisfying customer expectations. When workers see that reducing quality costs not only frees up resources, but leads to a higher level of customer satisfaction, there is a subtle but important shift in attitude. The negative focus on attacking defects as problems can be replaced with the more positive attitude of striving to exceed customer expectations.

Improved attitudes and aspirations about quality.
Traditional accounting systems focus on classifying and recording the cost of spoiled units as normal or abnormal spoilage. This approach assumes that a certain level of defects and waste is expected. The unfortunate behavioral impact of this approach is that there is no motivation to reduce defects or spoilage classified as "normal" by the accounting system. Also, when the only quality costs recognized are in production departments, there is no aspiration for the (potentially much greater) quality improvements which can come from product redesign. Measuring quality costs is a way to encourage people to reduce these costs and not just accept them.

Better management through visibility.
The type of firm-wide analysis of quality costs conducted by DFP Technologies can serve as an important awareness tool, informing decision makers of the impact of quality on the company's financial performance. Until quality measures are translated into financial terms, there cannot be aggregation across the entire firm. When quality costs are measured and become visible, people focus attention on those activities which have a favorable impact on quality costs.

Another element of visibility is the use of the term failure costs. The language conveys a subtle but important message that certain actions cause failures. No one likes to admit that their actions result in failure. This language can be an effective way to send a clear message that these costs are undesirable and should be avoided.

Budget padding.
The four-way classification of quality costs can have one potential dysfunctional behavioral impact in the short run—budget padding. Reductions in failure costs are not seen until well into the future, while prevention costs have to be incurred today. There is a danger that future reductions in failure costs can become a "holy grail" used to justify any budget increase. Management must make certain that quality spending does not become a way to "pad" departmental budgets by allowing these categories to build budgetary slack.

Cultural Attributes of a Quality Cost System.

A good quality cost measurement system can create an organizational culture in which quality becomes a way of life and a central ethical value.

Quality as a way of life.
Accounting, as the language of business, has the ability to frame the terms in which to think about and discuss issues. It has the aura of rationality that lends credence and respectability to issues that may have not been previously considered. A quality cost system has the potential for creating a value system in which quality becomes a way of life in the organization. By measuring quality and putting customers at the center of quality cost management, a customer-focused value system can be created. These values, once internalized, can provide an organization with a healthy organizational culture in the long run.

Quality as an ethical value.
Quality can be an important ethical issue in cases where product failures are life threatening, as in the tragic Challenger disaster, when the failure of a small component called O-ring resulted in the loss of the astronauts' lives. In these situations, financial measures of external failure costs may be inadequate. Further, the implication that a given level of defects is normal and to be expected is unacceptable.

The story of the Model 700 rifle manufactured by Remington Arms Co. illustrates the serious ethical considerations which can be related to product quality. In 1994 a jury awarded $17 million in damages to a man whose foot had to be amputated when he was injured by a Remington Model 700 which fired accidentally.[8] Evidence indicated that the company had known as early as 1979 that the model could easily fire without the trigger being pulled. The company had estimated the cost to fix the defective trigger mechanism to be 32 cents per gun. The company decided against a product recall, however, indicating that only one percent of the rifles were estimated to be defective, which meant two million rifles would have to be recalled to discover just 20,000 defects.

For some products, a one percent defect rate might be considered adequate. For the customer who lost his foot, however, this is entirely unacceptable. The total cost to Remington of this quality failure goes well beyond the millions of dollars in judgments in this and other pending lawsuits. The loss of public trust and damage to the firm's reputation will continue to plague the firm for years to come.

▲ LESSONS LEARNED

There are several important lessons to learn from this module.

- ▲ Traditional management accounting systems do not separately identify quality costs. Because these costs are not measured and reported, management may not realize how large these costs are and how important it is to manage them.
- ▲ Quality costs are part of a firm's quality management system. Quality management requires understanding customer requirements for performance and translating these requirements into appropriate quality goals for work processes.

[8] See Loren Berger. "Remington Faces a Misfiring Squad," Business Week, May 23, 1994, p. 90.

- ▲ There are four types of quality costs, including prevention and appraisal costs, which are incurred to prevent or measure product failures, and internal and external failure costs, which result from product failures either within the plant or after delivery to customers.
- ▲ Quality costs help quality management by informing management about the amount spent on quality, the distribution of quality spending throughout the firm, the financial benefits from improved quality, the extent to which quality spending is aligned with customer requirements, and the amount spent on preventing particular root causes of failure.
- ▲ A well-designed quality cost system must support quality management decisions, provide an understanding of how the design of work processes results in quality costs, encourage behaviors that enhance quality, and create a culture in which customer expectations are not just met but exceeded.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

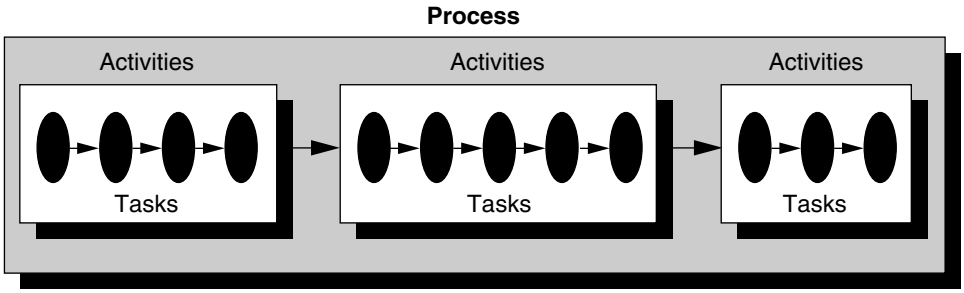
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self-test questions.

a. What negative impact could result from a lack of quality control in the production processes with regard to an organization's quality strategy?
b. What negative impact could result from a lack of quality control in the production processes with regard to an organization's cost strategy?
c. What negative impact could result from a lack of quality control in the production processes with regard to an organization's time-based strategies?
d. Why has quality become an issue in many U.S. industries?
e. What statistical properties of a process are used to identify quality problems?
f. Why is the product/process design stage so important for quality control?
g. A company purchases parts for assembly into automobile brakes. Identify possible costs related to this activity which could be classified as: 1) prevention, 2) appraisal, 3) internal failure, and 4) external failure costs.
h. Why must an adequate quality management system go through the six steps outlined in the module?
i. Why is it important to look at quality costs from a firm-wide perspective and not just at the product or departmental level?
j. What will be the impact on total costs as a firm moves toward zero defects? Use the cost curves to support your answer.
k. As a firm moves closer to zero defect, must its prevention and appraisal costs remain at a high level?
l. Why would a firm choose a six-sigma level of allowable defects rather than a three-sigma level?
m. Why might a firm choose a three-sigma level of allowable defects rather than a six-sigma level?
n. If a grocery store found that correct pricing when items are scanned at the cash register has a Value Index of .825 what does this mean? What steps should be taken?
o. Should a root cause analysis be performed on all problems? What is accomplished by performing a root cause analysis?
p. How can technical information be used to make decisions regarding quality costs? What are the measurement issues involved in gathering such information?
q. Can quality costs be determined from an organization's set of traditional financial statements without a special study or reorganization of information? Explain.
r. Explain how increased visibility of quality costs can cause positive behavioral changes in managers and employees of an organization?
s. An organization's strategy is to be a low-cost, high-quality producer of lawn mowers. Describe possible design decisions which would support this strategy.
t. Why might an increase in prevention costs cause a shareholder backlash?
u. What might managers' reactions be to increases in prevention costs?

2. Visit a local business and identify an individual product or process.

Required:

Determine the following for your selected product or process:

i. Identify inputs (suppliers or previous processes) and outputs (customers or subsequent processes) for the product or process.
ii. Identify what the customer needs are from the outputs.
iii. Identify quality indicators for the product or process.
iv. Choosing one of the quality indicators, identify root causes for sources of variation, problem areas, and opportunities for improvement.
v. Determine costs of quality failure if possible.
vi. Develop workable potential solutions to the problem.

3. The accounting department at a major university recently conducted a survey of its faculty, students, and employers of past graduates on the importance of the various activities performed by the department. The table below shows ten of the activities listed in the survey. The second column shows the current importance ranking that the department places on these activities. The last three columns show the importance rankings generated by the survey. A ranking of one means top priority is assigned to an activity while 10 is the lowest priority.

Survey Results for the Accounting Department

Activity Description	*Current Ranking*	*Faculty Ranking*	*Student Ranking*	*Employer Ranking*
Providing instruction to student	1	1	1	1
Recruiting new students	2	4	10	3
Establishing and maintaining contact with Big 6 and other CPA firms	3	7	5	4
Hiring, granting tenure, promoting, and dismissing faculty	4	2	7	8
Providing access to computer facilities	5	6	3	2
Updating course curriculum	6	3	8	7
Advising students on courses	7	9	2	9
Advising students on career alternatives	8	8	6	6
Coordinating departmental curriculum with other business courses	9	5	4	5
Providing information on the university procedures and policies	10	10	9	10

Required:

1. Where should quality efforts be concentrated? Since quality is determined from the wants and needs of the customer, who is the customer for the accounting department — is it the students, the faculty, or the employers who will hire the students?
2. How should quality be measured? What areas will require an increase in quality spending? Which area can afford a reduction in quality spending?
3. How can conflicting rankings be handled? Which should receive the most importance — current emphasis, faculty, students, or employers?

4. One of the most prestigious awards given to businesses that demonstrate achievement of a high standard of quality throughout the organization is the Malcolm Baldridge Award. There are many people who doubt that such awards can identify a truly "quality" company. Further, they are skeptical that winning one of these prestigious awards pays off for a company. Many see the pursuit of the award as a public relations avenue for a company, and not as an effort to achieve higher quality.

Required:

1. Use the Internet to investigate the criteria for the Baldridge award. Some Internet sources that would be useful in the research include:

http://davisref.samford.edu/tqm/baldridge.html which describes the past award winners and new award criteria, also **http://www.nist.gov/quality_program/doc/95_criteria/1995_AWARD_CRITERIA.html** which gives the actual award criteria for 1995. There are also numerous addresses of individual companies and the processes used toward accomplishing the quality necessary to win the award.

2. Argue whether these awards can benefit a company that is striving to increase its quality of output.
3. Indicate how cost information can help in this endeavor.

5. Classify the following costs as prevention, appraisal, internal failure, or external failure.

i. Certifying vendors as quality suppliers.
ii. Reinspection of products reworked due to a defect discovered during production.
iii. Fees for a consultant hired to perform a quality audit.
iv. Canceled sales orders due to a quality deficiency on a previous shipment to that customer.
v. Time spent performing a root cause analysis on a defective product.
vi. Establishing preventive maintenance schedules for equipment.
vii. Salary for three inspectors to perform final checks before products are shipped to customers.
viii. Time lost due to work interruptions to correct defects found during inspection.
ix. Damages paid in a product liability suit.
x. Altering a production process to reduce worker strain and fatigue.
xi. Testing of machinery to assure accuracy.
xii. Formation of "quality circles" for all employees and all departments.

6. The controller of a medium-sized firm that manufactures three styles of metal folding tables has noticed that sales returns and allowances have been increasing over the last several years. While none of the annual increases are material, cumulatively the total percentage of sales returns to sales is becoming significant. The tables are sold in large quantities to schools, convention centers and banquet centers, and to individuals through phone orders from ads placed in the back of home decorating magazines.

Eight hundred and twenty-one tables were returned last year because the customer did not like the product when it arrived (10 percent), defects were found (35 percent), or the wrong table was shipped (55 percent). The controller has decided to begin with the incorrect filling of orders since it is the largest of the three main causes. After questioning the accounting clerk, inventory control manager, and warehouse workers she listed the following information for receiving and reshipping an order.

i. The accounting clerk spends approximately 10 percent of her time issuing credit memos, replacement invoices, or refund checks. She is paid $6 per hour.
ii. Tables are sold with a 40 percent markup for large orders and a 60 percent markup for individuals.
iii. Company policy is to pay the $7.50 per table for return shipping if the return is due to an error on the company's part.
iv. The inventory control manager spends around five percent of his time updating inventory records for returns. He is paid $9.50 per hour.
v. A warehouse worker must inspect any returned tables, restock them in the warehouse, and repackage them for future shipment. He is paid $5.50 per hour and estimates that it takes one half hour to perform these tasks for five tables. New shipment cartons are $.60 each.

vi. If more than 30 tables are returned the controller must replan production for the upcoming two-week period. Updates to production schedules are run each Friday and take approximately two hours. The controller earns $65,000 per year.

Required:

1. Calculate the cost of returns due to incorrect filling of orders for the past year.
2. Identify cost differences for individual returns versus institution returns.
3. Identify any additional items that are a result of poor quality in filling orders and has not been included in the cost of returns.

7. Provide an example of a cost that would fall into each of the four quality categories for a manufacturer of T-shirts.

Type of Quality Cost	*Cost Description*
Prevention	
Appraisal	
Internal failure	
External failure	

8. Mole is a software company that produces leading database software. Programmers write "lines of code" which is tested and shipped to computer and software retail stores for sales to customers. If a software has "bugs," that is, it does not function as desired by customers, it causes various problems such as downtime, loss of data, incorrect results from data sorts, and so on. For each major "bug" identified by customers the company has estimated that it loses 20 percent of its sales for that product. Quality control is currently at three sigma level for detecting bugs in each "module." A typical product has 100 modules. During the last five years sales have declined from $15 million to $12 million due to quality problems.

The company has recently switched to an activity-based accounting system. As part of documenting activities it came across the following tasks that are related to managing software quality. These tasks have been costed but have not been classified to any activities. The costs are shown below.

	Annual Cost	
Activities	**5 Year Average**	**Last Year**
Testing of code lines written by programmers	$150,000	$175,000
Training in latest programming languages	500,000	650,000
Rewriting code that has "bugs"	600,000	1,000,000
Processing software returns from customers	250,000	450,000
Answering telephone queries from customers	250,000	575,000
Installing artificial intelligence software to detect "bugs"	50,000	250,000
Recruiting of trained software engineers	400,000	200,000
Additional Information		
Sales revenue	$15,000,000	$12,000,000
Average sale per customer	1,000	700

Required:

1. Classify the activities into the four categories of prevention, appraisal, internal, and external failure.
2. Compute and evaluate spending in the four categories. What does this cost data tell you about how well the company is managing product quality?
3. Assume that increasing to six sigma quality will cost the company $500,000. Is it cost effective for the company to do so? Why? Support your answer with calculations.
4. Assume that an investigation reveals that a key root cause for bugs is hiring of software engineers who did not have adequate training. Evaluate the company's spending on quality relative to this finding.

9. Use the data on quality costs associated with the root cause analysis presented in Exhibit 12 of the module to answer the questions below.

Required:

1. For two of the root causes of customer downtime, paper feed problems and overheating, compute the ratio of failure costs (internal failure and external failure) to non-failure costs (prevention and appraisal).
2. Assume that for these two root causes a 10 percent increase in spending on prevention and appraisal results in a 10 percent decrease in failure costs. If DFP increases its investment in prevention/appraisal by 10 percent, what will be the return (net benefit) on this increased investment? What will be the new ratio of failure costs to non-failure costs?
3. For each of these root causes, compute the return on the increased investment (net reduction in failure costs divided by the increased spending on prevention/appraisal). What conclusion can you draw about the relationship between the failure costs and prevention/appraisal costs and the return on quality spending?

▲ PROBLEMS AND CASES—ADVANCED LEVEL

10. Burnwood Products is a manufacturer of home office and accessory furniture. Products are sold in unassembled kits to discount stores. Last years sales were over $13 million for 21,435 orders. The following information about the production costs was obtained from the accounting records for last year.

Cost Item	*Amount*
Salaries and wages:	
Design	$210,000
Inspection	28,000
Administration	120,000
Production—regular	630,000
Production—overtime	13,000
Materials and supplies	2,500,000
Consulting fees	33,000
Interview expenses	8,430
Phone system installation	47,500
Utilities and facilities charges	3,727,500
Total	**$7,317,430**

Further analysis revealed the following:

i. Replacement of defective parts to customers cost $3,240 for the year.
ii. Burnwood's purchasing and production staff performed a quality audit on the company's 35 suppliers. The audits averaged 10 hours per supplier and the average wage cost was $24 per hour.
iii. Sixty more candidates were interviewed for the position of operator of the computerized cutting machine than the previous time the position was filled to assure the best possible candidate was found. Each interview costs $45 to perform.
iv. The phone system was upgraded at a cost of $47,500 during the year to allow the customer service representatives faster response time and better handling of customer calls. These employees earn $7 per hour.
v. It was estimated that 30 percent of the orders received must be recalculated and the purchaser notified for incorrect prices due to outdated catalogs. Each of these calls takes approximately 15 minutes for the customer service representative.
vi. In an effort to provide better customer service, the instruction manuals that accompany the furniture kits were lengthened. The additional cost per kit was $1.20 and reduced the number of calls for clarification and reduced frustration on the part of the customer. An outside writer was hired to rewrite the instructions at a cost of $3,500.
vii. The design of several kits were changed to reduce the number of pieces. The five designers spent two months of their time on these design changes. Designers are paid $42,000 per year.
viii. One of the $7 per hour production workers is in charge of measuring and charting the defect rate of imperfectly cut pieces. This takes approximately one hour of his time per week.
ix. Two inspectors are on the staff and are paid $7 per hour. One of the inspectors spends 70 percent of his time inspecting incoming lumber.
x. A marketing analysis was obtained, at a cost of $33,000, from an outside consultant to determine customer satisfaction and future desires.
xi. Several furniture kits from a competitor were purchased at a cost of $1,200 to compare to Burnwood's kits. The design staff spent 80 hours assembling and analyzing the kits.
xii. A quality training program was undertaken with the production staff. After this emphasis on quality, overtime increased by 20 percent in the month following, but then dropped back to normal rates.
xiii. The final inspection area constitutes 10 percent of the total square feet of the plant.
xiv. Cost of boards recut due to a miscalculation in measurement was $2,200 during the year.

Required:

1. Determine Burnwood's spending on quality.
2. Classify the quality costs into the categories of prevention, appraisal, internal failure, and external failure.
3. Analyze Burnwood's quality spending. Are they spending enough on quality? Are they concentrating their spending in the right mix between the categories?
4. Design a report for the quality cost information that will allow all employees to understand the impact of poor quality on costs. Keep in mind that most of the employees generally do not receive accounting information and are unfamiliar with traditional accounting terminology.

11. A recent cover story in a national business magazine mentioned the *To The Hilt Hotel* chain (TTH) as an example of how **not** to manage quality. Following the article, TTH hired a consulting firm to recommend ways to improve customer satisfaction. The consultants' study concluded that the factors which determine guests' satisfaction level include the friendliness and efficiency of hotel staff, the attractiveness of the lobby, comfort of beds, and room size. Value Index analysis revealed that TTH was under spending on employee friendliness/efficiency and lobby attractiveness relative to the value placed on these dimensions by hotel guests.

In response to the consultants' recommendation, TTH has decided to experiment with a Total Quality Management program including new training procedures and lobby renovations at its downtown Atlanta hotel, timed to be completed for the heavy tourist traffic expected during the 1996 Summer Olympics. The training is estimated to cost $115,000, and the renovation is estimated to cost $145,000. Last year, 85,000 guests stayed at the hotel.

The consultants' report included the following percentages relating to customer satisfaction:

	Without TQM	**With TQM (estimated)**
Expectations exceeded	.30	.37
Satisfied	.52	.60
Not satisfied	.18	.03
Estimated new guests	31,000	34,000

Statistics indicate that 80 percent of hotel guests whose expectations are exceeded will return. Of those who are satisfied with their experience, 45 percent will return, and of those who are dissatisfied, only 20 percent will return. Analysis of TTH accounting records indicate that returning guests stay longer, upgrade to higher priced rooms, and require fewer advertising expenses. As a result, the contribution margin per stay (revenue minus cost of servicing the stay) is $41 for returning guests, compared to $39 for new guests.

Required:

1. In analyzing the financial benefit from quality programs, TTH evaluates the return on quality (ROQ), as the net benefit from the program divided by spending required. What is the ROQ of the total quality program recommended by the consultant?
2. Suppose TTH has decided to implement only one quality improvement effort at a time. Based on expected customer satisfaction levels provided by the consultant (below), what will be the ROQ if only the training program is implemented? Only the renovation?

	Training	**Renovation**
Expectations exceeded	.32	.36
Satisfied	.58	.55
Not satisfied	.10	.09
Estimated new guests	32,000	32,000

3. TTH's Director of Marketing claims it doesn't matter whether TTH undertakes the training program or the renovation, because both will generate the same amount of new business. How would you respond? Use quantitative analysis to support your recommendation.

12. Quality in service after sale is an important part of many businesses that sell products to consumers. The revenues generated on these after-the-sale services can be a substantial

part of total revenues. For example, Xerox's service division accounts for 45 percent of the company's gross revenues. When it lost the account to service five printers at the Sprint Corp. headquarters to an independent service organization (ISO) that promised better service, there was much concern.[9] ISOs are a rising industry as customers demand more and better service on the products they buy, and revenue potential of such service increases.

As the controller of a large manufacturer of air conditioning and heating units you are aware that after-the-sale service is important to your business. However, no focus has ever been placed on understanding what after-the-sale service means or the relationship between manufacturing quality and service needs. While the small units sold to individual customers through company-owned dealers are usually only serviced when there is a breakdown or defect, the large units sold to schools, businesses and contractors require annual servicing in addition to breakdown calls. You have become concerned after reading the *Business Week* article and have commissioned a study to investigate how to avoid the loss of this business to ISOs.

Required:

1. How would you define service quality for this type of business?
2. What elements of product quality impact on the need for service?
3. What information relating to cost, quality, or time would help you, the controller, to improve service quality?
4. What behaviors are needed to improve service quality? How can cost of quality data help to generate these behaviors?
5. What kind of organizational culture, values, or mindsets do you need to improve service quality? How can management accounting data help to create or foster a service-oriented organizational culture.

Case 1: Cascade Seating.

Cascade Seating Inc. is a large manufacturer of automobile seat covers. Jan Davis, the controller just received a disturbing call from the plant manager, Dave Garcia. General Motors had just downgraded Cascade from preferred supplier to backup supplier. GM cited the inconsistent fit of the seat covers as the reason, and suggested to Dave that he read an article "How Velcro Got Hooked on Quality."[10] GM had downgraded Velcro a few years back in a similar fashion, but Velcro had managed to turn its quality around and was again a successful preferred supplier to GM.

Jan and Dave immediately got a copy of the article GM had recommended and read it several times through. Both were alarmed at how familiar the story sounded to Cascade and the current situation. Two main points of the article really hit home. Velcro had a quality program in place and thought it was doing well. "We're in the same boat, Dave," Jan said. "We have a quality program which has been showing steady increases in quality for the past two years. But if it's working, then why are we being cited for poor quality products?" "I don't know, Jan, but I know there's another similarity between Velcro and us." Dave went on, "One of GM's big complaints with Velcro was that they were 'inspecting quality in' rather than 'manufacturing quality in.' We work it the same way. We have 15 people assigned to the Quality Control Department right now, and their main task is to be sure that the product going out the door has been inspected. You'll have to ask Ronald,

[9] "Slugfest in the Service Biz," *Business Week,* February 28, 1994.
[10] Harvard Business Review, September–October 1989.

the supervisor over there, but I don't see them out on the plant floor working with the production workers, I mostly see them over by finished goods or in their offices."

Jan called a meeting with Dave and the managers of Quality Control, Purchasing, Customer Service, and Inventory Control. As the discussion developed, it became clear that these managers had never met to discuss product quality. Jan listened to each of the managers as they made excuses and pointed fingers at the other departments. "Gentlemen," she finally interrupted, "I don't care about assigning any blame to anyone, and neither does GM. The point here is to figure out where our quality problems lie, and what we can do about them." After that, discussion centered on the problems with quality.

After several hours, the managers concluded that the four main areas of quality problems were in poor quality material, cutting of the material, sewing, or poor inspection. The purchasing manager explained that he spends four hours each month preparing a quality report on the suppliers and performs a yearly review of all suppliers, which takes about 40 hours to complete. Last year he found a new fabric supplier who helped to cut material costs. However, the new supplier's fabric quality was probably not as good as that of his predecessor. As he spoke Jan jotted a note to herself to check the purchasing manager's performance evaluations to see if possibly he was part of the problem as well. She seemed to remember that his evaluations were not very favorable, and that he had not been given a raise above his $22,000 salary.

Dave was unhappy with the cutters and sewers in the plant. Last year the cost of scrapped material was $147,900. Upon investigation he found that 63 percent of the cost for scrapped material was from four cutting related reasons while the other 37 percent was from sewing related reasons. He produced the following data from his files to support this contention:

Reason for scrapping of material	Percentage of Total
Cutter cut material incorrectly	28
Cutting machine calibrations off	16
Pattern was incorrect	10
Dull blades on the cutting machine	9
Sewers sewed material incorrectly	25
Sewing machine calibrations off	12

Dave also told the group that when he discovered that the cutting and sewing machine calibrations were incorrect on one of the machines, he had all the cutting and sewing machines checked. This resulted in $5,500 in downtime costs for the cutting machines and $7,400 for the sewing machines. Another $8,200 had been spent last year in rework by the sewers.

At this point the inventory control manager chimed in, "I kept records on the reason for returns last year, and you must do something about your people, Dave. Poor seaming by the sewers accounted for 31 percent of the $56,000 in rejected seat covers by the customer. But the biggest reason for returns, 62 percent, were due to poor fit, most likely due to your cutters not following the patterns correctly. Another seven percent were due to defects in the material. And don't forget about the big shipment of material we returned in October. Around $25,000, as I recall."

Jan was starting to become very dismayed. How could there be quality reports that showed steady increases and yet have all these problems? "Dave, what kind of training takes place for the cutters and sewers?" she finally asked. "Well, cutters go through 40 hours of training, and sewers have six hours. We have 10 cutters, making $7.25 per hour right now, and 36 sewers at $5.50 per hour. My training budget's been cut back so many times that I can't afford to give them any more," he replied. "That's okay, Dave," Jan said,

"we're just trying to figure out what our problems are right now, we'll worry about costs and how to solve them later."

Jan next turned to Ronald Fanucci, the manager of the Quality Control Department. He informed her that the quality control procedures had been written four years ago and, except for minor changes, had not been updated since. Further, the procedures had been written primarily by the Quality Control Department with little input from production supervisors. Jan was now quite disturbed. "So where are these 15 people in your department during the day, Ron?" she asked. "Well, three are in incoming inspection, and there's one supervisor over there, and one is in with the pattern making. But the bulk of my staff is in final inspection. I have eight inspectors and one supervisor there." Jan looked at the budget and noted that the inspectors received $12,000 salary per year, the supervisors $18,000 per year, and Ron made $31,000 per year.

As the meeting closed, Jan knew some real progress had been made in determining where the quality problems were. She also knew that there would be a lot of hard work ahead in solving those problems.

Required:

1. Prepare a fishbone diagram, similar to Exhibit 14, identifying the root causes of Cascade Seating's quality problems.
2. Determine the quality costs by category (prevention, appraisal, etc.) and by the performance problems identified in requirement one, similar to Exhibit 12.
3. Why has Cascade run into a quality problem, despite a sizable number of people performing the quality control function?
4. Has the current accounting system helped or hindered the quality efforts?
5. Write a report outlining how Cascade Seating should shift its quality spending to improve product quality?

Case 2: Nuclear Safety Research Inc.

Nuclear Safety Research Inc. (NSR) is a consulting firm which conducts safety examinations of steam tubes in nuclear reactors. Its clients include nuclear power plants throughout the world. In the U.S., most of NSR's clients use what are referred to as "boiling water reactors" (BWR). With all reactors, the steam pipes are one of the more vulnerable points. With boiling water reactors, however, the steam passing through the tubes is radioactive, so the danger is much greater. In addition, the cost of repairs is extremely high, because repairs must be done remotely using sophisticated and expensive robotics equipment. Of approximately 330 reactors world-wide, approximately one-fourth are BWRs. In the U.S., BWRs represent about one third of approximately 110 reactors in use.

The testing procedure to examine steam tubes for flaws and cracks involves using an electronic probe to measure the thickness of the tubing. Under normal conditions, the tubing is the same thickness throughout. Variations in thickness indicate wear, and signal possible future problems. This method is called "nondestructive examination" (NDE), because the tube is left intact. When nondestructive examination indicates a possible defect, the section of tubing is cut out and inspected.

One of NSR's engineers has suggested a way to redesign the electronic probes used in NDEs. The engineering department estimates that redesign of the probes will cost approximately $450,000. NSR's president is intrigued by the idea, since improved accuracy of testing would greatly reduce both cost and risk. He asks Jack Trelligar, NSR's controller, to do a quality cost analysis of probe redesign.

Using normal procedures and existing equipment, NSR's safety review of a reactor takes six to eight months. Of this time, almost two months is preliminary work. First, a schematic diagram of the steam tubes is marked off with a grid, to define sections a few inches square. Testing work is planned so that an examination will be made in each square of the grid. For sections where the risk is higher, such as where the tube attaches to nozzles or flanges, a finer grid is used, and test readings are closer together.

NSR routinely monitors equipment reliability in its testing lab by taking readings of sample tubes, some of which are known to have defects. In addition, NSR routinely re-tests some tubes examined in the field. Last year, the firm completed NDE engagements at 57 nuclear power plants world-wide, and examined a total of 969,000 steam tubes. Of these, the firm re-analyzed 226,500 tests. Re-tests found erroneous test results in 679 cases.

Two types of errors may occur in testing. A ***false positive*** occurs when test results identify the tube as defective, but there is in fact no flaw in the tube. A ***false negative*** results when the tube passes inspection, but there is in fact a crack or hole (see Exhibit 15). A false positive is expensive for the client firm, because cutting the tube section open disrupts operations. A false negative, however, is far more dangerous.

Exhibit 15
Types of Testing Errors

Actual Condition of Tube	*Test Result*	
	Defective	*Not Defective*
Defective	True positive	False negative
Not defective	False positive	True negative

At the client facility, there is no way to know when a false negative has occurred. This is particularly dangerous, since the Nuclear Regulatory Commission routinely extends licenses of facilities which receive clean test results for an additional 20 years beyond the normal 40-year life of a reactor. This means tubes are operated well beyond the intended life, and the danger of an accident is greatly increased. Recently, based on the results of NSR's tests, a client facility was shut down and all 17,000 steam tubes were repaired, at a cost of $40 million.

Required:

1. Is NSR operating at three-sigma quality levels or six-sigma levels?
2. When a test of steam tubes at a client facility produces a ***false positive*** result, what activities will NSR perform? What activities will the client perform? How would you estimate the costs of these activities?
3. When a test of steam tubes at a client facility produces a ***false negative*** result, what activities will NSR perform? What activities will the client perform? How would you estimate the costs of these activities?
4. Do you think the probe should be redesigned? With so little cost data available, how can the firm analyze this decision?
5. Should the firm go to six-sigma quality levels? Will this decision be cost effective or is it likely to show diminishing returns at some point?
6. One of the firm's major markets is developing countries, where the availability of low-cost electricity generated by nuclear power plants makes economic development possible. The citizens of these countries rely on subsistence agriculture which has resulted in soil depletion, desalination, and "desertification" making life increasingly difficult. Would you advocate a six-sigma quality level if these countries are willing to certify a plan at the current three-sigma level?

M O D U L E

Target Costing

Version 1.1

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Module Contents
Target Costing

Target Costing*

TARGET COSTING GLOWS WITH THE "NEON"

In 1990 Chrysler Corporation found itself in a very unhappy financial situation. Profits were down, cash flow was tight, and the stock was trading at a low price of $10 per share. The Japanese auto industry posed a serious threat. Despite a strong Yen, they had captured and continued to preserve a healthy share of the U.S. auto market. Chrysler management decided it was time to change their approach to new car design. They adopted a competitive weapon that the Japanese auto industry had used for many years called target costing. Target costing was applied to all product development efforts in the Company including the NEON, a new small car developed for the lower price range. A price and profit target was set for the car and it was then designed to meet that profit without sacrificing major customer requirements. The results of using target costing on the NEON were impressive. The NEON:

- ▲ Provided dual airbags and a powerful engine for a small car.
- ▲ Was named "Auto of the Year" in 1994.
- ▲ Had a relatively short development time going from product concept to market in 31 months.
- ▲ Came in below its project development and investment budget.
- ▲ Is one of a handful of small cars made in the USA that makes a positive return.
- ▲ Is environmentally friendly built using a recyclable facia and non-toxic materials.

Since the introduction of target costing, Chrysler's profits have increased significantly. Its share price went up from $10 per share in 1990 to $54 per share in 1995.

▲ STRATEGIC IMPLICATIONS OF TARGET COSTING

A *target cost* is the allowable amount of cost that can be incurred on a product and still earn the required profit from that product. It is market driven costing. The Chrysler story shows how a target costing process, when well executed, can improve a firm's competitive position by improving quality, reducing costs, and accelerating the time to market.

- ▲ **Quality.** Target costing improves product quality by making it an explicit objective of the product development and costing processes. Cost targets *cannot* be achieved by compromising the features that a customer desires or by reducing the performance or reliability of a product.
- ▲ **Cost.** Reducing costs is at the heart of target costing. Unlike traditional methods, however, target costing does not wait for production to start before managing

* This module is based on material developed jointly with the Consortium for Advanced Manufacturing (CAM-I). The complete work is contained in book form in S. Ansari, J. Bell and The CAM-I Target Cost Core Group, *Target Costing: The Next Frontier in Strategic Cost Management,* Irwin Professional Publishing, 1996.

costs. It makes cost planning a part of profit planning and uses an intelligent, customer-focused design process to manage costs before they are incurred.

▲ **Time.** Target costing reduces the time from concept to marketing of products because products and processes are designed simultaneously. No time is lost in trying to determine how to manufacture a product after it is designed or in correcting design errors.

▲ PURPOSE OF THIS MODULE

This module explains the use of target costing as a strategic profit planning and cost management tool. We will identify its key principles, contrast it with traditional cost management tools, show the critical steps in the process, and demonstrate its functioning in practice. After you study this module, you will understand:

▲ A brief history and background of target costing.
▲ The need for target costing.
▲ The key ideas underlying target costing.
▲ A description of the target costing process.
▲ How to attain target costs for products.
▲ How cost reduction occurs in practice.
▲ The management accounting implications of target costing.
▲ The technical, behavioral, and cultural implications of target costing.

▲ HISTORY AND BACKGROUND OF TARGET COSTING

Target costing originated in Japan in the 1960s. As it did with quality, Japanese industry took a simple American idea called *value engineering* and transformed it into a dynamic cost reduction and profit-planning system. Value engineering originated at General Electric during World War II. It was an organized engineering approach to determining how to produce products in the face of parts' shortages. The practice was instituted to design products that could do more with fewer parts. Later it became an organized effort to examine how to provide the needed features or functions in a product at the lowest possible cost.

U.S. industry did not realize the potential of value engineering as a systematic profit and cost planning tool and did little with it after World War II. Japanese industry expanded the basic concepts of value engineering into the target-costing process. Today more than 80 percent of all assembly industries in Japan, such as automobiles, electronics, consumer appliances, and machine tools and dyes, use target costing.[1] Naturally, some of the best practitioners of target costing are leading Japanese companies such as Toyota, Nissan, Sony, Matsushita, Nippon Denso, Daihatsu, Cannon, NEC, Olympus, Komatsu, and many others.

In the United States, target costing has been used only since the late 1980s. The loss of market share to Japanese companies, as in Chrysler's case, has been a major motivation for adopting target costing. Adoption of target costing in the United States remains slow for several reasons. Some managers fail to appreciate its strategic importance. Others mistake

[1] See Y. Kato. "Target Costing Support Systems: Lessons from Leading Japanese Companies," *Management Accounting Research 4,* 1993, pp. 33–47. Also see T. Tani, H. Okano, N. Shimizu, Y. Iwabuchi, J. Fukuda, and S. Cooray. "Target Cost Management in Japanese Companies," *Management Accounting Research 5,* 1994, pp. 67–81.

it for a narrow cost reduction technique and confuse the simplicity of its ideas for a simplistic process. Still others use some elements of target costing but mistakenly think they have adopted the entire process.

▲ NEED FOR TARGET COSTING

What makes target costing so important today? The answer lies in the nature of the contemporary industrial environment. Today businesses face a global environment that has four characteristics. It is:

- ▲ **C**ompetitive, because prices cannot be increased in many key industries. Many new producers, some with a lower cost of doing business, have entered the global marketplace.
- ▲ **R**apidly changing, because the dissemination of technology and knowledge has accelerated considerably. This faster pace makes it difficult to use any one factor, such as quality, for a long-lasting competitive advantage.
- ▲ **U**nforgiving of mistakes or delays, since shorter product lives leave little time to respond to changes in the marketplace or to recover from mistakes.
- ▲ **D**emanding, because sophisticated consumers have knowledge of many products and want better quality products at an affordable price. It is difficult to sell inferior products with reduced features at a lower price.

In short, the environment is dealing a **CRUD** hand. Target costing responds by coming up with **ACES**. Target costing is a process that:

- ▲ **A**nticipates costs before they are incurred.
- ▲ **C**ontinually improves product and process designs.
- ▲ **E**xternally focuses on customer requirements and competitive threats.
- ▲ **S**ystematically links an organization to its suppliers, dealers, customers, and recyclers in a cohesive and integrated profit and cost planning system.

▲ TARGET COSTING—KEY IDEAS

Achieving target costs requires a formal process. The most comprehensive definition of the **target costing process** comes from the Consortium for Advanced Manufacturing International (CAM-I):

> Target costing is a system of profit planning and cost management that is *price led, customer focused, design centered* and *cross functional*. Target costing initiates cost management at the earliest stages of product development and applies it throughout the product *life cycle* by actively involving the entire *value chain*.[2]

The *purpose* of target costing is to ensure adequate profits by undertaking simultaneous profit and cost planning. The CAM-I definition contains six key ideas that provide the conceptual foundations for target costing. Each of these six foundations is explained below.

1. **Price led costing** means that target costs are established by first determining a competitive market price and then subtracting the required profit margin from it. This is summarized in the equation:

[2] S. Ansari, et al. *Target Costing—The Next Strategic Frontier,* Irwin, 1996.

$C = P - \pi$

where

C = Target cost
P = Competitive market price
π = Target profit

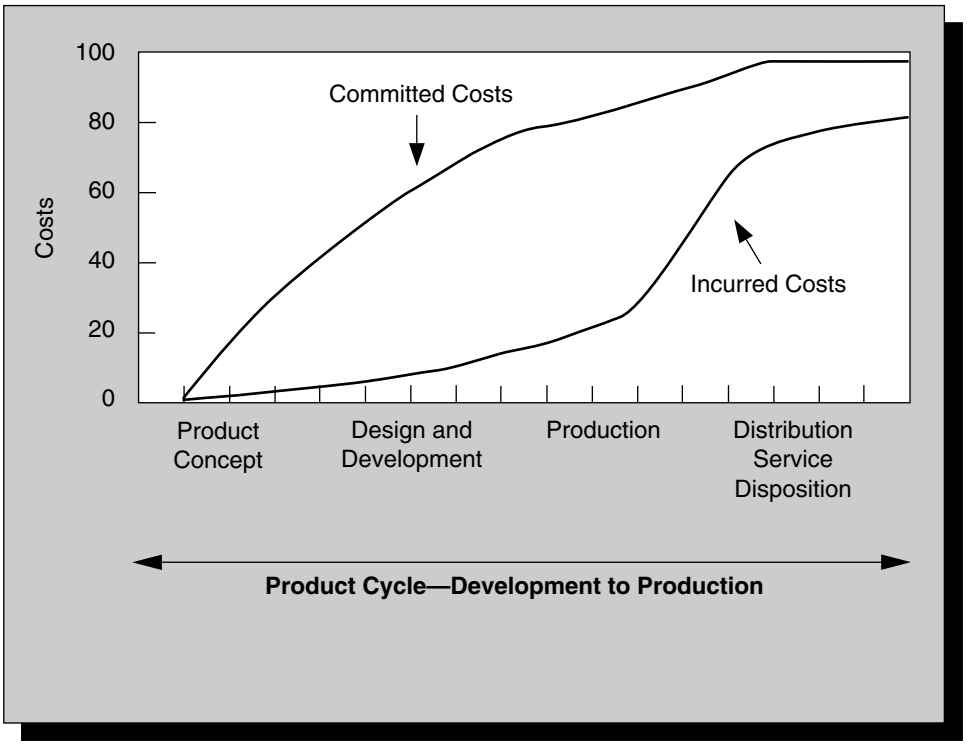
In target costing, market price is the independent variable; costs allowed for designing, manufacturing, marketing, and other functions (the target costs) are dependent on the market price.

For example, if the competitive price for a product is $100, and the company requires a 15 percent profit margin, then the target cost for this product is set at $85 (100−15).

2. **Customer driven** means that customer requirements about product quality, price, and timeliness guide cost analysis. It is essential to understand what quality features and timeliness customers expect at a given market price and what competition is currently doing or might do to respond to a company's product offerings. The target cost must not only yield the target profit but also allow the manufacturer to match competitive product dimensions. The target cost cannot be attained by sacrificing the features that customers want, lowering the performance or reliability of the product, or delaying its introduction in the marketplace.
3. **Design** of product and processes is the key to cost reduction efforts. Target cost systems design products and their manufacturing and delivery processes simultaneously. This is sometimes called *concurrent engineering*. Traditional cost reduction methods focus on production efficiencies such as waste reduction or buying in quantity to reduce cost. This is not the prime focus of target costing. Target costing focuses on product design because most costs, nearly 70–80 percent, are *committed* at the design stage, while only 10–20 percent of the costs are *incurred* at this stage. Exhibit 1 shows the typical relationship between committed and incurred product costs. As depicted there, the majority of the costs are committed at the design stage, while the majority of costs are incurred after production starts. The best opportunity to manage costs is while a product is still in design. Concurrent engineering design eliminates costly features and minimizes the need for engineering changes after production begins.
4. **Cross-functional product teams** with members representing design and manufacturing engineering, sales and marketing, material procurement, cost accounting, service, and support typically are jointly responsible for attaining target costs. The teams also include outside participants such as suppliers, customers, dealers, and recyclers. The teams are responsible for a product from initial concept through production. *A cross-functional team is not a set of specialists who contribute their expertise and leave. They are responsible for the entire product!* A good example of product team participation occurred during the development of Chrysler's Neon. During the development of this car, the financial analysts assigned to the team had to travel to Nova Scotia in the winter to observe crash testing.[3]
5. **Life cycle costing** considers all costs of owning a product over its life, such as purchase price, operating costs, maintenance and repairs, and disposition costs. Life cycle costing's goal is to minimize the *cost of ownership* to a customer. For

[3] The idea of having accountants participate in crash testing is to make them understand how the product works, take ownership of the product, and appreciate the impact of their recommendations on a product's performance. It is certainly not because they need an extra dummy for crash testing.

Exhibit 1
Typical Product Cost Curves



example, when a customer owns a refrigerator, he or she pays more than the initial purchase price. The customer must pay for electricity (operating cost), repairs, and any final disposition cost of removing the refrigerator at the end of its useful life.[4] From a producer's point of view, life cycle costing means *designing products that minimize all costs* from birth (R&D) to death (disposition or recycling costs). In the case of the refrigerator, a design that reduces weight, locates parts so that they are easy to access during repairs, and uses remanufacturable material will decrease delivery, installation, repair, and disposition costs.

6. **Value chain** members such as suppliers, dealers, and service and support personnel are part of the target costing process and help to focus cost reduction efforts throughout the value chain. Target costing systems involve an active and collaborative relationship in which cost-reduction techniques are shared by all members of this extended enterprise. A target costing system is based on long term, mutually beneficial relationships with suppliers and other members of the value chain such as distributors and recyclers.

These six features distinguish target costing from traditional cost-plus systems. Traditional cost-plus systems typically start with costs and then add a profit margin to obtain a market price. If the market is unwilling to pay the price, the firm tries to find cost reductions. Target costing starts with a market price and a planned profit margin for a product and establishes an *allowable cost* for the product. Product and process design are used thereafter to reduce product cost so it is equal to this allowable cost.

[4] The costs of disposition can be very significant for products that have an adverse environmental impact.

Exhibit 2
Comparison of Target Costing and Cost-Plus Approaches

Target Costing	*Cost-Plus*
Competitive market considerations drive cost planning.	Market considerations are not part of cost planning.
Prices determine costs.	Costs determine price.
Design is key to cost reduction.	Waste and inefficiency are focuses of cost reduction efforts.
Customer input guides cost reduction.	Cost reduction is not customer driven.
Uses cross-functional teams to manage costs.	Cost accountants are responsible for cost reduction.
Suppliers involved early.	Suppliers involved after product designed.
Minimizes cost of ownership to customer.	Minimizes initial price paid by customer.
Involves the value chain in cost planning.	Little or no involvement of the value chain in cost planning.

Exhibit 2 provides a comparison of the traditional cost-plus approach with the target costing approach.

▲ THE TARGET COSTING PROCESS

Since target costing relies on design for cost reduction, it is applied primarily to new product development efforts. Most products are developed in four stages:

1. *Product planning,* during which a product and customer niche are defined.
2. *Concept development and feasibility testing,* during which a product concept is developed and its feasibility is tested.
3. *Design development,* during which a feasible concept is turned into a detailed product design.
4. *Production*, which occurs after a final design is released.

Target costing occurs in two phases that correspond *roughly* to the first and second halves of this product development cycle. They are called the **establishment phase** and the **attainment phase** of target costing. The establishment phase occurs during the product planning and concept development stages of the product development cycle and involves establishing a target cost. The attainment phase occurs during the design development and production stages of the cycle and involves achieving a target cost. The relationship of target costing to the product development cycle is shown in Exhibit 3.

▲ ESTABLISHING TARGET COSTS

Target costs are established within the parameters defined by a firm's product strategy and long-term profit plans. These plans define new markets, customers, and products that a company plans to pursue. Product concepts aimed at specific customers are tested for feasibility and then target costs are set for feasible products. Exhibit 4 provides an overview

Exhibit 3
Target Costing and the Product Development Cycle

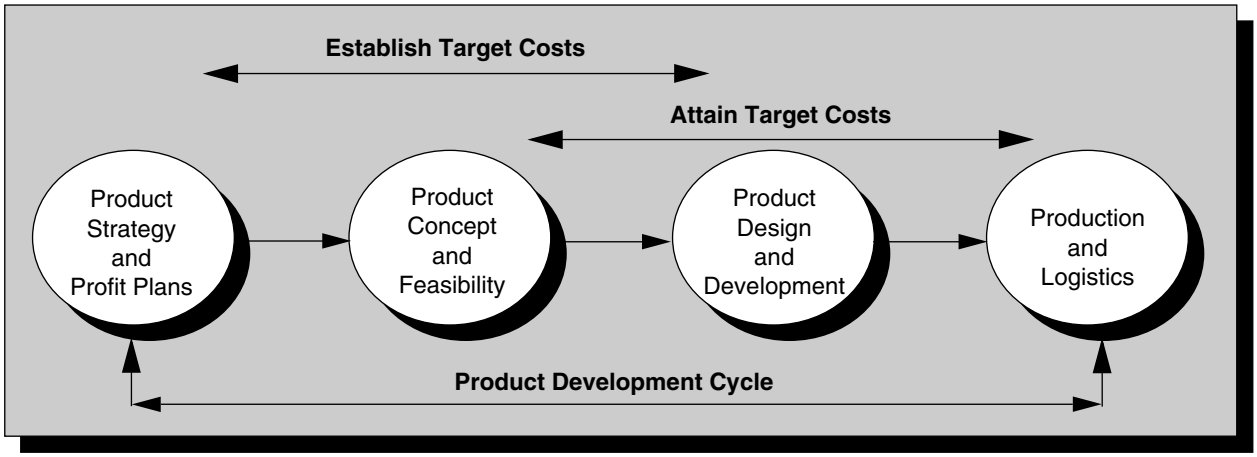
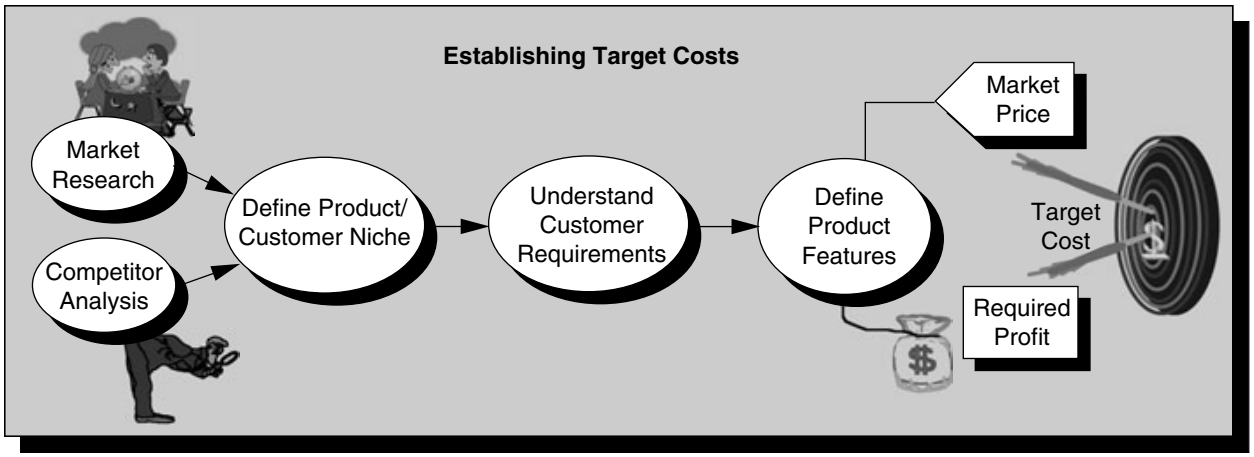


Exhibit 4
The Establishment Phase of Target Costing



of the establishment phase of target costing. It shows that there are seven major activities that must be performed to establish target costs.

1. **Market research** gains information about unmet needs and wants of customers. This research defines the market and/or product niche that a company plans to exploit. Typically, a market niche is a broadly defined class of customers such as "health-conscious eaters" or "upwardly mobile professionals."
2. **Competitor analysis** determines what competitors' products are currently available to our target customers, how the customers evaluate these other products, and how our competitors might react to our company's new product introductions.
3. **A customer or product niche** is defined by analyzing market and competitor information to decide what particular customer segment to target. A customer niche is a more specifically defined customer, such as "young, professional, two-income family between the ages of 30 and 45."

4. **Customer requirements** are determined by introducing an initial product concept and asking customers for their reactions. Preliminary designs are then refined, based on continued input from customers, until the product meets their requirements.
5. **Product features** are defined by setting specific requirements for the features the product will have and the levels of performance of each feature.
6. **A market price** is established that is acceptable to customers and capable of withstanding competition. Market prices can be established in many different ways. Three common methods are:
   a. Existing price plus the market value of new features added. For example, if a new car model has dual air bags, we might take the price of the previous model and add the value of the air bags to determine the new price.
   b. The projected market price that will provide a target market share. For example, a CD player manufacturer may set a price that will give them a 25 percent market share.
   c. Existing price plus the value of added physical attributes. This method is typically used for products for which a customer's desired performance is captured by some physical characteristic of the product. A good example is a lawn mower. A customer's performance requirement for how fast and close the lawn mower cuts the grass is closely related to the engine horsepower. Therefore, if a lawn mower with a two-horsepower motor sells for $200, then we might be able to charge $250 for a three-horsepower motor if we can establish that the market pays $50 per horsepower.
7. **The required profit target** is set. This is the profit that a product must yield. It is typically expressed as a return on sales (ROS) percent. This ROS percent depends upon the long-term profit plans and the financial return on assets a company must earn in a given industry. A common practice in Japan is to use a weighting scheme that combines a company's *historical* ROS with the average *industry* ROS and the company's *projected* ROS to yield the required ROS for a product. Japanese companies typically ignore the return on assets since it is difficult to determine and complicates the calculation of target profit. The following formula reflects this practice:[5]

   $$\text{Target ROS} = w_1\,(\text{Historical ROS}) + w_2\,(\text{Industry ROS}) + w_3\,(\text{Projected ROS})$$

   where

   $$w_1 + w_2 + w_3 = 1$$

For example, assume that the historical ROS of a TV manufacturer has averaged 12 percent. Further assume that the industry average is 10 percent and that this manufacturer plans to increase their ROS to 15 percent in the next few years. Their target ROS for this year's TV production may be:

$$(30\% \times 12\%) + (20\% \times 10\%) + (50\% \times 15\%) = 13.1\%$$

In this example, notice that 50 percent of the weight is placed on the future ROS, and the remaining weight is divided between past (30 percent) and the industry's average (20 percent). As time passes, the weights assigned to past experience and to the industry ROS

[5] Yasuhiro Monden. *Target Costing and Kaizen Costing*, Productivity Press, 1995, p. 40.

are designed to go to zero. Only the projected ROS becomes the key variable in determining a product's target ROS.[6]

Key Point

It is important to note that profits, prices, and market shares are targets to be achieved and not simply desires of management or probabilistic estimates about future states of these variables. Target costing is, therefore, an action plan requiring commitment by organizational members.

▲ TARGET COSTING—AN ILLUSTRATION

We will illustrate the key activities at each stage of the target costing process with the help of a hypothetical company, Kitchenhelp, Inc.

Kitchenhelp is a manufacturer of small kitchen appliances such as toasters, coffeemakers, grinders, blenders, juicers, electric carving knives, can openers, and other items. Competition is tough; several other major brand names on the market include Mr. Coffee, Moulinex, Braun, Krups, Sharp, and Toshiba. The company is looking for market opportunities to exploit in their various products. One such product is their coffeemaker line. Currently, Kitchenhelp makes a conventional drip coffeemaker and an espresso/cappuccino maker. How can the company apply the target costing steps in Exhibit 4 to its coffeemaker line?

You will recall from Exhibit 4 that the first three steps in target costing require that the company conduct market research and competitive analysis in order to define a market niche.

Assume that Kitchenhelp's market research and analysis show that there is an upwardly mobile, college educated consumer who is interested in more gourmet types of food at home. The company decides to go after this "home gourmet" market niche. Further market research results in the discovery that one area in which the home gourmet market niche can be exploited is through its coffeemaker line. Kitchenhelp has determined that there is a market for a coffeemaker that provides espresso quality coffee but is not as complex and time-consuming to operate as an espresso/cappuccino maker. There is also little competition in this market segment.

Kitchenhelp must form a cross-functional team to come up with an initial product concept and to test its feasibility. Assume that Kitchenhelp's product team proposes an initial product concept that combines a coffee grinder and a drip system into a single coffeemaker. The new design will grind fresh coffee beans and push extra hot water through the grinder basket to make regular coffee smell and taste more like espresso.

If this type of coffeemaker is technically and financially feasible, then the next steps for the product team are to understand customer requirements and define product features.

Market research aimed at coffee-drinking consumers is needed to better understand customer requirements. Assume that, based on surveys and focus groups, Kitchenhelp has identified eight features important to customers. These are:

[6] When a company produces a mix of products, the ROS for a product line is the weighted average of the ROS assigned to individual products in that line. Profit simulations are typically used to determine the optimal mix and ROS distribution for the product line. The topic is too broad to be discussed here. It is the subject of a separate module on strategic profit planning.

▲ Coffee tastes and smells like espresso.

▲ The unit is easy to take apart and clean.

▲ Capacity is at least six cups.

▲ Coffeemaker looks nice.

▲ Unit has a clock timer to start automatically at designated time.

▲ Grinder performs well with different kinds of coffee beans.

▲ Coffeemaker keeps the coffee warm after making it.

▲ Unit automatically shuts off after a designated time period.

These customer requirements become the basis for the engineering design of the coffeemaker. Engineers must ensure that the product encompasses all the features that are important to customers. This initial set of features becomes the first product definition for design purposes. The product team now must convert this customer input into a more precise product definition. For the proposed coffeemaker, the product definition will include specific items such as an eight-cup coffee carafe, grinder size, blade rotation speeds, size and shape of coffeemaker, the heating unit size, the water heater specifications, and so on. A product definition is typically in the form of a blueprint, a computer designed drawing or model, or an actual scale model.

The last two steps in establishing the target cost for this proposed coffeemaker are to set market price and profit margin.

Kitchenhelp's market research shows that the market price for an eight-cup drip coffeemaker with a clock timer is currently $69. A stand-alone coffee grinder sells for $15. Since the two features are being combined and the coffee taste is being enhanced, Kitchenhelp can charge a price slightly higher than $84. Given their desire to capture a 20 percent market share, assume that Kitchenhelp can set the target price at $100.[7]

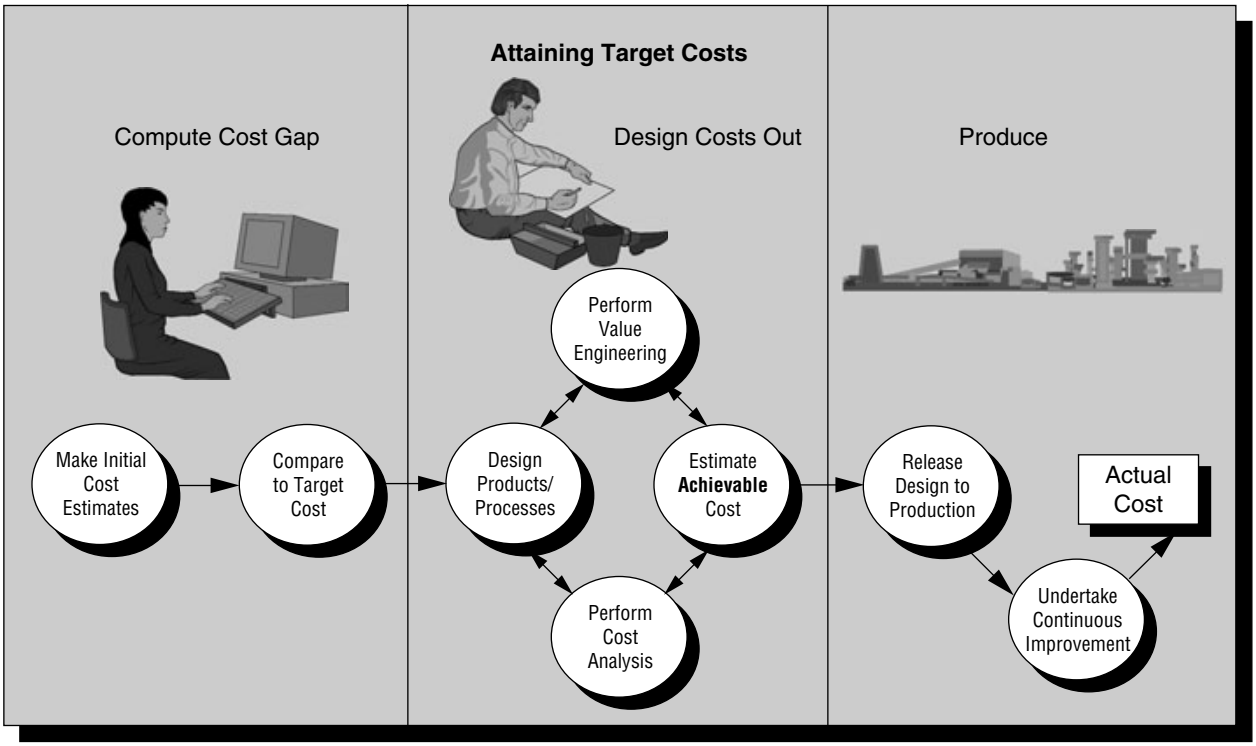
The final step is to establish a target profit by determining the desired return on sales for the coffeemaker. The common return on sales in the small appliance industry is 7–10 percent. Kitchenhelp decides to set a target profit margin of 10 percent on the product. The target cost for this new coffeemaker, therefore, is $90 (100 − 10). This is also referred to as the *allowable cost* for the product.

▲ ATTAINING TARGET COSTS

The second phase of target costing addresses how to attain the $90 target cost; that is, how to turn this *allowable* cost into an *achievable* cost. There are three steps in attaining target costs: (1) compute cost gap, (2) design costs out of a product, and (3) release design for manufacturing and perform continuous improvement. These three steps are shown in Exhibit 5.

[7] To keep the example simple, we have not introduced multiyear planning. Clearly, the price projection will have to be over the life of this product, and it will be a declining price since competitors are likely to introduce their own products. Cost reduction therefore will be more important over time for this product than it is at its introduction.

Exhibit 5
The Attainment Phase of Target Costing



Computing the Cost Gap.

Computing the difference between the *allowable cost* and the *current cost* is the first step in attaining target costs. For Kitchenhelp's coffeemaker, the allowable (target) cost is $90. ***Note that this is total product cost, not just manufacturing cost.*** The current cost is the initial "as-is" estimate of the cost of producing the coffeemaker based on current cost factors or models. The overall gap between allowable and current must be *decomposed* by life cycle and by value chain. A *life cycle* decomposition assigns total product cost to the birth-to-death categories of research, manufacturing, distribution, service, general support, and disposal. *Value chain* decomposition breaks down the cost by whether it is incurred by Kitchenhelp or by one of its value chain members such as suppliers, dealers, or disposers.

Key Point

The two breakdowns take the same total cost and provide two different kaleidoscopic views of the product cost. Each helps to highlight where cost reduction efforts need to be focused.

Exhibit 6
Comparing Allowable and Current Cost Life Cycle and Value Chain Breakdowns

Value Chain ➜	Inside			Outside			Total		
Life Cycle ↓	***Allow-able***	***Cur-rent***	***Gap***	***Allow-able***	***Cur-rent***	***Gap***	***Allow-able***	***Cur-rent***	***Gap***
Research and development	$3.60 (4%)	$5	$1.40				$3.60	$5	$1.40
Manufacturing	15.30 (17%)	20	4.70	$21.60 (24%)	$30	$8.40	36.90	50	13.10
Selling and distribution	5.40 (6%)	6	0.60	12.60 (14%)	17	4.40	18.00	23	5.00
Service and support	9.00 (10%)	10	1.00				9.00	10	1.00
General business overhead	18.00 (20%)	19	1.00				18.00	19	1.00
Recycling costs	4.50 (5%)	7	2.50				4.50	7	2.50
Total	$55.80 (62%)	$67	$11.20	$34.20 (38%)	$47	$12.80	$90.00	$114	$24.00

Computing cost gap—an illustration.
Exhibit 6 provides an assumed breakdown of the allowable and current costs by life cycle and by value chain for Kitchenhelp's coffeemaker. How did the company arrive at these cost breakdowns? The breakdown of allowable costs by life cycle typically requires estimating the costs to be incurred on research and development, manufacturing, marketing, distribution, repairs and other support, and disposition at the end of the product's life. The value chain requires estimating the costs that are incurred within a firm and those incurred by its suppliers, dealers, and recyclers. A company can use its past historical average as an initial estimate for these costs. For example, Kitchenhelp's past experience shows that manufacturing costs are typically 41 percent of total product costs for small appliances. Further, of the 41 percent, inside costs are 17 percent, and the remaining 24 percent represent components purchased from suppliers. These percentages can be used as a starting point to set the allowable cost for the coffeemaker for each category in the life cycle and value chain of costs.

Exhibit 6 shows these estimates for Kitchenhelp's proposed coffeemaker. It shows the life cycle breakdown as a percent of the allowable cost of $90 as follows: R&D (4 percent), manufacturing (41 percent), selling and distribution (20 percent), service and support (10 percent), general business overhead (20 percent), and recycling (5 percent). It also shows that 62 percent of the allowable cost of $90, or $55.80, is within Kitchenhelp and 38 percent, or $34.20, is in the value chain.

Kitchenhelp's initial estimate also shows that the total product cost of the new coffeemaker will be $114, a gap of $24 (114 − 90). The total $114 consists of $67 inside (gap = $11.20) and $47 outside (gap = $ 12.80). Exhibit 6 also shows that the largest cost gap is in manufacturing cost, followed by marketing and distribution costs.

Think Along

How does the information in Exhibit 6 help you to focus your cost reduction efforts?

The information in Exhibit 6 shows us that the three largest cost gaps exist in external manufacturing costs ($8.40), internal manufacturing costs ($4.70) and external selling and

distribution ($4.40). It is clear that Kitchenhelp's cost reduction efforts must be external as well as internal. The company needs to work closely with its suppliers and dealers and involve them actively in cost planning and reduction efforts. This will require partnerships and mutual trust and sharing of information among these various entities.

Designing Costs Out.

Reduction of cost through product design is the most critical step in attaining target costs. The key to cost reduction is to ask one simple question: *How does the design of this product affect all costs associated with the product from its inception to its final disposal?* To include all costs, not just manufacturing costs, may appear farfetched at first. However, many "downstream" costs such as distribution, selling, warehousing, service, support, and recycling can be greatly impacted by product design.

Consider for example a product such as a convection oven. Its weight and control panel are two elements affected by design. The design choices impact manufacturing and many other costs as well. A heavy machine will increase loading costs, transportation costs, and installation costs since two people instead of one may be needed to handle it. A fancy electronic control panel will increase the time salespeople have to devote explaining to customers how the oven works. It may also increase product support and repair costs because both electronic and mechanical components may fail in operation. Finally, the material used to give it the extra weight may pose an environmental hazard that requires cleanup at the time of disposal. All these add to a product's cost. Many of these costs can be reduced if they are anticipated and explicitly considered by product and process designers.

Cost reduction relies on four major activities: product design, cost analysis, value engineering, and cost estimation. These four activities will be explained in greater detail later in this module when we discuss how cost reduction actually takes place in practice. Cost reduction is recursive since the activities cycle back several times as the product goes from an initial concept to a final design. The recursion is a characteristic of target costing. Recursion exists to generate a cost effective design, not to correct design errors.

Release Design and Undertake Continuous Improvement.

The final stage in attaining target costs is to continue to make product and process improvements that can reduce costs beyond that which is possible through design alone. It includes steps such as eliminating waste, improving production yields (i.e. getting more production from raw materials), and other such measures. Japanese companies refer to this process as *kaizen costing*. Some U.S. companies refer to it as *value analysis,* others refer to it as *continuous improvement*. It is after production starts that actual costs can be compared against targets and lessons learned can be applied to the next generation of products developed.

Key Point

The achievable cost is not an actual incurred production cost. It is an estimate, prior to the start of production, of whether the target cost can be achieved. Estimating that the target cost is achievable is simply a signal to release the product design for actual production.

▲ HOW COST REDUCTION OCCURS IN PRACTICE

Cost reduction would be a trivial task if there were no constraints on the features and functions offered in a product or on the time available to develop it. For example, Kitchenhelp could simply delete the coffee grinder from its coffeemaker and probably reach its target cost of $90. However, this would defeat the basic product concept of providing a fresh espresso taste in the coffee. The challenge, therefore, is to reduce costs without sacrificing any of the features that are important to a customer.

This section describes in greater detail the process of cost planning and reduction. We will use the Kitchenhelp example to illustrate what happens in the recursive four-step activity cycle of design ⇒ cost analysis ⇒ value engineering ⇒ cost estimation. The purpose is to describe what happens during these four cost reduction *activities* and the key cost reduction *tools* that are used. Using the data in Exhibit 6, we will illustrate how these activities lead to reducing the currently estimated manufacturing cost of $50 to the target cost of $36.90. Note that the target includes both inside and outside manufacturing costs, because suppliers are part of the product team during this cost reduction phase.

Design Product and Processes.

An initial product concept design starts the cost planning cycle. It is important to note that both the product and the process are *concurrently designed*. In our Kitchenhelp example, the coffeemaker and manufacturing process that will be used to produce the coffeemakers are designed and considered at the same time. This avoids costly changes later because machines may not be available or capable of executing a product as designed. Common tools used at this stage are Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM). Cost parameters are sometimes built into these computer models so cost impact of design changes can be simulated concurrently.[8] A product design goes through several iterations before it is released for manufacturing.

Perform Cost Analysis.

The activities here consist of analyzing what components to target for cost reduction and assigning individual cost targets to the major subcomponents and parts of a product. For Kitchenhelp it means deciding what components of the coffeemaker (heating element, control panel, grinder) to target for cost reduction and then assigning a cost target to each of these components. Cost analysis also focuses on the interaction between components and parts. Often a reduction in the cost of one component is more than offset by a cost increase elsewhere. For example, decreasing the cost of the outer shell of the coffeemaker by making it small may increase the costs of the control panel, electronic circuitry, and heating element.

Cost analysis requires five major subactivities. These are:

1. *Developing a list of product components and functions*. Cost reduction efforts start by listing the various product components and identifying the functions that they

[8] A new class of computer simulation tools called MADE (Manufacturing and Design Evaluation) models is becoming increasingly popular. These models bring together engineering and life cycle cost simulations within a single program using artificial intelligence rules.

Exhibit 7
Major Components of Kitchenhelp's Proposed Coffeemaker[9]

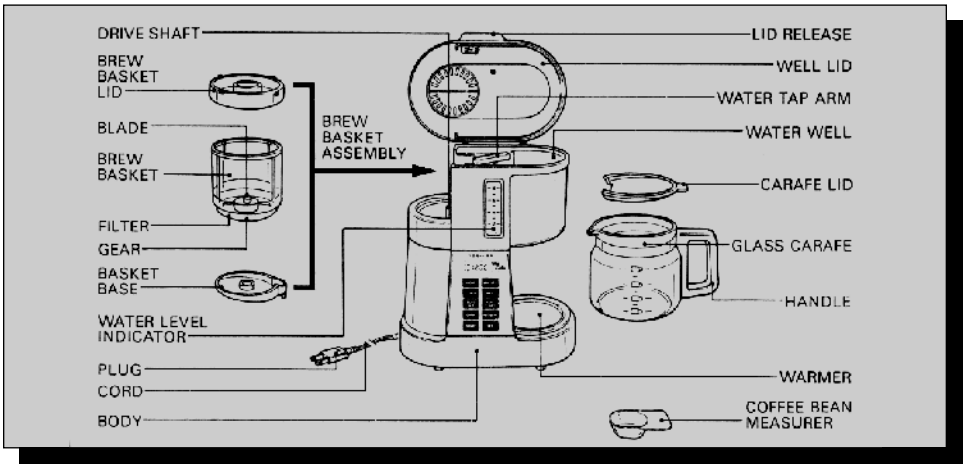


Exhibit 8
Functional Cost Breakdown for Kitchenhelp's Coffeemaker

		Cost	
Component	***Function***	***Amount***	***Percent***
Brew basket	Grinds and filters coffee	$9	18
Carafe	Holds and keeps coffee warm	2	4
Coffee warmer	Keeps coffee warm	3	6
Body shape and water well	Holds water and encasement	9	18
Heating element	Warms water and pushes it	4	8
Electronic display panel	Controls grinder/clock settings	23	46
Total		**$50**	**100**

perform and their current estimated cost. The initial product design and cost estimates provide this information. The list tells us what components and functions are needed to satisfy customer requirements and what it might cost to provide these functions. Exhibit 7 shows a diagram of the various components of the proposed coffeemaker.

2. *Doing a functional cost breakdown.* Each of the various parts and components of the coffeemaker performs a specific function. The next step is to identify that function and to estimate its cost. The functional cost breakdown is shown above in Exhibit 8. For example, the function of the brew basket is to grind and filter coffee. The current estimated cost is $9 for the basket, which represents 18 percent of the total manufacturing cost for this product. To keep the example simple, we have combined several functions and components for the coffeemaker. At a detail level, the brew basket or the electronic control panel will be broken into several subcomponents. The total for all components is $50, which is the same as the manufacturing cost estimate shown in Exhibit 6.

[9] This example is based on a coffee machine first introduced by Toshiba Corporation.

Exhibit 9
Customer Feature Ranking for Kitchenhelp's Coffeemaker

Customer Requirements	Customer Ranking					Relative Ranking	
	1 Not Important				*5 Very Important*	*Raw Score*	*%*
Coffee tastes and smells like espresso					5	5	20
Coffeemaker is easy to clean				4		4	16
Looks nice		2				2	8
Has 6+ cup capacity			3			3	12
Starts automatically at designated time				4		4	16
Works well with different coffee beans	1					1	4
Keeps the coffee warm			3			3	12
Automatically shuts off			3			3	12
Total						25	100

3. *Determining relative ranking of customer requirements.* Engineers view a product in terms of its functions. This is not a customer's view. You will recall that Kitchenhelp had identified eight features that were important to its customers. The engineer's view of a product as functions must be reconciled with a customer's view of a product as a set of features. We must relate product functions to features customers want. To do this we must first assess the relative importance that customers place on the various features. A formal survey of prospective customers asking them to rank the importance of these eight features can be used to rank customer requirements. An assumed ranking for each feature, based on survey results, is shown in Exhibit 9 above. The importance ranking is based on a five point scale. A score of five means the feature is very important, a score of one indicates that it is very unimportant. For instance, taste and smell of coffee is the most important feature and multiple grinder setting is the least.

   The last column of Exhibit 9 converts the raw scores for the importance of features into a **relative ranking of features.** This is done by first adding together the raw scores for the eight functions ($5 + 4 + 2 + 3 + 4 + 1 + 3 + 3 = 25$). Each function's score is then expressed as a percentage of this total score of 25. For example, coffee taste has a score of 5 out of 25. The relative ranking, therefore, is $5/25 = 20$ percent. It says that of the total value a customer derives from this coffeemaker, 20 percent comes from the way the coffee tastes.

4. *Relating features to functions.* The relative rankings of features must be converted into an importance ranking for each function. Since components carry out the functions of a product and are the key design parameters, this step relates customer rankings to the components that best meet that particular requirement. A tool called Quality Function Deployment (QFD) is typically used for systematically arraying information about these three variables—features, functions (components), and competitive evaluation—in a matrix format.[10]

   The QFD matrix is a useful tool for target costing because it highlights the relationships among competitive offerings, customer requirements, and design

[10] The term *QFD* comes from the quality literature, where it is used to signify the process of ensuring that product design and quality meet customer requirements. Target costing uses it for focusing costing efforts.

Exhibit 10
A QFD Matrix For Kitchenhelp's Coffeemaker

Components or Functions ➜ / **Customer Requirements ↓**	Brew Basket	Carafe	Coffee Warmer	Body/ Water Well	Heating Element	Display Panel	**Comparison** Competitor vs. Our Product 1 2 3 4 5	Customer Feature Ranking
Tastes/smells like espresso	▲				▲		■ ❑	5
Easy to clean	●	●		▲			❑ ■	4
Looks nice				▲		▲	❑ ■	2
Has 6+ cup capacity		▲		▲			■ ❑	3
Starts automatically on time						▲	❑ ■	4
Works with different beans	❍					▲	■ ❑	1
Keeps the coffee warm		●	▲				■ ❑	3
Automatic shutoff						▲	❑ ■	3

Correlation of design parameters and customer requirements.
▲ = Strong correlation
● = Moderate correlation
❍ = Weak correlation

Comparative competitor rankings.
■ = Competitor ranking
❑ = Our ranking

parameters. A typical QFD matrix for Kitchenhelp's coffeemaker is shown in Exhibit 10. The QFD matrix summarizes the information about product functions from Exhibit 8 with customer rankings from Exhibit 9. It adds two other pieces of information that are collected in the market research phase. First is the correlation between a component or design parameter and customer requirements. Second is information about how customers evaluate competitor offerings on these same features.

The matrix shows, for instance, that the requirement that coffee taste like espresso has a high correlation with the design of the brew basket and the heating element. Similarly, how many cups the coffeemaker can hold is correlated to the water well and the carafe size. It also shows that taste, the most important feature to a customer, is currently rated at three for Kitchenhelp and two for its competitor. This tells Kitchenhelp that while it is ahead of the competition, it still is far from what the customer would like to see as far as taste goes. On appearance, the competition obviously has a better looking product, with a rating of five. However, the customer ranking for this feature is two, which suggests that it is not worth spending too many resources in improving the appearance of the coffeemaker.

Exhibit 11
Kitchenhelp Coffeemaker—Percent Contribution of Each Component to Customer Requirements

Components → / *Customer Requirements ↓*	*Brew Basket*	*Carafe*	*Coffee Warmer*	*Body/ Water Well*	*Heating Element*	*Display Panel*	*Relative Feature Ranking*
Tastes/smells like espresso	50×20=10				50×20=10		20%
Easy to clean	30×16=4.8	10×16=1.6		60×16=9.6			16
Looks nice				60×8=4.8		40×8=3.2	8
Has 6+ cup capacity		50×12=6		50×12=6			12
Starts automatically on time						100×16=16	16
Has multiple grinder settings	5×4=0.2					95×4=3.8	4
Keeps the coffee warm		20×12=2.4	80×12=9.6				12
Automatic shutoff						100×12=12	12
Converted Component Ranking	15.0	10.0	9.6	20.4	10.0	35.0	100%

Think Along

Can you tell which design feature is most closely related to the customer requirement for starting automatically at designated time?

5. *Developing relative functional ranking*. The QFD matrix provides valuable information that allows us to convert feature rankings into functional or component rankings. This is critical because customers think in terms of features, but products are designed in terms of functions and components. To do this we need one other piece of information: the percentage contribution of each component to a customer feature. This information is shown as a general correlation in Exhibit 10. Engineers have to convert this correlation data into specific contribution percentages. Such a breakdown for our coffeemaker is shown in Exhibit 11 and interpreted as follows. The feature "tastes like espresso" is a function of the brew basket and heating element design. (You can verify this from Exhibit 10.) Engineers feel that both these components contribute equally to this "taste" feature. Therefore they assign each component a 50 percent contribution to taste. The relative value ranking of the "taste" feature is 20 percent. Therefore, since both components contribute equally, we assign each of the two components a value ranking of 10 percent. The last row of Exhibit 11 adds the value contributions of a component to all features to arrive at *that component's approximate value to a customer.* The brew basket is now said to have a value of 15 percent to a customer, the carafe has a value of 10 percent, and so on. Note that the last row and last column both add up to 100 percent. They are simply different views of customer values. The column represents value of features and the row represents the value of components.

Think Along

Can you calculate and reconcile the 35 percent value ranking assigned to the display panel?

Exhibit 12
Value Index for Kitchenhelp's Coffeemaker

Component or Function	*Component Cost (EX.8) (% of total)*	*Relative Importance (EX.11) (in %)*	*Value Index (Col 3 ÷ 2)*	*Action Implied*
Brew basket	18	15.0	0.83	Reduce cost
Carafe	4	10.0	2.50	Enhance
Coffee warmer	6	9.6	1.60	Enhance
Body shape and water well	18	20.4	1.13	O.K.
Heating element	8	10.0	1.25	Enhance
Electronic display panel	46	35.0	0.76	Reduce cost
	100%	100%		

Do Value Engineering (VE).

Value engineering is an organized effort directed at analyzing the functions of the various components for the purpose of achieving these functions at the lowest overall cost without reductions in required performance, reliability, maintainability, quality, safety, recyclability, and usability. For example, the purpose of a heating element is to bring water temperature to a specified level. This is called its "function." Value engineering asks how this function of raising water temperature to 110° can be achieved in three minutes at a lower cost. It analyzes both product and manufacturing process design and reduces cost by generating ideas for simplifying both.[11] Value engineering is at the core of target costing. It consists of the three major subactivities discussed below:

1. *Identifying components for cost reduction* is the first activity. Choosing which components to select requires computing a **value index.** This is a ratio of the value **(degree of importance)** to the customer and **percentage of total cost** devoted to each component. For our coffeemaker, the value information is in the last row of Exhibit 11, and the relative cost information is in the last column of Exhibit 8. Both these quantities are expressed as percentages. Exhibit 12 computes the value index and shows its implications for cost reduction.

   As Exhibit 12 shows, components with a value index of less than one are typically prime candidates for value engineering. Components with high value are candidates for enhancement since we are spending far too little for a feature that is important to a customer. These components present an opportunity to enhance the

[11] A useful tool for analyzing manufacturing processes is *Design for Manufacture and Assembly* (DFMA). It refers to engineering processes designed to optimize the relationship between materials, parts, and manufacturing processes. The purpose of DFMA is to reduce cost, increase quality, and reduce time to market by making it easier to manufacture or assemble parts or to eliminate them.

Exhibit 13
Value Index Chart for Kitchenhelp's Coffeemaker

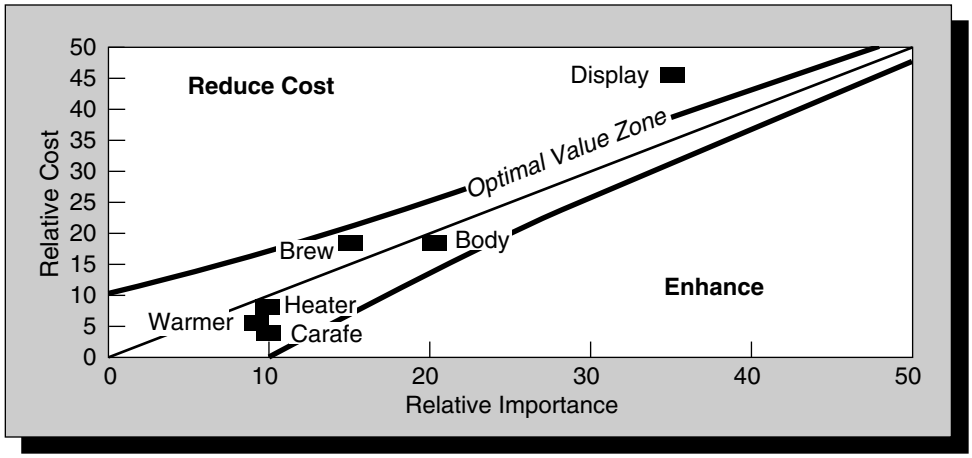


Exhibit 14
Kitchenhelp Coffeemaker—Electronic Display Panel
Value Engineering Ideas to Reduce Cost

Panel Sub-Component	*Cost Reduction Idea*
Power supply	**Reduce** wattage—more than needed in current design.
Flexible circuit	**Eliminate** flexible circuit. Use wiring harness.
Printed wire board	**Standardize** board specifications. Use mass-produced unit.
Clock timer	**Combine** with printed wire board.
Central processor chip	**Substitute** standard 8088 chip instead of custom design.
Heater connector	**Rearrange** layout of board to heater connection.

product. The two variables in the value index, cost and relative importance, are plotted on a graph shown in Exhibit 13.

The optimal value zone in Exhibit 13 indicates the value band in which no action is necessary. The optimal value zone is based on experience and opinions of the target costing team members. The zone is usually wider at the bottom of the value index chart, where low importance and low cost occur, and narrower at the top, where features are important and cost variations larger. The area of the graph above the optimal value zone indicates components that are candidates for cost reduction. Items below the zone are candidates for enhancement.

2. *Generating cost reduction ideas,* the second activity, requires creative thinking and brainstorming. The purpose is to ask what can be *reduced, eliminated, combined, substituted, rearranged, or enhanced to provide the same level of functionality from a component at less cost*. Exhibit 14 lists some sample cost reduction ideas that Kitchenhelp may consider to reduce the cost of the electronic display panel, the prime target for cost reduction identified by the value index.

   Note that the cost reduction ideas in Exhibit 14 contain some general principles that can be applied to many different situations. These ideas focus

Exhibit 15
Component Interaction Matrix

Components	Basket	Coffee Carafe	Warmer	Body	Heater	Display	**Cost**	**Available Until**
Brew basket					✓		$9	2004
Carafe	✓			✓			2	2010
Coffee warmer	✓			✓			3	2010
Body		✓	✓			✓	9	2008
Heater						✓	4	2010
Display panel				✓			23	2005

on reducing the number of parts, simplifying the assembly, and not over-engineering the product beyond what will meet a customer's need. A cross-functional team is essential because these types of engineering design choices must be guided by customer and financial input.

The contribution of management accountants in evaluating cost reduction ideas is critical. Engineers need to know quickly and reliably whether the cost reduction ideas they are considering are worthwhile from a financial standpoint. For example, to consider whether to eliminate the flexible circuit, we must have a good idea of its purchase cost as well as good cost tables that allow us to determine what a flexible circuit adds to the other manufacturing costs of a coffeemaker.

3. *Testing and implementing ideas* is the last activity within value engineering. Promising ideas are evaluated to ensure that they are technically feasible and acceptable to customers. Those ideas that are feasible and acceptable to customers are developed and incorporated into the product or process design and cataloged in a *VE ideas database* so they are available for future design efforts. One tool often used for testing the feasibility of ideas is the component interaction matrix. This matrix, which helps to identify the impact of changing one component on other components, requires cost data. It ensures that no current or soon out-of-production components are used. The use of such components can increase product costs significantly. Exhibit 15 shows a sample component interaction matrix for Kitchenhelp's coffeemaker. The Cost column of Exhibit 15 shows the cost of a component. The Available Until column shows the remaining life in years before the component may be obsolete or no longer available. A ✓ entry indicates whether there is a relationship between the components.

Estimate Achievable Cost.

Cost estimation is an important activity in target costing. This activity takes place at each iteration of the product design cycle. At the product concept stage, cost estimations are rough approximations that typically use few product specifications and assume no change

in technology. New designs are generated as value engineering ideas are implemented. Each revised design requires a new estimate of achievable target cost. Each new cost estimate is different from prior cost estimates. Early cost estimates are typically performed on a concept drawing, while later estimates use a more developed design, in which many of the parts and processes have been specified. Consequently, these later estimates of achievable costs are expected to be more accurate since more data is available. Many Japanese companies require estimates of achievable cost at the design development stage to be within 3–5 percent of actual costs.

The following are cost estimation methods used in the "compute cost gap" and "design costs out" phases of target costing.

Estimating (initial) current cost.

The current or initial cost estimate is generated by using simple but reliable cost estimation methods. There are several cost estimation tools used in practice. They include statistical regression, learning curves, and parametric estimations.[12] The levels of accuracy required in cost estimates increases as the product moves from concept to completed design.[13]

Estimating manufacturing costs.

For estimating manufacturing costs, two methods are commonly used in practice:

1. **The physical attribute method** typically establishes a relationship between physical characteristics of a product and its manufacturing cost. Some common physical parameters used in industry are:

   Square feet, used for estimating construction cost.
   Wing lift, load, and seats, used in the commercial aircraft industry.
   Horsepower, used in the mechanical equipment industry.

2. **Cost tables** are common in Japanese industry. They are databases of detailed cost information that enable timely cost estimates for new products. Cost tables include data on cost elements such as material, purchased parts, processing costs, overhead, and depreciation on new investments as well as cost models. Well designed cost tables usually contain very specific information on both internal and supplier manufacturing processes. Information includes machine hour rates, labor rates, scrap rates, cycle times, and cost of operations. It also identifies the major factors (drivers) that cause costs to change. While cost tables are more useful in generating detailed manufacturing cost estimates, they can be used to generate an initial cost estimate for a new product that is likely to use existing materials and manufacturing processes.

Estimating other costs.

For other costs such as distribution, marketing, and support, two methods are used as well:

1. **Activity-based costing (ABC)** is used for items such as manufacturing overhead, marketing, distribution, service and support, and some business overhead.[14] The

[12] These tools are described in a separate module.

[13] Japanese companies typically expect a 12–15 percent error rate in their forecasts of initial costs and 3–5 percent when the design is final. The primary purpose of an initial cost estimate is to define a cost gap and to test the feasibility of the product concept. If the cost gap is too large, product development efforts probably should be abandoned or reconsidered.

[14] Separate modules describe the use of activity-based management (ABM) and activity-based costing (ABC) for cost management.

key is to trace activities needed to sell or support the product and assign a cost based on the consumption of activities to the product.

2. **Historical burden rates** are used for items for which it is difficult to establish a direct relationship between costs and activities. Typically these are general business support costs such as accounting, data processing or legal services, which are difficult to trace to products. For example, if Kitchenhelp's past experience suggests that accounting, legal and other general support costs are 20 percent of product cost, then the 20 percent is called a burden rate. It can be used to generate an initial cost estimate for the product.

▲ MANAGEMENT ACCOUNTING AND TARGET COSTING

Traditionally, management accountants have been functional experts who do not have much contact with their marketing and production counterparts. They see their role as providing financial data, measuring performance after the fact, and auditing resource usage. Target costing requires a change in the traditional role of management accountants and the type of information they provide.

Role of Management Accountants.

Target costing systems require management accountants to have *early involvement* with a product and to learn to function as cross-functional team members.

Early involvement means starting when the product is still in the concept stage and staying with it for the rest of the development cycle. Management accountants need to provide good cost estimates for each design iteration. They must look ahead and provide information about product costs from incomplete design data. It is not helpful to wait until the product specifications are final. Further, each successive cost estimate must be more accurate as the design moves from concept to release for manufacturing. The focus is on estimation and not on actual costs.

As a cross-functional team member, a management accountant must help other team members from engineering and marketing to do their jobs. For example, engineers need to know the financial implications of their value engineering ideas. In the Kitchenhelp example, design engineers need to know what cost savings will result from the redesign of the heating element. Similarly, marketing must know what the company can afford to spend on a feature so they do not promise customers something that a company cannot deliver. For example, many customers probably desire a VCR and a TV in their minivans. Car companies such as Chrysler, Ford, and GM must have good cost data to see if the feature is affordable for them at a price a customer is willing to pay.

Management Accounting Information.

Target costing requires a shift away from traditional responsibility (department-focused) accounting systems to more process-oriented accounting information. In responsibility accounting the prime focus of accounting is the organizational unit. Process oriented data focuses on interunit and interorganizational relationships. It collects cost data by how a product flows across the units/organizations, what activities it requires, and what drives

costs at each stage. In particular, six types of cost data not routinely collected by most management accounting systems are critical for target costing.

1. **Life cycle costing** focuses on how each stage from birth (R&D) to death (disposition) contributes to a product's cost. Life cycle costing requires cost accumulation by life stages of a product instead of using traditional cost objects such as departments or products.
2. **Value chain costing** requires cost accumulation across traditional organizational boundaries to include suppliers, dealers, and others. It helps to focus on the contribution each member of the value chain must make to achieve target cost and how their actions are *co* dependent on each other. Exhibit 6 shows an example of value chain costing.
3. **Feature/function costing** is illustrated in Exhibits 10–12 of this module. This type of costing requires a management accountant to decompose and assign cost targets to product components based on how each component is related to a customer requirement and how much importance customers place on that requirement or feature.
4. **Design driver costing** focuses attention on the impact of design on the life cycle and value chain costs. It collects data on how and what changes in the physical attributes of a product (design) lead to changes in cost. For example, in the case of a tractor, Caterpillar considers weight, horsepower and bucket capacity to be the primary design drivers. Changing these parameters leads to an increase or decrease in the number of parts used, number of manufacturing processes used, and the extent to which common or standard parts can be used. These latter can be considered secondary or derivative design drivers.
5. **Operations costing** provides data about the cost of using a particular manufacturing operation. Accounting team members provide this information to designers, who can use it to design products that use less time in costly operations. For example, a final step in semiconductor manufacturing is "burn-in" tests. These tests are performed using electric ovens to test the resistance and performance of a chip under heat. Since the primary cost driver is the number of hours in an oven, overspecifying the burn-in test hours can increase costs for products that do not operate under or generate high heat.
6. **Activity-based costing** is particularly valuable for identifying drivers for indirect manufacturing costs such as material handling and for marketing, distribution, service, and support activities. It is a valuable cost management tool because it focuses attention on how product design leads to the consumption of various activities and therefore increases costs. For instance, materials handling is related to the number of unique parts purchased, which is a function of design complexity.

▲ TECHNICAL PROPERTIES OF TARGET COSTING

As a cost and profit management tool, target costing must possess two important technical properties. It must lead to better decisions, and it must provide a good process understanding of cost drivers and work flows in an organization. It performs well on both these criteria.

Decision Relevance. The six fundamental ideas of target costing, discussed earlier in this module, show how target costing brings together five critical management decisions under one umbrella. These are:

How to increase profits and returns.
How to react to competition.
What prices to charge for products.
What features to provide and what specifications to use for those features.
When to introduce new products and stop building old products.

Target costing integrates cost, quality, and time related issues into a single decision around product design. Managers consider profits and competitive reaction as part of setting prices. Costing is aimed at achieving target profits and returns. New products are timed by considering lifetime profitability and technology cycles of new products.

Process Understanding. Enhancing process understanding is at the heart of target costing. As this module shows, target costing focuses on the product as it moves through time, across units, across organizations, and across activities. All of this is accomplished by cross-functional teams who have a product and process focus, not a responsibility unit or single organization focus. In fact target costing cannot function in an organization that is not ready to adopt a process orientation.

▲ BEHAVIORAL ISSUES IN TARGET COSTING

There are two sets of behavioral issues in target costing. The first is the *behaviors needed* for successful target costing. The other is the *behavioral consequences* of using target costing.

Behaviors Needed.

Target costing requires different behaviors from all members of an organization. In this module we focus only on the behavioral implications for management accountants.[15] They need to change their behaviors in two ways:

- ▲ Management accountants must learn to get involved early and develop a tolerance for ambiguity. Design is by nature an incomplete process. It is forward looking and requires many estimations. Accountants always want verifiable data. They must shed this desire.
- ▲ Team playing is an important attribute for management accountants. They need to get involved with other disciplines, understand the technical dimensions of the product, and know what customers require. They must learn to talk to other team members from marketing, engineering, and procurement, and explain to them the financial implications of design decisions in an easy and understandable way. Effective communication is an essential behavioral requirement for management accountants who participate in target costing.

[15] For a discussion of the behavioral implications for other organizational members, see S. Ansari et al. *Target Costing—The Next Strategic Frontier,* Irwin, 1996.

One reason target costing has been hard to implement in U.S. firms is because these two behaviors are not currently ingrained in these firms. Most managers tend to be functional specialists who know a lot about their own areas such as marketing, engineering or accounting and do not feel the need to communicate with managers in other areas. In addition, performance evaluation has not depended on team performance.

Behavioral Consequences.

Target costing can lead to undesirable behavioral consequences if not employed carefully. Kato et al.[16] report four behavioral problems experienced by Japanese companies who have installed target costing. These are discussed below.

Longer development times.

In some companies, an overemphasis on design led to a longer product development cycle and delayed the product from reaching the market on time. This behavioral dysfunction can be avoided by setting simultaneous targets for quality, cost, and time. Behavior must be driven to all three targets, not just cost!

Employee burnout.

Pressure to attain targets, particularly demanding ones, can cause employee burnout and frustration. Failure to attain targets despite working many hours of overtime and doing their best is likely to reduce employees' future aspiration levels or lead them to reject the targets as unattainable. There are three ways to reduce the likelihood of these adverse behavioral consequences.

1. *Use employee participation in setting targets.* Research on the effects of participation are mixed.[17] However, it does suggest that employees, particularly professionals such as engineers, are better motivated to attain targets when they have a voice in setting those targets.
2. *Create and manage slack.* In their pioneering work on organizations, March and Simon argued that a certain amount of slack is functional because it allows organizations to harness extra energy for crisis periods. It may be in an organization's best interest not to operate in a constant crisis mode but instead to create a certain amount of "acceptable" slack in targets whenever possible.
3. *Focus on continuous improvement and not radical changes.* Learning reinforcement theory suggests that frequent positive reinforcement is a useful way to motivate and keep behaviors on a desired path. Continuous improvement is one way to use frequent positive reinforcement. Making small incremental improvements provides employees a sense of accomplishment in the near term. Individuals do not have to meet an entire target before they are rewarded for their efforts. This incremental move toward targets can mitigate some of the pressure for meeting targets.

Market confusion.

Too much attention to customers can cause "feature creep." That is, additional features are added on without regard to cost, and a proliferation of product models causes market

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[16] The discussion of these four consequences comes from Y. Kato, G. Boer, and C. Chow. "Target Costing: An Integrative Management Process," *Journal of Cost Management,* Spring, 1995.

[17] For a summary of research findings on the effects of participation, see Peter Brownell. "Participation in the Budgetary Process, When It Works and When It Doesn't," *Journal of Accounting Literature,* Spring, 1982, pp. 124–153.

confusion. Management accountants can help to avoid this by making certain that engineers are aware of the costs of new features and that marketing does not just produce a customer "wish list." Both disciplines should be guided to consider cost trade-offs so that features are added only when customers are willing to pay for them. A good example is a Danish manufacturer of optical scanners who has adopted the slogan "state-of-the-market" technology. What they mean is that new technology is introduced in their products not because it is "state-of-the-art," but because customers will purchase those features.

Organizational conflict.
The traditional focus of target costing is product design. Other costs, such as marketing or general business support (overhead), are either exempt from cost targets or are treated as "fixed" by prior decisions and part of the "legacy" of the existing cost system. Design engineers feel that other parts of the organization are getting a free ride while they try to squeeze every penny out of a product. This leads to internal conflict. There are two ways of avoiding this problem.

1. *Set targets for all costs.* All costs, including marketing, logistics, and support, must be part of a product's target cost. This makes sense from both a cost management and a behavioral perspective. Just as we cannot exceed a certain amount to manufacture a product, we cannot exceed a target for advertising and promoting that product either. These costs need to be managed as part of achieving overall profit targets.
2. *Use target costing philosophy to manage all costs.* Target costing represents a philosophy that says costs are driven by the way we design our products and processes. This philosophy can be used to manage the "fixed" or "legacy" costs by looking at the design of these support functions and processes. Indeed, activity-based management and business process reengineering are two techniques that employ a design orientation to manage processes.

▲ CULTURAL IMPLICATIONS OF TARGET COSTING

In addition to right behaviors, introducing and sustaining target costing in an organization requires appealing to and creating a set of shared cultural values, beliefs, and mindsets within an organization.

Creating a Receptive Culture for Target Costing.

Introducing a new process in an existing organizational culture is always hard. People have their existing beliefs, values, and mindsets. A new process that does not appeal to shared organizational values is unlikely to take hold. A good example of appealing to shared cultural values is Chrysler's launch of target costing on their Neon car project.

When the Neon was launched, Chrysler was in a difficult financial situation. General Manager Robert Marcell introduced the need for target costing by showing Neon project team members slides of life in his hometown of Iron River, Michigan, where he grew up. These slides showed Iron River, named after its principal industry, iron mining, as a prosperous community located amidst beautiful lakes and woods. Later in the talk he showed pictures of Iron River as it is today—a ghost town of largely abandoned mine shafts and a population less than half of what it was in the early 1960s, with more than 75 percent of the residents below the poverty line. The reason: Iron River was unable to compete against

imports from Brazil and Canada. As Marcell put it, Iron River's inability to compete made it into "an economic Chernobyl." The talk ended with Marcell asking the team members if the present day auto industry in America and Chrysler in particular are likely to become Iron River. Can they rise to the challenge and disprove critics who think the U.S. auto industry is "soft, lazy, dumb . . . and can't compete"? Can they compete and save the auto industry and maybe in a small way make a significant contribution to the U.S. as well?

The Marcell presentation launched what Chrysler described as a cultural appeal of "dare to be different!" The presentation is a powerful evocation of symbols and values important to Chrysler workers, driving home the necessity for building small cars cost effectively. It has all the elements of an appealing story. The slides of small town U.S.A. invoke the symbols of a nostalgic past. These are the images that Norman Rockwell has burned into our consciousness forever. Add to this an element of challenge from Japanese and European auto makers. The image of a sleeping giant awakening provides a rich subtext. There is a villain to be proven wrong. The villain is the infamous "they" (the media, foreign critics, our own citizens and top management) who have lost faith in our ability to do things right. Finally, it ends with a Kennedy-style appeal to do something for the country. The Chrysler speech has all the images, symbols, values, and emotions that appeal to a Midwestern work force. It is not surprising that Chrysler's introduction of target costing has been very successful.

Sustaining Values that Support Target Costing.

Introducing target costing is only a beginning. To sustain target costing, an organization also needs a supportive culture. It must either create a set of shared values if absent or nourish them if present. While the entire organizational culture must change, our focus here is only on the cultural values and beliefs that are part of the management accounting function. Traditionally, accountants have been trained to be neutral and distant. They function as technical specialists rather than involved team members. Management accountants who participate in target costing need a different mindset. They must internalize three important values:

Customer focus means that their work must always focus on how it creates value for a customer. Serving and listening to the customer must be more than a marketing gimmick. It must be an internalized belief.

Cross-functional cooperation is another important value to be internalized. The management accountant must set aside narrow parochial concerns in favor of cross-functional cooperation. Teamwork must be the norm. The management accountant must not operate as a corporate policeman.

Open sharing of information is an important part of creating an open culture. Management accountants must provide information to team members and not use it as a source of power.

These three values and beliefs are the cornerstone of a culture supportive of target costing.

▲ LESSONS LEARNED

There are six key lessons we want you to learn from this module:

- ▲ Target costing is a powerful strategic tool that allows an organization to address all three dimensions of quality, cost, and time simultaneously.

- ▲ Target costing is essential for coping with today's globally competitive environment.
- ▲ Target costing controls costs before they are incurred; that is, at the design stage.
- ▲ Customer requirements must drive all target costing activities.
- ▲ Target costing uses cross-functional teams that include suppliers, dealers, and others.
- ▲ Target costing requires change in behaviors and can lead to employee frustration and burnout if not used carefully.
- ▲ Target costing requires a culture that values customer input, cross-functional cooperation, and open sharing of information.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See process diagram.)

Activity Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities, and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

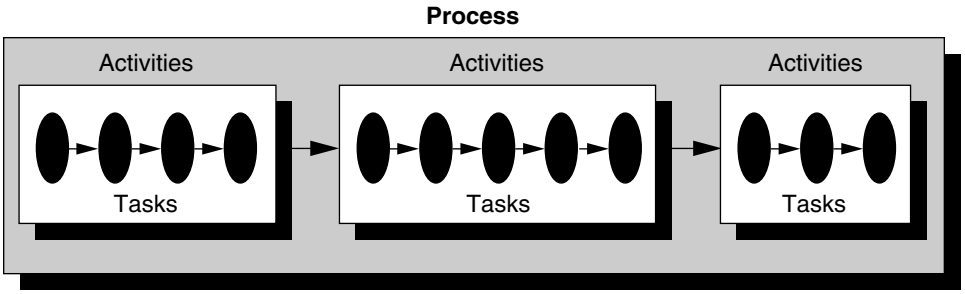
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

Value Chain See extended enterprise.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

***1*. Self-test questions.**

a. What is a target cost? How is it different from a budgeted cost?
b. What are the six fundamental principles of target costing?
c. Why is it important to manage costs before products have been produced?
d. What are the different ways in which you can set a target market price for a product?
e. What is the difference between cost estimates done at various stages of the product development cycle?
f. At what stage of the product development cycle does target costing play a key role?
g. What is the difference between an allowable cost and an achievable cost?
h. Explain how target costing is different from cost plus pricing.
i. What does a value index of less than one imply?
j. Target costing is the process of translating a customer's view of a product into an engineer's view of a product. Illustrate what this statement means using a product. (Hint: Use a product you are familiar with such as a telephone, a watch, a radio, a cassette player, and so on.)
k. Explain how a well executed target costing process can help a firm achieve its quality, cost, and time objectives simultaneously.
l. What is meant by concurrent engineering of products and processes? How does this lead to cost reduction?

***2*.** "HP's new Vectra 486N uses an 85-watt power supply . . . contains 450 parts, a 46 percent reduction . . . has just one screw (Dell has 25 screws)."[18] Explain how these redesign steps reduce the cost of Hewlett Packard's Vectra 486N personal computer. List the types of costs saved.

***3*.** What is the target profit that you would recommend for a product that has the following return on sales (ROS) profile? (Consider the three items together.)

(i) Industry average return on sales for this type of product—11 percent.
(ii) Company average for this product line—14 percent.
(iii) Company's future plans for this product line—16 percent.

Explain your recommendation.

***4*.** Listed below are several design choices for manufacturing a dishwasher. Comment on how each design choice will impact costs. List which costs will be impacted and in what direction.

a. Steel versus PVC tub for dishwasher.
b. Electronic versus nonelectronic control panel. (Hint: Electronic panels require circuit boards that can take high heat, humidity, and vibration.)
c. Subassembly for blades and rotor redesigned to use 30 percent fewer parts.
d. Rinse and hold and plate warmer cycles eliminated.
e. Use of a power supply used by the firm's existing lines of garbage disposers and trash compactors.
f. Use of a 10-year power supply rather than one that lasts 25 years.

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[18] From "Penny Pinching PCs: How They Did It," *BYTE Magazine,* November 1992, p. 131.

5. Ariane Electronics makes power supply devices in their plant located in Malayasia. The power supplies are used in various products such as hair dryers, electric knives, drills, and so on. The power supplies vary primarily by the watts of output they produce. They range from 5 watts to 30 watts. Ariane's main competitor is Nikko Electrical. Nikko sells a 45 watt power supply at a price of $22. Ariane currently has only a 30 watt power supply that sells for $16. Ariane's engineers think they can produce a 40 watt power supply that can compete with Nikko. The company's market research indicates that prices are adjusted for wattage differences between power supplies. The adjustment formula is as follows:

(Competitor's wattage/Our wattage)^0.79, where .79 is the customer's perceived value for wattage.

Based on this relationship, what is the target market price for Ariane's 40 watt power supply?

6. Assume that you worked for Chrysler in 1990 and were assigned to the development team for the Neon project. This project was developed under the target costing approach rather than the traditional cost-plus approach.

Answer the following questions regarding the development of the Neon car. Be creative, using your knowledge of cars in general, in answering the questions. You should provide car specific examples.

Required:

a. Identify the seven steps in the establishment phase of target costing. Provide specific examples of activities undertaken for each of the seven steps.
b. Discuss how each of the three steps in attaining target costs might have applied to the Neon project. Also discuss how Chrysler could design costs out or reduce costs through design improvements.
c. List some behavioral problems that may occur when target costing is used. Provide an example of how these problems may have impacted the Neon project.

▲ PROBLEMS AND CASES—ADVANCED LEVEL

7. Quote from a senior manager of a major company: "Our firm has always had a design to cost philosophy. Our engineers have to achieve very tight cost standards when designing new products. Target costing is just the new fashionable term for something we have done all along." Do you agree with this statement? Has the firm been practicing target costing?

8. Hightech manufactures color printers. It is in the process of planning the production and design of Model CX-700, one of its popular-selling models. The breakdown of the cost for producing Model CX-700 and the value index computed for this last period are shown below. (For simplicity assume there are only three components.)

Component	Cost	Function
Ink cartridge	$45	Determines color quality
Color sensor	35	Matches screen color to printed color
Paper sensor	20	Lights up indicator when out of paper

The customers want sharper colors, a better correspondence between what they see on screen and what they print on paper, and a sensor that can be connected to the PC speaker

to issue an audio "out of paper" warning. The additional spending required to provide these features and the value index for these three components are as follows:

	Additional Cost	Value Index
Ink cartridge	$ 27	.780
Color sensor	18	1.4689
Paper sensor	5	.500
Total additional cost	$ 50	

The company feels that if it were to provide all three of these features, the customers would pay an additional $49 for the printer.

Required:

Do you think that Hightech should provide all of these features in the new model? Some of these features? None? Show your calculations.

9. Just the Fax, Inc. manufactures various models of fax machines for office and home use. The following data has been collected by the market research staff about customer preferences for features for its Model P-400 fax machine. A score of one represents not important. A score of five means very important.

Feature	Importance Ranking	Competitor's Product Rank
1. Should be easy to operate	5	3
2. Memory to store faxes when out of paper	3	2
3. Speed of transmission	4	3
4. Print speed	4	1
5. Different settings for quality of original	3	1
6. Handset for phone	2	3
7. Paper size accepted	3	4
8. Interface with a personal computer	2	3

The company's engineers have provided you with the following correlations between the components used in the fax machine and features desired by customers. Features are referred to by numbers. H, M, and L refer to high, medium, and low correlation. For example, the first entry means that there is a high correlation between the component display panel and the customer feature one, easy to operate. Similarly, display panel has a medium correlation with feature five, different settings for quality of original.

Component	Features Impacted	Correlation
Display panel	1, 5, 6	H, M, L
Print engine	4, 7	H, M
Modem speed	2, 3, 8	H, H, L
Paper tray	7	H
Memory board	2, 3, 5, 8	M, H, H, M
Interface card	1, 2, 4, 6, 8	M, H, L, L, H

Required:

a. Array the data in a Quality Function Deployment (QFD) matrix of the type shown in the module for the coffeemaker example.

b. Write a brief explanation of the insights provided by the QFD matrix. In particular, what are its implications for cost planning?

Case 1: SmartCOM, Inc.

SmartCOM, Inc. manufactures internal modems for use with personal computers (PC). A modem is a device that allows a personal computer to communicate with other computers or fax machines through ordinary phone lines. The company is working with a PC manufacturer who is thinking of bundling the SmartCOM modem as a standard component with each new PC. SmartCOM's marketing manager has determined that PC buyers would be willing to pay $110 for a modem. The cost to the PC maker of installing and testing the hardware and the software is $25. In addition, the PC manufacturer requires a 10 percent return on sales. The net selling price that SmartCOM can charge the PC maker, therefore, is $74.

Research conducted jointly by the PC maker and SmartCOM's marketing personnel shows that customers want six features. These are: (1) ability to communicate at high speeds, (2) ability to send and receive clear faxes, (3) error-free communication over "noisy" telephone lines, (4) voice mail capability for multiple mailboxes, (5) compatibility with most brands of PCs, and (6) ability to work in the background.

Based on this research, SmartCOM's engineers have come up with a modem design that uses four main modules: (1) a converter module that would convert digital signals into analog signals so they can travel over standard phone lines; (2) a fax module that would provide the capability to communicate with standard fax machines; (3) a voice module that would take messages for multiple voice mail boxes; (4) a processing module that would direct traffic to the right place, that is, to the computer, fax/printer, or voice recording/playback chip. Each module has several major components. A list of the major components in each module, together with preliminary cost estimates for manufacturing or buying each component, appears in Table 1 below.

Table 1
Cost Estimate for SmartCOM Modem

Module	*Component*	*Cost of Each*	*Quantity*	*Cost*
Converter	Signal processor	$8.00	1	$8.00
	Phone I/O chip	1.50	1	1.50
Fax	Interpreter chip	2.50	1	2.50
	Printer I/O switch	1.50	1	1.50
	Fax signal chip	4.50	1	4.50
Voice	Amplifier	3.00	1	3.00
	Voice chip	5.00	1	5.00
Processor	Bus controller chip	3.00	1	3.00
	CPU	20.00	1	20.00
	Memory chips	2.00	8	16.00
	I/O controller	7.00	1	7.00
	Total cost			**$72.00**

In addition to the above, the marketing department estimates that order filling (primarily order processing and delivery) costs would run $4.00 per unit. General and administrative costs are expected to be $14.00 a unit. SmartCOM expects to earn a 15 percent return on sales.

SmartCOM's engineers have determined the relationship or contribution of each of the various functional components to customer features. This relationship is shown in Table 2 below.

Table 2
Function-Feature Mapping for SmartCOM's Modem

Feature	*Importance to Customer*	*Component*	*% Contribution to Feature*
High speed	5	CPU	40
		Bus controller	10
		Phone I/O chip	50
Send/receive faxes	3	Fax signal chip	40
		Interpreter chip	40
		Printer I/O switch	20
Error-free communication	5	Signal processor	60
		Phone I/O chip	40
Voice mail	3	Amplifier	40
		Voice chip	60
Compatibility with PCs	4	CPU	70
		Signal processor	30
Background operation	2	Memory chips	50
		I/O controller	50

Required:

a. What is the overall target cost for the modem? What is the target for the manufacturing cost of the modem?
b. What is the cost gap between allowable and current cost? What is the gap for the manufacturing cost?
c. Calculate a value index for the components of the modem.
d. For each component, indicate what action is implied by the value index.
e. Explain how value engineering can help in closing the gap between allowable and achievable target costs for the modem. List some of the major ideas you would consider for cost reduction.

Case 2: Modern Office Machines.

Modern Office Machines is a manufacturer of small office equipment. Its product line includes electric pencil sharpeners, disk holders, tape dispensers, hole punchers, computer stands, and a range of desktop accessories. The electric pencil sharpener is one of its best known products. Until recently, the company had a dominant share of the pencil sharpener market, as much as a 30 percent share of total sales in the U.S.

Because of recent competition from Far East manufacturers, who sold their pencil sharpeners for lower prices while offering comparative quality, Modern has lost sales and market share. This year only 10 percent of pencil sharpener sales were of Modern's brand. Initially, Modern had responded to competition by lowering prices and squeezing margins. Since this approach hasn't proven satisfactory, the company has decided to try a different approach of designing products to a tight cost target.

Modern established a team that included representatives from engineering, accounting, and production. The team was responsible for redesigning Modern's pencil sharpener and improving its production process to achieve a 25 percent reduction in costs over the next two years. Since the current manufacturing cost is $16, this means a cost reduction of $4 for manufacturing.

The team members reviewed the design and production of the pencil sharpener at one of its meetings. They found that the sharpener is made from stainless steel casing. The shell is divided into two parts: a base and a top. The motor, blades, and bin drawer are attached to the base using 12 screws and washers. The top is then attached to the base using another four screws. All parts are assembled by hand. The motor and bin drawer are purchased from an outside supplier. The blades are manufactured by a blade machine. At standard, the assembly takes 30 minutes per pencil sharpener.

The team also met with the marketing group and reviewed that group's research on customers' expectations about features and price. Their research indicates that there are three features a customer desires in an electric pencil sharpener: speed of sharpening, ease of cleaning scrapings, and appearance. Using a five point scale, with five representing high importance, the marketing group found that customers rated speed of sharpening a four, ease of cleaning scrapings a four, and appearance a two.

Modern's engineers familiar with pencil sharpeners' functioning felt that four components could address these features: motor, blade assembly, drawer, and outer casing. Motor and blade assembly contribute 75 percent and 25 percent respectively to the speed of sharpening. The design of the drawer is 100 percent responsible for ease of cleaning scrapings, while the appearance is 100 percent determined by the casing. They proposed a solution which would use a cheaper, less powerful motor (saving $3.00/motor) and a less expensive plastic bin drawer (saving $1.00/drawer) to meet the 25 percent cost reduction target.

The accountant on the cost planning team collected information about the current actual cost of producing each of the components and other costs. Her cost data is summarized in Table 1 below.

Table 1

Component	*Source*	*Current Actual Cost*
Manufacturing costs:		
Motor	External supplier	$ 6.40
Blade assembly	Internal	3.20
Drawer	External supplier	2.40
Outer casing	Internal	4.00
Subtotal		**$16.00**
Selling/distribution	Internal	6.00
General and administrative	Internal	3.00
Total cost		**$25.00**

Currently Modern's pencil sharpener sells for $27.00. This yields a return on sales of 7.4 percent. In general, the small office machinery industry gets a 15 percent return on sales. To respond to competitive pressure in past years, Modern had dropped its price from $29.40 to $27. Modern would like to capture its lost market share and go back to its 15 percent return on sales. However, analysis of competitors' prices and market response to those prices indicates that a price of $23.50 would stimulate sales and restore market position.

Required:

a. Evaluate the cost planning efforts of Modern in light of what you have studied about target costing. Is their approach consistent with target costing?
b. How would you change their process to be consistent with target costing?
c. Compute a target cost for the pencil sharpener. Assume that a 15 percent return on sales is required.
d. Compute a value index for the pencil sharpener's various components.
e. Which components should be targeted for cost reduction? Should any components be targeted for increased spending?
f. What target cost would you establish for each of the components?
g. In the light of your analysis, what suggestions would you provide for the redesign of the pencil sharpener?

Case 3: Dragon Development.

Dragon Development is in the business of building single family homes. It is currently in the process of developing a tract in which it will offer 20 single family homes. With the decline in real estate market, the company has been losing profitability. It wants to regain its profitability by adopting target costing to manage profits and costs.

The following *initial* specifications have been worked out for the new tract of homes that will be the pilot for the target cost system:

Table 1
Proposed Construction Specifications—New Tract

Foundation/Roof Area (sq. ft.)	2,800
Heated Floor Space (sq. ft.)	3,600
Garage (sq. ft.)	600
Deck	500
Patios/Walkways/Lawn	5,500
Number of Bathrooms	5

The intended buyers for these homes are professional upper middle class families (e.g. lawyers, doctors, accountants, managers, small entrepreneurs, etc.) in which both spouses typically work. The quality specifications are designed to meet the expectations of this class of buyers.

Target Profit & Prices.

It is customary for developers to aim for a 20% contribution margin from each house. Recent market surveys indicate that a house with the proposed quality and design specifications will sell for around $399,000. Typically, marketing and sales commissions costs average 4% of the selling price. Therefore, if the proposed house sells for $399,000, the net price to the developer will be $383,000 (rounded off). Also, the desired profit contribution will be $80,000 (rounded off). The $399,000 price represents a drop in prices due to the recent decline in real estate values. When the concept for these homes was originally developed, this type of home sold in the $450,000 range. The Company has come to the conclusion that to earn the 20% desired profit margin with the lower price of $399,000, it must have a good system for planning and managing costs.

Cost History/Estimates.
The initial cost estimates suggest that the total development cost will be much higher than the price the market is willing to pay. Besides construction cost, the new homes are expected to have land cost of $70,000 per home and construction financing of 8% per annum with a typical construction period of 9 months. These estimates are based on using, as a *starting* cost estimate, the cost of a recent housing tract with similar quality homes. Table 2 below provides the specifications for a typical home (123 Main Street) in this recently completed tract.

Table 2
Construction Specifications—
123 Main Street (Two Story Home)

Foundation/Roof Area (sq. ft.)	1,800
Heated Floor Space (sq. ft.)	2,935
Garage (sq. ft.)	490
Deck	500
Patios/Walkways/Lawn	5,300
Number of Bathrooms	3

While 123 Main Street is smaller than the proposed tract, its quality is similar. The costs of building 123 Main Street are detailed in Table 3.

Customer/Competition Analysis.
To make trade-offs intelligently, the Company has commissioned a market survey that shows the relative values customers place on different "hard" and "soft" functionalities in a home. The survey also ranked competitor offerings on these same functionalities. This data was arrayed in a "Quality Function Deployment" (QFD) matrix so all relevant data could be related to the design parameters. The QFD matrix is shown in Table 4.

Value Engineering.
To make design changes the company formed a team consisting of the architect, interior designer, structural engineer, and framer to develop some value engineering ideas for cost redesign. The team met and came up with a set of ideas to guide them through the specific changes they wanted to consider. These ideas are summarized in Table 5.

Required:

a. What is the overall "target cost" for the new housing tract? What is the construction cost target?
b. Prepare an initial cost estimate for the proposed home using 123 Main Street as a cost model. (Hint: You may want to group costs by common drivers and then use these drivers to predict the new tract's costs.) What is the gap between the target cost and your initial cost estimate?
c. Develop a cost reduction strategy for the company that considers the life-time ownership costs to the customer and will allow Dragon to meet the target cost for the new tract (including land and financing). Use the customer preferences shown in Table 4 and the value engineering ideas in Table 5 as a guide. However, if you need to make additional assumptions state them in your analysis.
d. Write a brief paragraph on each major cost reduction strategy you have adopted. Briefly explain the quality and functionality tradeoffs you have used to meet the target cost and defend these trade-offs.

Table 3
Construction Costs—123 Main Street

Item	*Cost*
Architectural Fees	$ 7,500
Interior & Landscape Design	1,500
Building Permits	5,253
Construction Insurance	235
Temporary Facilities	750
Water Meter & Utility Trench	488
Excavation	750
Concrete Forms	1,500
Concrete for foundation and floors	8,500
Roof Covering	4,750
Garage Door & Opener	650
Site Clean-up	500
Lumber Rough for framing	17,500
Lumber Finish for doors/window trims and molding	8,944
Framing Labor	22,225
Carpentry Finish installing cabinets, trims, etc.	6,375
Doors & Frames	3,453
Windows & Sashes	6,413
Stucco Exterior	8,025
Sheet Rock (gypsum board for interior walls)	8,763
Rough Electrical Wiring	5,013
Rough Plumbing	7,975
Telephone Wiring	413
Cost of Framing Changes & Bonus for on-time finish	1,405
Bathroom and Kitchen Cabinets	7,856
Hardware for framing	900
Hardware Finish (door knobs, hinges, etc.)	1,719
Plumbing Finish	2,519
Electrical Finish (wall switches, plates, etc.)	4,954
Light Fixtures	3,591
Heating/Ventilation (equipment plus labor)	6,125
Built-in Window Planter Boxes	1,044
Insulation	4,825
Finish Flooring (carpeting and tile)	13,343
Built-in Kitchen Appliances	5,616
Spiral Stairway—Metal	2,319
Mirrors, Towel Holders, etc.	1,250
Fireplace	1,690
Blinds and Shutters for windows	3,381
Painting & Wall Paper	7,925
Garage Cabinets	438
Tile Work (materials and labor)	6,181
Fencing	725
Concrete Driveway and Walkways	5,129
Plants & Lawn	4,606
Sprinkler System	956
Total Cost	**$215,972**

Table 4
Dragon Contracting—QFD Matrix for Proposed Home

	Design Parameters									Competitor Ranking					Customer Rating
Customer Requirements	*Square Feet*	*Number of Baths*	*One vs. two Floors*	*Electric Wiring*	*Electric Appliances*	*Finished Carpentry*	*Floor Covering*	*Finish Material*		*Low*			*High*		
										1	*2*	*3*	*4*	*5*	
Spacious feeling inside	M								M			C	O		5
Adequate bathrooms	M	S							S		C		O		4
Good use of space	S		S							O	C				5
Fully equipped kitchen				S	S	S			W		O	C			5
Lots of storage space	S		W						O			C			4
Bonus room or library	S										O		C		3
Easy to maintain house/yard									S				O/C		4
Lots of decks and balconies	W		S											O/C	2
Earthquake and fire safe			S						W			O	C		5
High quality cabinets		S				S			W		O		C		3
Burglar/Fire Alarms				S					M					O/C	5
Wood or Marble Floor finish								S				O		C	3
Decorative finish									S			O		C	2
Fireplaces	W								S		O			C	1

Key to Symbols:
S = Strong Correlation ⇒ Numerical Rating = 7
M = Medium Correlation ⇒ Numerical Rating = 4
W = Weak Correlation ⇒ Numerical Rating = 1
O = Our Product
C = Competitor's Product

Table 5
Value Engineering—Brainstorming Starters*

ADAPT	What else is like this? Does the past offer similarities? What could we copy? What other ideas does this support?
COMBINE	Can we combine? Combine purposes? Combine ideas? Combine functions?
MAGNIFY	What can we add? Thicker? More frequent? Stronger?
MINIMIZE	What can we subtract? Smaller? Omit? Streamline?
REARRANGE	Can we interchange? Different layout? Different sequence? Change pace? Different pattern? Different schedule?
REVERSE	What's the opposite? Can we turn it around? Upside down, backward? Can we reverse roles?
MODIFY	Could we change the form or shape? What new twist?
SUBSTITUTE	What can we use instead? Who else can? Another approach? Another material?

* This checklist has been adapted from one used by Chrysler Corporation.

Table 5 (Continued)
Test for Value

YES	NO	
_____	_____	1. Can we do without it?
_____	_____	2. Does it do more than the customer requires?
_____	_____	3. Can we use other materials? List them.
_____	_____	4. Does a specialty vendor have it for less?
_____	_____	5. Is there a simpler way of doing the job?
_____	_____	6. Can somebody's standard item be used?
_____	_____	7. Could less costly tooling or fixtures be used?
_____	_____	8. Does it cost more than we feel is reasonable?
_____	_____	9. Are we buying too much reliability?
_____	_____	10. Using my money, would I refuse the price?

M O D U L E

The Theory of Constraints and Throughput Accounting

Version 1.0

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The Theory of Constraints and Throughput Accounting

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GO TAKE A HIKE!

Imagine leading a group of 15 twelve-year-old boys on a 10-mile hike through the woods. As leader, you have two critical goals. First, you need to arrive at your destination, Devil's Gulch, in five hours. Ten miles in five hours simply requires that the group maintain an average pace of 2 miles per hour. Second, you need to arrive safely with *all* 15 boys—losing even one boy is obviously unacceptable!

As you survey your group, you're struck by the fact that there is tremendous variety within a group of twelve-year-old boys; the difference in height, weight, and physique is extraordinary. Clearly, some boys are better suited than others to hike 10 miles with a heavy backpack. With map in hand, you begin hiking, and the boys fall in behind you.

Because the trail is rather narrow, it's difficult to pass another hiker. Every time one boy stops to adjust his pack, to tie his shoe, or to throw a rock at a tree, others behind him are held up on the trail. This stopping and starting has little impact on boys near the front of the line, but the rippling effect causes increasingly more delays on boys further back. Yelling at individual boys to "hurry up!" doesn't appear to help much, since everyone needs to stop at least occasionally. By noon you are painfully aware that the group has only traveled roughly 3 miles. At this rate, you will arrive at your destination late.

During lunch, you call the boys together for a brief pep talk. The boys understand the need to pick up the pace and keep moving. With you in the lead, everyone attacks the trail after lunch with ferocity. Soon, though, you hear some arguing in the ranks behind you (what do you expect from 12-year-old boys?). When you turn around, you're a bit surprised to see that the group has separated itself into two groups. The group immediately behind you is spread out on the trail. The second group, much further back, is bunched behind a rather chubby young lad named Herbie.

Nobody wants to be stuck behind Herbie. So you decide to organize the group by speed with the fastest hiker in the front. Obviously, Herbie is the caboose, so you stay back with him.

Initially, this new arrangement appears to be succeeding. Everyone is able to go their maximum walking pace. However, soon the lead hiker is so far out in front that he is out of sight. Likely, he will make Devil's Gulch by 4:00 P.M. On the other hand, Herbie is really huffing under his heavy backpack. It appears that he won't make the destination until well after dark. As you reflect on your two goals from this morning, you realize that neither goal is being met. First, the group doesn't really "arrive" until *everyone* arrives, including Herbie. Worse, having the boys this spread out on the trail is definitely not a safe situation.

▲ STRATEGIC IMPLICATION OF CONSTRAINTS

A *constraint* is anything in an organization that limits it from moving toward or achieving its goal. The theory of constraints (TOC) is a way to manage constrained processes in order to maximize profits by increasing system throughput (defined as sales revenue less direct materials).

Managing a large business process is much like this hiking scenario. In a manufacturing or service organization, many processes depend on one another. Achieving a perfectly balanced production flow is nearly impossible. In the same manner that boys have their

individual hiking speed, machines and people produce goods and services at different rates. Errors, maintenance needs, varying skill levels, and many other factors combine to create fluctuations among individual processes within an overall production operation. These fluctuations can create serious challenges to organizations trying to compete on quality, cost, and time.

- ▲ **Quality.** Individual processes often depend on one another. Work-in-process inventory is an output from one process waiting for another process. It is a natural result of fluctuations in processes (such as assembly, mounting, and insertion). Unmanaged constraints in a process inventory cause work-in-process inventory to pile up. Because work-in-process inventory can hide quality problems in both products and processes, it may take several days for workers to discover defects. Meanwhile, faulty output is produced.
- ▲ **Cost.** Traditional accounting methods often compute cost and efficiency variances for each individual process to help control costs in an organization. As a result, managers often produce units at or above budgeted capacity. This situation results in large inventories that tie up money and often create losses. TOC manages costs by discouraging inventory buildups and by increasing system throughput.
- ▲ **Time.** To compete effectively in the open market, companies must deliver products and services on time as promised. This task can be a major challenge when there are interdependencies among production processes. If each individual process is encouraged to produce at capacity, the overall organization can actually *slow down* because of the problems inherent with managing increasing levels of work-in-process inventory. Not only does a specific order have to work through each sequential process, it also has to work through the pile of work-in-process inventory in front of each process.

Key Point

When constraints in an operation are poorly managed, costs can go up, overall production time can slow down, and quality problems can go unchecked as unnecessary work-in-process inventory builds.

▲ PURPOSE OF THIS MODULE

Beginning in 1984 when Eliyahu M. Goldratt introduced TOC[1] in his book *The Goal*,[2] Goldratt and his boys-on-a-hike scenario have captured the imagination of many managers. TOC has had a strong effect on the way accountants provide information to business process managers.

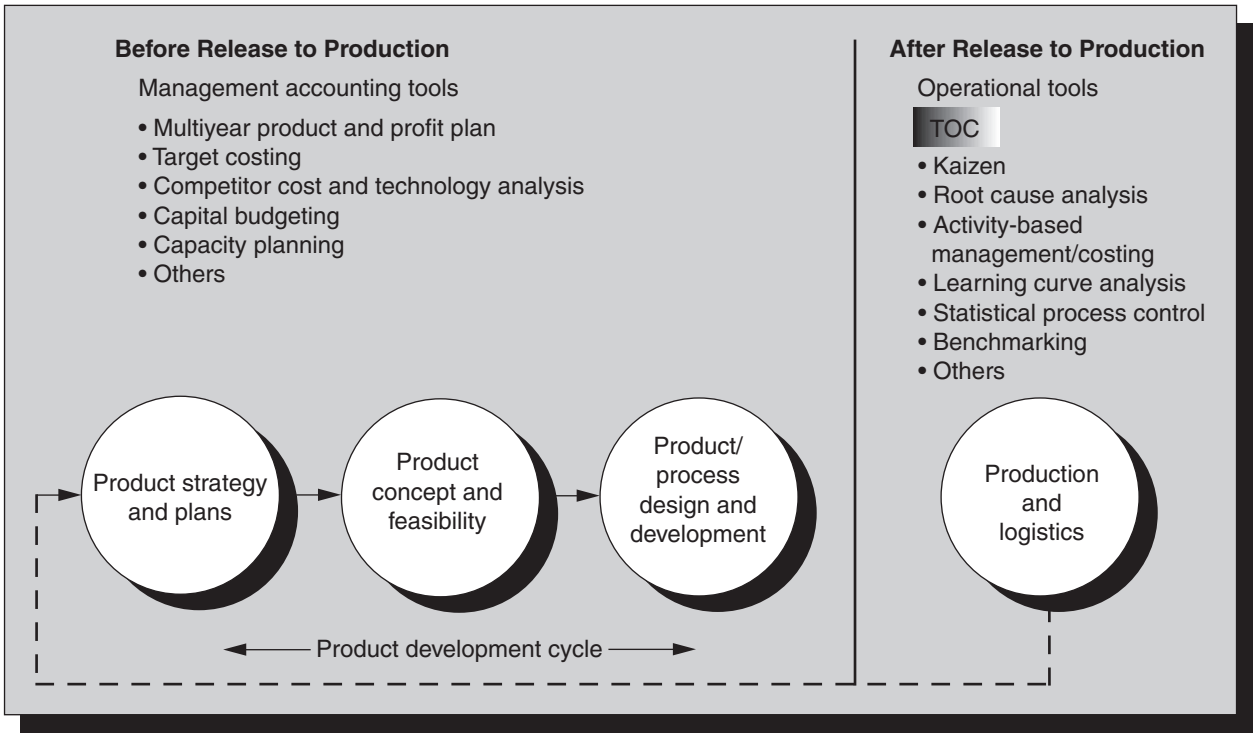
The purpose of this module is to describe TOC and to demonstrate how TOC-based accounting, called throughput accounting, affects and is affected by traditional management accounting practices. We discuss the technical, behavioral, and cultural issues involved in merging throughput accounting with traditional accounting systems. After reading this module you should understand the following points:

- ▲ The relationship of the TOC model to an organization's strategy.
- ▲ The basic TOC model.
- ▲ The essentials of throughput accounting theory.
- ▲ The interfacing of throughput accounting with traditional accounting systems.

[1] Like many of the new management techniques, theory of constraints (TOC) has several synonyms such as synchronous manufacturing, optimized production technology; drum-buffer-rope systems; and constraint, bottleneck, or throughput management. The process of accounting for a TOC operating environment is called Throughput Accounting.

[2] E. M. Goldratt and J. Cox, *The Goal: A Process of Ongoing Improvement,* Croton-on-Hudson, NY, North River Press, 1984.

Exhibit 1
Strategic Position of TOC



▲ The mechanics of throughput accounting.
▲ The technical, behavioral, and cultural attributes of throughput accounting.

▲ TOC LINKAGE TO PRODUCT STRATEGY

TOC is intimately linked to an organization's product strategy and its product development cycle. *Product strategy* defines the market segments the firm will sell in, the specific products to be produced for those markets, and the profits expected. TOC is one operational tool used to facilitate production of those products. TOC assures that daily activities produce the proper products and services to satisfy customer demand most profitably. It assures efficient use of existing capacity and identifies work processes that need immediate, additional resources to produce the products and services specified by product strategy.

Key Point

To get the most out of TOC, organizations must ensure that it is closely aligned with product strategy.

Product Development Cycle.

Exhibit 1 illustrates the activities that comprise the product development cycle and shows the strategic positioning of TOC. In discussing the development cycle, we use the term

product to refer to physical goods, as well as services such as consulting, transportation, and entertainment. The product development cycle starts with high-level strategic planning. The result is a business, product, and profit plan that defines the market segments a firm intends to sell in and the products it intends to produce for this chosen niche. The next step in the product development cycle is to translate product and profit plans into specific product concepts. Product feasibility is determined by making preliminary estimates of life cycle cost, evaluating required investments in technology and training, and estimating capacity needs. Once a product concept is accepted and its feasibility tested, it goes into full-fledged design and development. Detailed specifications for manufacture and assembly are developed at this stage for physical goods. In the case of services, details regarding scheduling, responsibility and reporting, and communication lines are established.

Production.

Production is the physical process of creating goods and services. It involves day-to-day scheduling, monitoring, and problem solving for products, manpower, and machines. Many management tools support production: TOC, continuous improvement (kaizen), root cause analysis, ABM/C (Activity-Based Management/Costing), learning curve analysis, statistical process control, benchmarking, and others. Each of these tools offers different information about improving or estimating costs of production. TOC provides information about managing capacity optimally while producing products and delivering services specified by product strategy. It searches for areas within an organization where inventory is stockpiling or customers are waiting (a bottlenecked area) and determines how to redeploy manpower and machinery to eliminate the bottleneck and maximize profits. It shows how to use available capital equipment (capacity) and manpower to produce products and when to switch production from one product to another. It provides feedback for capacity planning about expenditures necessary to eliminate bottlenecks.

Key Point

TOC is an operational tool that assists operating personnel to most efficiently produce the goods or provide the services specified in an organization's strategic plan.

▲ THE BASIC TOC MODEL

Solving the Hiking Dilemma.

Let us return to the hiking scenario. As the expedition leader, you face a dilemma. The boys are spreading out very fast on the trail, and Herbie is going slower and slower. You observe that Herbie loses ground for two reasons. First, he is simply slower than everyone else on the trail. Second, every time the boy directly in front of Herbie stops to tie a shoe or look at a bird, Herbie must stop and wait. Each time this happens, you feel your irritation mounting. As frustrating as it is that Herbie is slow, it is even more exasperating to have him wait for someone who is actually a faster hiker.

Think Along

How can you manage to keep the boys together and moving forward as fast as possible?

It is then that you realize Herbie is the key to achieving your two goals (safety and timeliness). Quickly, you call everyone together and have the boys line up exactly as they were on the trail. Then you have everyone hold hands, and you lead Herbie to the front of the line, effectively putting the group in reverse order! With the slowest boy (Herbie) now leading and the fastest boy bringing up the rear, you ensure that everyone stays together. Further, you reduce the effect of fluctuations in the overall hiking speed of the group. With the slowest boy in front, any time one of the other boys stops on the trail, it is relatively easy for everyone to catch up.

The remaining problem is that Herbie's speed now limits the entire group. Although everyone is safely bunched together, it is unlikely that the group will make Devil's Gulch before 6:00 P.M. You then realize that Herbie could go faster without a large, heavy backpack. You stop the group, explain your two goals, and propose to empty Herbie's backpack and share its contents among the hikers. Initially, the boys resist the idea until you explain that no one arrives at Devil's Gulch before Herbie. When the boys realize that they can carry more weight and still keep up with Herbie, everyone agrees.

Completing the analogy.

Hiking the trail is analogous to a production process. "Walked trail" is the product that the troop produces. The lead boy in the group starts the production process by beginning to walk. Then the second hiker processes the trail, followed by the boy behind him, and so on. Only after all 15 boys have walked the trail is the product fully processed. The rate at which this manufacturing plant (i.e., the troop of boys) produces product (i.e., walked trail) is solely a function of the slowest hiker's speed. Efforts to help other hikers speed up are wasted.

The amount of unwalked trail between each boy is analogous to work-in-process inventory. As boys spread out on the trail, work-in-process inventory is increasing. Hiking expenses increase as boys spend extra energy turning this work-in-process inventory into processed trail. Time spent hiking wrong trails, having to hurry to catch up with the next boy, or arguing about delays causes hiking (operational) expenses to increase unnecessarily.

To connect this analogy to actual business processes, consider the example of a computer manufacturer. Workers assemble the CPU (central processing unit) case, insert the motherboard, insert various driver cards (sound, monitor, input/output, etc.), mount the hard drive and floppy drive, and perform a quality check to ensure that the system functions properly. Obviously, no computer is complete until the last operation occurs.

Assume that quality inspection is the bottleneck operation. If production at preceding operations (case assembly, motherboard insertion, driver card insertions, and drive mounting) flow unchecked, a large amount of work-in-process inventory will build up in front of quality inspection. As these work-in-process inventories continue to build while waiting for the quality inspection to take place, inferior quality operations may be operating undetected. As a result, unnecessary costs accumulate.

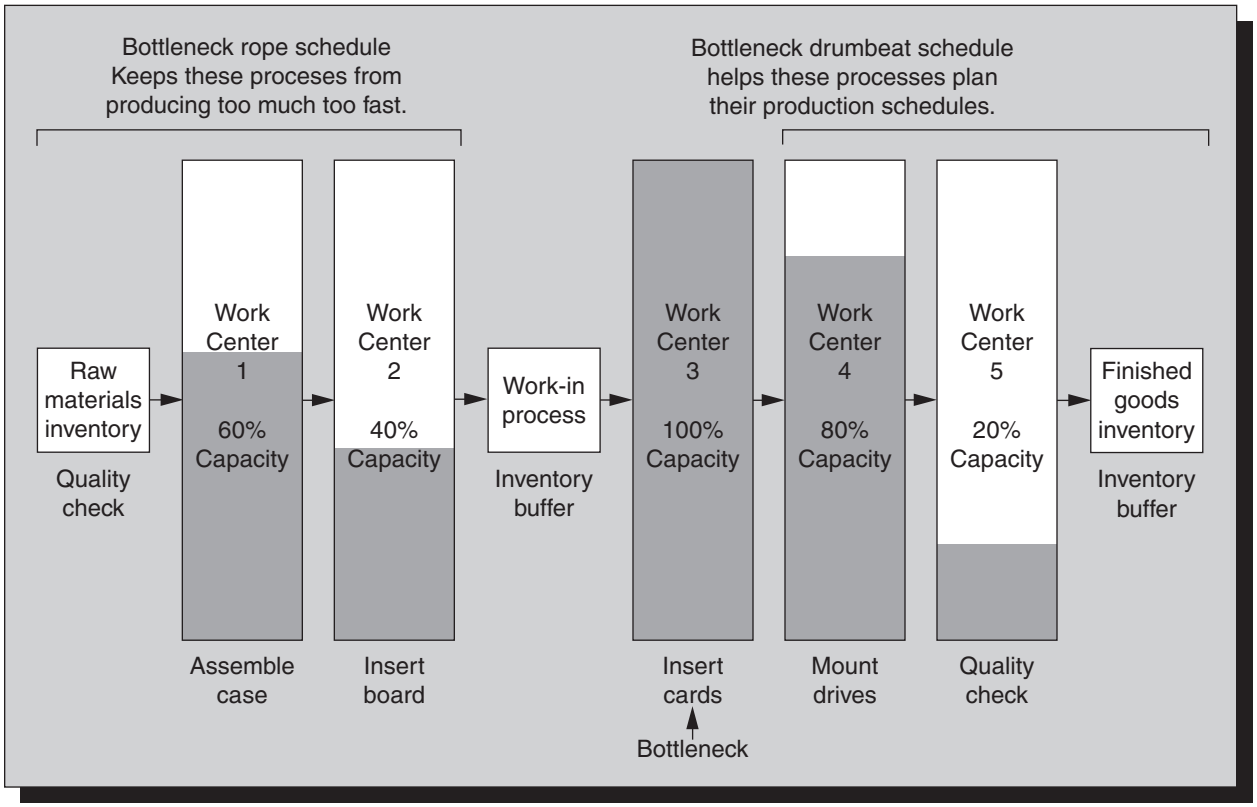
Key Point

Unnecessary work-in-process inventory can cause operational expenses to increase.

Drums, buffers, and ropes.

Goldratt uses the idea of drums, buffers, and ropes to implement TOC in the typical operation where the bottlenecked operation is somewhere other than the beginning of the

Exhibit 2
Drums, Buffers, and Ropes in a Production Process



production process. A *drum* sets the tempo or pace of the work for the plant and is particularly useful for downstream operations (operations after the bottleneck) to help anticipate work-in-process inventory output flow from the bottleneck. Work-in-process inventory in front of the bottleneck forms the buffer and assures that the bottlenecked operation works at its maximum output and is not idle waiting for another upstream operation (operations before the bottleneck). The rope restrains the upstream operations from overloading the bottleneck with too much work-in-process inventory input flow.

For example, rather than quality control, suppose that inserting the various driver cards is the slowest operation in the computer assembly plant. The maximum number of computers the plant can assemble is limited to the maximum number of driver card insertions that can be made. The plant loses production time if the driver insertion operation has to wait for the motherboard insertion operation in front of it to finish its work. Nevertheless, you cannot simply move the driver card insertion operation to the front of the production line. CPU boxes have to be assembled and the motherboard card inserted before driver cards can be inserted.

Exhibit 2 graphically demonstrates how the drum-buffer-rope concept looks in the computer assembly plant.

In Exhibit 2, computers flow through the work centers from left to right. Exhibit 3 provides some production numbers for the computer assembly plant. Work Center 3 takes

20 minutes to insert all driver cards into a computer unit. Because this is more time per unit than any other work center, Work Center 3 is the bottleneck operation.

Think Along

> Even though Work Center 5 (quality check) can actually inspect 120 computers each workday, it will not be able to inspect more than 24 computers because of the bottleneck operation in front of it. However, can Work Center 1 assemble more than 24 CPU cases per workday? More important, *should* Work Center 1 assemble more than 24 CPU cases per workday?

Exhibit 3
Production Data

Work Center	***1***	***2***	***3***	***4***	***5***
Work description	***Assemble Case***	***Insert Board***	***Insert Cards***	***Mount Drives***	***Check Quality***
Minutes per hour	60	60	60	60	60
Minutes per unit	÷12	÷8	÷20	÷16	÷4
Units per hour	5	7.5	3.0	3.75	15
Production hours per day	×8	×8	×8	×8	×8
Maximum units per day	40	60	24	30	120

Clearly, Work Center 3, as the bottleneck will limit the actual output of all downstream work centers (i.e., Work Centers 4 and 5) to 24 computers per day. However, upstream work centers (i.e., Work Centers 1 and 2) are not limited by the bottleneck (although Work Center 2 is limited to inserting motherboards in only 40 computers each day due to the production ceiling in Work Center 1). Nevertheless, these two work centers should *not* be allowed to assemble cases or insert motherboards faster than Work Center 3 can insert driver cards. If the production manager in this plant chooses to keep all centers working at their full potential, the result will be piles of work-in-process inventory. As noted earlier, high levels of inventory results in increased costs, decreased quality, and difficulty with timeliness. On the other hand, if the production manager (along with the management accountant) uses TOC to schedule the production process, the results will be as shown in Exhibit 4.

Exhibit 4
TOC Management of Work Processes

TOC-Based Schedule	***1***	***2***	***3***	***4***	***5***
	Assemble Case	***Insert Board***	***Insert Cards***	***Mount Drives***	***Check Quality***
Balanced units per day	24	24	24	24	24
Capacity used	60%	40%	100%	80%	20%
Work-in-progress inventory	0	3	0	0	0

In the TOC-based production schedule above, only Work Center 3 is working at full capacity. In addition, the only work-in-process inventory in the plant[3] is right in front of

[3] TOC is similar in many respects to the concept of just-in-time (JIT) management and production of inventory. Both concepts promote reducing work-in-process inventory in the plant to increase efficiency and eliminate waste. However, one fundamental difference between these two concepts is that TOC recognizes it is important to keep some work-in-process inventory in front of the bottleneck process to ensure that it is always operating at full capacity.

the bottleneck operation. The three work-in-process units in front of Work Center 3 serve as a buffer. The purpose of this inventory buffer is to ensure that Work Center 3 keeps operating in the event that either Work Center 2 or Work Center 1 slows or interrupts the production pace. With three work-in-process units at the bottleneck, either of the upstream work centers could shut down for as much as an hour (60 minutes ÷ 20 minutes per unit) without interrupting production at Work Center 3. If the two upstream operations worked perfectly well without any delays, breakdowns, scrapped products, or variety in how fast workers assemble cases and insert motherboards, then an inventory buffer in front of the bottleneck would be unnecessary. However, such perfection in the production of computers (and most other goods or services) is quite unrealistic.

The rope for the computer assembly plant is a production schedule that is based on the amount of time it takes the case assembly and motherboard insertion operations to prepare a computer unit to receive driver cards. The rope production schedule restrains these first two operations from producing work-in-process units faster than the bottleneck can insert driver cards. A similar production schedule serves as a drum to the drive mounting and quality inspection operations. The drum schedule allows these last two operations to anticipate exactly *when* they can expect the bottleneck to hand off computer units. As a result, these operations can complete final work on these units without unnecessary delay.

Key Point

Work-in-process inventory costs money and hides quality problems. However, having the bottleneck operation sit idle while other production operations that should have been faster scramble to catch up creates an irreplaceable loss of production output (i.e., throughput) in the overall process. Hence, work-in-process inventory in front of a constrained operation is necessary to avoid lost throughput.

Think Along

How might you decide how much of a work-in-process inventory buffer to maintain in front of a bottleneck?

Insufficient buffer inventory results in lost throughput and reduced profits. On the other hand, too much work-in-process inventory is an unnecessary expense and delays discovery of quality problems. Managers in TOC-based operations must make important trade-off decisions to determine the appropriate amount of inventory to keep in front of the bottleneck operation.

▲ DEVELOPING A TOC OPERATION

The goal of profit-seeking organizations is to maximize profit. It is important, though, that you understand that TOC defines profit in terms of throughput. *Throughput*, defined as the rate at which the system generates money, is calculated as revenue minus

totally variable costs. The term *totally variable costs* usually means direct materials (and can also include other variable expenses, such as commissions, delivery costs, and other out-of-pocket selling costs). TOC is emphatic, however, that direct labor is not variable. However, field research shows that actual companies using TOC differ in their individual working definitions of totally variable costs. In at least one instance, a company used its current policy of radical downsizing to include direct labor as a variable cost.[4]

Key Point

Throughput is used in TOC as both a measure of, and a management tool for, profit. Generally, throughput is measured as sales revenue minus the cost of direct materials expenditures (and out-of-pocket selling expenses, if any).

An organization managed using TOC will do three things to maximize throughput:

1. Establish sales prices higher than the totally variable costs (and out-of-pocket selling costs, if any).
2. Focus on providing goods or services that have the largest difference between totally variable cost and price.
3. Minimize the time between spending money to produce, and receiving money from selling, goods and services.

Sounds simple, right? Actually, all three of these things can be a challenge to accomplish consistently in a large organization. The key to effectively accomplishing these goals revolves around *constraint management*.

The Five-Step TOC Process.

Managing constraints in TOC is a five-step process:

Step 1: Identify the system's constraint(s).

Step 2: Decide how to exploit the system's constraint(s).

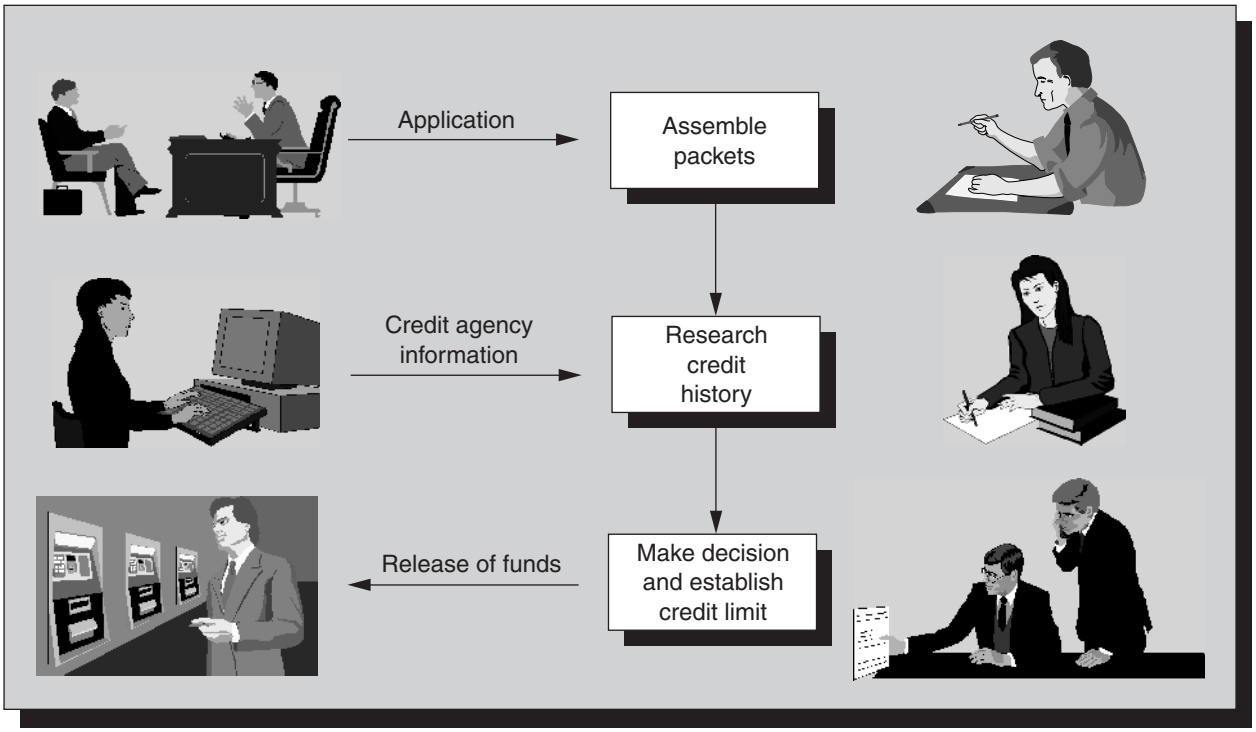
Step 3: Subordinate everything else to the preceding decision.

Step 4: Elevate the constraint(s).

Step 5: If a constraint has been broken, go back to step 1.

[4] E. Noreen, D. Smith, and J. T. Mackey. *The Theory of Constraints and Its Implications for Management Accounting,* Great Barrington, MA, North River Press. Research sponsored primarily by the IMA Foundation for Applied Research, Inc., and Price Waterhouse, LLP.

Exhibit 5
Bank Loan Process



To help you understand these five steps, consider a loan department in a bank. Exhibit 5 illustrates the steps in the loan approval process. The process starts when the customer meets with an agent to initiate the loan application process. Once the customer has completed the application, a loan officer completes a three-step operation before the customer receives funds. The first step is to assemble the loan application with additional information from the customer's account. The second step requires working with credit agencies to establish a credit history on the applicant. The final step is to decide whether to extend a loan and to establish an appropriate credit limit.

Step 1: Identify the system's constraint(s).
Constraints can be classified as either internal constraints (internal to the organization) or external constraints (outside the organization).[5]

[5] See B. Atwater and M. L. Gagne, "The Theory of Constraints versus Contribution Margin Analysis for Product Mix Decisions," *Journal of Cost Management* (January/February 1997): 6–15. Also S. E. Fawcett and J. N. Pearson, "Understanding and Applying Constraint Management in Today's Manufacturing Environment," *Production and Inventory Management Journal* (Third Quarter 1991): 46–55.

Internal constraints include both process and policy constraints. *Process constraints* occur when a given process or operation in the company has insufficient capacity to fully satisfy market demand. *Policy constraints* occur when management or employee unions enforce a rule that limits an organization's operation abilities or restricts its flexibility (e.g., a freeze on overtime or hiring or a restriction on purchasing direct materials).

In the bank example, internal constraints may cause the loan department to struggle to get loans approved in a timely manner. The bottleneck is a process constraint if the loan officers are physically unable to perform the three steps on all loans requested in the time allotted. On the other hand, this internal constraint may be the result of a policy constraint. For example, if the bank requires every loan, regardless of loan size or the nature of the customer, to go through a formal approval process, a bottleneck may occur.

External constraints include material constraints and market constraints. *Material constraints* occur when an outside source of material becomes restricted. This can happen in the absence of adequate suppliers to meet the organization's needs or when regulations restrict a direct material source. *Market constraints* occur when market demand does not fully utilize a company's capacity to make the product. In other words, the company cannot sell all the products it can make.

Assume the bank is able to process all loans requested. A material constraint exists if the bank lacks sufficient loan funds to satisfy the number of loans that are approved. On the other hand, a market constraint exists if bank customers are not demanding as many loans as the bank is able and willing to supply.

Step 2: Decide how to exploit the system's constraints.

Once a bottleneck is identified, the organization must effectively maximize the money-making capacity of the bottleneck. Essentially, we must view an hour of downtime at a bottleneck operation very differently than an hour of downtime at a non-bottleneck operation. We should calculate the throughput yield per unit of the constrained resource. Using this calculation helps us measure the effectiveness of managing (i.e., exploiting) the constraint. For example, if loan officers are unable to process all loan applications, the accountant could measure the loan revenue potential of *each hour spent* approving loans. Alternatively, if the bottleneck is an external constraint (e.g., a lack of funds or a lack of demand), accountants could calculate the revenue potential of *each dollar loaned*. This calculation helps management to decide how and why exploiting the bottleneck will maximize the throughput of the system.

Step 3: Subordinate everything else to the preceding decision.

Once we decide the constraint that is to be exploited, we must treat all other constraints as secondary. Constraint management recognizes that increasing the productivity of a non-bottleneck operation does not necessarily contribute to profits and can cause inefficiencies for the bottleneck (that directly affect profits) by allowing unexpected work-in-process inventory to arrive at the bottleneck work center. Essentially, the nature of Goldratt's drum-buffer-rope system is to support this step of the TOC process. The bottom-line goal is to coordinate production efforts at non-bottleneck operations to keep the constraint operating at optimal capacity.

Step 4: Elevate the constraint(s).
TOC teaches that the best way *to make money in an operation is to elevate (improve) the capacity of the constraint* or bottleneck. Elevating the constraint can involve off-loading some of the processing work to non-bottleneck operations despite their less efficient production capability. For example, one way of elevating the process constraint in the loan approval process would be to assign much of the packet-assembly and credit-check work to less experienced bank clerks. Likely, the clerks will not be able to assemble packets and research credit histories as quickly as loan officers. However, the point of TOC is only to maximize the efficiency of the constraint operation in the loan process (the loan officers' time), not to maximize the efficiency of every operation in the overall process. (This approach can play havoc with traditional measures of efficiency based on traditional standard cost accounting systems.)

Typical methods of elevating constraints in other production examples include

- ▲ Adding more shifts.
- ▲ Scheduling overtime.
- ▲ Acquiring more equipment.
- ▲ Outsourcing some bottleneck work.
- ▲ Inspecting work-in-process inventory before it enters the bottleneck to ensure that bottleneck time is not wasted processing bad parts.
- ▲ Scheduling long production runs for the bottleneck operation to reduce the number of setups.

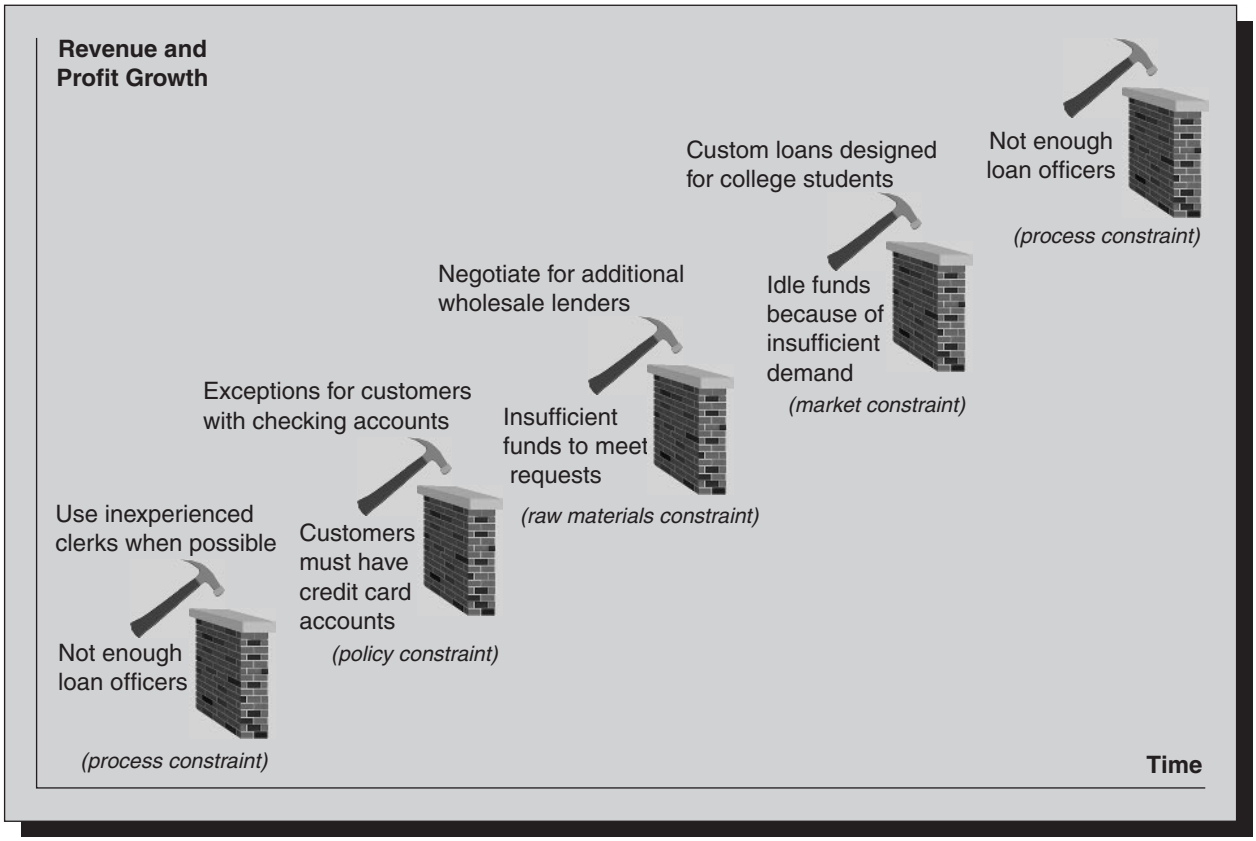
Note that applying these methods in *non-bottlenecked* operations is often a waste of process resources.

Step 5: If a constraint has been broken, go back to step 1.
As the organization works on elevating its constraints, other bottlenecks should emerge. These may be internal or external to the organization. The critical point here is that *there is always a constraint*.

Consider the bank loan example one more time. Elevating the capacity of the approval operation by using bank clerks to assist the loan officers will eventually lead to another constraint. Suppose the new constraint turns out to be a policy constraint—bank management will not extend consumer loans to clients who do not use the bank's VISA™ card services. Reconsideration of this policy leads to an exemption for customers who have checking accounts at the bank. Now the constraint shifts to outside the bank. There are not enough funds to supply all the demands for new loans (a "direct materials" constraint). Assume that the bank negotiates for more funds from an additional wholesale lending institution. Now the bank has the ability to process and provide more loans than clients are currently demanding; a market constraint has developed. With some effort, the bank marketing team is able to break this constraint by creating a special loan product tailored to the local college student community. Now the constraint shifts back inside the bank to the loan officers and bank clerks who are unable to process applications fast enough to keep up with demand.

Exhibit 6 illustrates the process of breaking constraints to discover new constraints.

Exhibit 6
The Cycle of Breaking Constraints in the Bank Loan Process



Key Point

The process of elevating and breaking a constraint must be consistent with the organization's product strategy. If not, the organization can move into new markets or offer new products or services that are not part of its long-term strategic direction.

▲ A COMPARISON OF THROUGHPUT AND TRADITIONAL ACCOUNTING SYSTEMS

Since about 1988, the term *throughput accounting* has been used to identify the assemblage of accounting systems, reports, and performance measures used to support a TOC implementation. It is important to understand that throughput accounting does not replace traditional managerial accounting methods. Throughput accounting supports a very specific and *extremely short-term* managerial view of an operation—the incremental value from a more effective employment of a constrained resource. It is not a strategic tool for making decisions about what products to produce and which customers to target.

New Accounting Definitions.

When Goldratt introduced TOC in 1984, he redefined two accounting terms: *throughput* and *operational expense*.[6] While the definitions of these terms vary in practice, this module follows the strict TOC-based definition that *throughput is sales revenue minus direct materials*. TOC throughput is similar to the traditional measure of *contribution margin*: sales revenue minus variable costs. However, there are important differences between throughput margin and contribution margin. The throughput measure assumes that the only variable costs are direct materials (and perhaps some out-of-pocket selling costs such as sales commissions). The contribution margin measure, on the other hand, typically categorizes direct labor and some manufacturing overhead as variable costs. The difference results from the time frame relevant to TOC. TOC focuses on maximizing short-term results—typically as measured within a matter of weeks.

The contribution margin definition of variable costs assumes a 6- to 12-month time frame. Think about this difference for a minute. Over a two- to three-week period, management is very reluctant to vary the level of direct labor and manufacturing overhead activities in a plant. To reduce or increase direct labor to handle a sudden two-week change in production would require management to hire and fire workers with abandon.[7]

Key Point

The difference between throughput in TOC and the traditional accounting measure is *time*. TOC generally assumes a time frame for maximizing profits as a matter of weeks. The traditional measure of contribution margin implicitly assumes a time frame over several months. Consequently, contribution margin measures assume that direct labor costs are variable, whereas throughput margin measures assume direct labor to be a fixed cost.

Operational expense is all the money an organization spends to turn direct materials into throughput. Operational expense includes traditional *conversion costs* (direct labor and manufacturing overhead), as well as selling and general administrative expenses. TOC considers operational expense to be a fixed cost.

Generally accepted accounting principles (GAAP) requires that conversion costs be allocated to work-in-process and finished goods inventories. On the other hand, *TOC treats all costs, even direct material costs, as period expenses*. Therefore, whatever costs are consumed during the production period are expensed regardless of whether the goods or services in production have been completed or sold.[8]

Key Point

Operational expense in TOC is the sum of all expenditures on production and administration activities other than expenditures on direct materials. TOC treats all costs (operational and direct materials) as period expenses.

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[6] E. M. Goldratt and J. Cox. *The Goal: A Process of Ongoing Improvement,* Croton-on-Hudson, NY, North River Press, 1984.

[7] As we shorten the time horizon (say, one day or one week) or consider different decisions (such as purchase volume guarantees given to key suppliers), even the cost of direct materials becomes fixed. Conversely, over extremely long periods, most costs can be avoided. The idea that variable and fixed costs are relative to time, cost object, and decisions is very significant and is discussed fully in another module in this series titled *The Kaleidoscopic Nature of Costs*.

[8] To immediately expense all product costs (materials, labor, and overhead) regardless of inventory status is a gross violation of GAAP and the matching principle. Remember, though, that TOC does not emphasize cost tracking for reporting purposes. *Throughput accounting does not replace the organization's conventional accounting system*. However, many companies often run multiple types of information systems to support various needs of the organization.

Don't underestimate the significance of these new definitions for throughput and operational expense. Accountants have established a long tradition of measuring performance of cost, efficiency, and output using standard costs. The result of these standard costs systems are well-known performance measures such as labor efficiency variance and volume variance. On the other hand, performance measures of costs, efficiency, and output in a TOC-managed organization can be significantly different from performance measures based on traditional accounting models of standard costing. Standard costing is often inappropriate as a tool for management of a production or service process based on TOC and should be supplemented, or even replaced.[9]

A New Profit and Loss (P&L) Statement.

With these definitions, throughput accounting provides a P&L statement that is significantly different from the GAAP-approved income statement and the traditional contribution margin statement used by managerial accountants for the last several decades. Exhibit 7 presents P&L statements for a company that is producing and selling 100 tons of finished goods.

Exhibit 7
Comparing Three Profit and Loss Statements

GAAP Basis		*Contribution Margin Basis*		*Throughput Basis*	
Revenue	$500,000[a]	Revenue	$500,000[a]	Revenue	$500,000[a]
Cost of goods sold	(120,000)	Variable costs[b]	(155,000)	Direct materials	(50,000)
Gross margin	$380,000	Contribution margin	$345,000	Throughput margin	$450,000
Selling and general administrative expense	(350,000)	Fixed costs[c]	(315,000)	Operating expense[d]	(420,000)
Operating income	$30,000	Operating income	$30,000	Operating income	$30,000

[a]Sales price is $5,000 per ton, 100 tons produced and sold.
[b]Direct materials ($50,000) + direct labor ($20,000) + variable manufacturing overhead ($15,000) + variable selling and general administrative expense ($70,000).
[c]Fixed manufacturing overhead ($35,000) + fixed selling and general administrative expense ($280,000).
[d]All costs in the organization other than direct materials.

GAAP Assumptions	*Contribution Margin Assumptions*	*Throughput Assumptions*
• All direct labor and direct material costs are specifically assigned to inventory. • All manufacturing overhead costs are allocated to inventory using a predetermined overhead application rate. • Inventory costs are not expensed to the income statement until the inventory is sold.	• Only variable product costs (direct labor, direct material, and variable manufacturing overhead) are specifically assigned to inventory. • Rather than allocating to inventory, fixed manufacturing overhead costs are immediately expensed to the income statement. • Variable product costs are not expensed to the income statement until the inventory is sold.	• No costs (including direct materials costs) are specifically assigned to inventory. • All product costs are immediately expensed to the income statement, regardless of when inventory is sold.

[9] For a discussion of the effects of TOC on standard costing, see the forthcoming module in this series titled *Standard and Kaizen Cost Systems*.

The first panel of Exhibit 7 includes GAAP-based statements, the second provides contribution margin statements, and the third provides throughput margin statements. Note that the revenues and operating incomes are the same across all three formats; all that has changed is the way costs are categorized. It would seem that the differences between these three formats of the P&L statement are not that significant. What's important, though, is how these three formats affect the priority placed on managing costs, inventory, and throughput.

Think Along

How might GAAP inventory costing encourage building inventory beyond the ability to sell?

GAAP uses "absorption costing" that requires organizations to assign values to work-in-process and finished goods inventory based on the direct material, direct labor, and overhead costs employed in the production process. Because unsold units are inventory, they carry their share of these costs. These costs, rather than being expensed on the income statement in the period incurred, go on the balance sheet as *assets*. GAAP, therefore, *rewards organizations that build inventory*, even if the inventory cannot be sold. Hence, when costs cannot be reduced, they can be hidden by *increasing inventory*.[10]

Contribution margin statements cause managers to focus on reducing variable costs or emphasizing sales of products with higher contribution margins. Emphasizing contribution margin will lead managers to focus on increasing sales without encouraging them to build unnecessary inventory.

Throughput P&L statements emphasize increasing throughput by maximizing the use of bottlenecked operations or removing constraints. Emphasizing throughput in the organization also encourages decreasing inventory and increasing the rate of production.

A simplistic emphasis on contribution margin or increasing throughput, however, can cause managers to become too short-run oriented. One result is that they may ignore fixed costs in making strategic decisions such as product pricing. Another consequence may be to enter new markets or products without good strategic analysis.

Because contribution margin and throughput margin per product use accounting-based numbers, they do not provide information necessary for identifying or managing constraints. Many resources, such as equipment depreciation, are based on traditional measures of "practical capacity." Managing constraints requires physical measure of capacity that communicate to operations personnel.[11]

Using the numbers from Exhibit 7, Exhibit 8 contrasts GAAP and throughput profits under three production scenarios: constant inventory, build inventory, and shrink inventory. In all three scenarios, the company is selling 100 tons of finished goods, so the revenue is always the same. However, notice how profit levels vary.

Production equals sales in the first scenario, so inventory levels are unchanged, and profit does not vary between the two P&L statements. However, watch what happens when inventory levels start shifting! In the second scenario, the company makes more inventory than it can sell. Most managers and stockholders would agree that accumulating unnecessary inventory is both expensive and unwise, yet notice the conflicting signals of the two

[10] D. Dugdale, "Accounting for Throughput," *Management Accounting* (UK) (April 1996): 24–29.

[11] For a detailed discussion of the difference between traditional (accounting based) and contemporary (physical) measures of capacity see the *Measuring and Managing Capacity* module in this series.

Exhibit 8
Inventory Effects of GAAP versus Throughput Accounting

	GAAP Basis			*Throughput Basis*		
	Scenario 1 Constant Inventory	***Scenario 2 Build Inventory***	***Scenario 3 Shrink Inventory***	***Scenario 1 Constant Inventory***	***Scenario 2 Build Inventory***	***Scenario 3 Shrink Inventory***
Sales	100 tons	100 tons	100 tons	100 tons	100 tons	100 tons
Production	100 tons	110 tons	90 tons	100 tons	110 tons	90 tons
Revenue	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000
Expenses						
Materials	50,000[a]	50,000[a]	50,000[a]	50,000[b]	55,000[c]	45,000[d]
Conversion	70,000[e]	63,636[f]	77,778[g]	70,000[h]	70,000[h]	70,000[h]
Selling and general administrative expense	350,000	350,000	350,000	350,000	350,000	350,000
Operating income	$30,000	$36,364	$22,222	$30,000	$25,000	$35,000

(Adapted from K. Constantinides and J. K. Shank, "Matching Accounting to Strategy: One Mill's Experience," *Management Accounting* [September 1994]: 32–36).

Assumptions: Sales price is $5,000 per ton; materials costs are $500 per ton, conversion costs (labor and manufacturing overhead are $70,000 per period.

Calculations:

[a]100 tons sold × $500 per ton.
[b]100 tons produced × $500 per ton.
[c]110 tons produced × $500 per ton.
[d]90 tons produced × $500 per ton.
[e]100 tons sold × ($70,000 ÷ 100 tons produced).
[f]100 tons sold × ($70,000 ÷ 110 tons produced).
[g]100 tons sold × ($70,000 ÷ 90 tons produced).
[h]Assumed fixed in the short run at $70,000 per period.

P&L statements. The GAAP-basis statement appears to "reward" the company for increasing inventory by showing higher profits. On the other hand, the throughput statement appropriately shows the negative impact of increasing inventory. Finally, the third scenario shows the company reducing unnecessary inventory levels. Notice that the throughput basis P&L statement sends a positive signal for reducing inventory levels.

Calculate what profits would be in each scenario if inventory shifted between 95 and 105 tons. Verify how the GAAP-based P&L statement appears to "punish" management for decreasing inventory by displaying reduced profits, whereas the positive effects of decreasing inventory are appropriately displayed on the throughput P&L statement.

The differences in Exhibit 8 occur because throughput accounting does not absorb any costs to inventory. *All costs* are expensed as period costs under throughput accounting, *including materials costs*. Note also that, consistent with assumptions of throughput accounting, material costs vary as production levels change, and conversion costs (labor and overhead) stay fixed in the current period despite changes in production levels. On the other hand, a GAAP-based P&L statement requires all production costs (materials, labor, and overhead) to be absorbed to inventory based on production and are expensed only as finished goods are sold.

Key Point

In contrast to GAAP requirements, throughput accounting does not allocate any costs to inventory. Remember, though, *GAAP-approved financial accounting is not a goal of throughput accounting.*

▲ THE MECHANICS OF THROUGHPUT ACCOUNTING—AN ILLUSTRATION[12]

The Operation.

Exhibit 9 shows an operation that manufactures two products, hockey sticks and baseball bats, for Weston Company. Hockey sticks sell for $55 and have an average market demand of 100 units per week. Baseball bats sell for $60 with an average weekly demand of 50 units. There are three machines in Weston's operation and a final assembly area. Exhibit 9 shows the direct materials requirements, routing, and average time at each production operation for each product.

Each of the four operations, (the three machines and final assembly) has 2,400 minutes of production capacity in an average workweek (60 minutes per hour × 8 hours per day × 5 days per week). Because of cost concerns, Weston has a company policy forbidding the use of overtime. You should note at this point that there are *potentially* two different types of bottlenecks in the company. First, there is a market constraint, since Weston can sell only 100 hockey sticks and 50 bats each week. In addition, Weston has instituted a policy constraint (no overtime allowed) that keeps machines from producing at their maximum capacity.

Identifying the constraint.

According to the five-step TOC model, the first step for Weston is to identify its bottleneck. You can see in Exhibit 9 that there are four operations in this operation (three machines and a final assembly). If the market constraints are creating a bottleneck in the operation, then we should be able to produce 100 hockey sticks and 50 baseball bats each week without using more than 2,400 minutes in any of the four operations. On the other hand, if Weston's policy constraint is the bottleneck, then Weston will be unable to produce all the sticks and bats that the market demands.

Exhibit 10 multiplies the time used by each product in each operation by the weekly demand for that product and then sums that number across both products for each operation. Based on the data in Exhibit 10, it looks like Machine 2 would require 2,750 minutes of weekly processing time to produce all the sticks and bats the market demands. Weston's company policy limiting the production process to 2,400 weekly minutes at each operation has created a bottleneck at the Machine 2 operation.

[12] This example is adapted from B. Atwater and M. L. Gagne, "The Theory of Constraints versus Contribution Margin Analysis for Product Mix Decisions," *Journal of Cost Management* (January/February, 1997): 6–15.

Exhibit 9
Routing and General Information for Weston Company

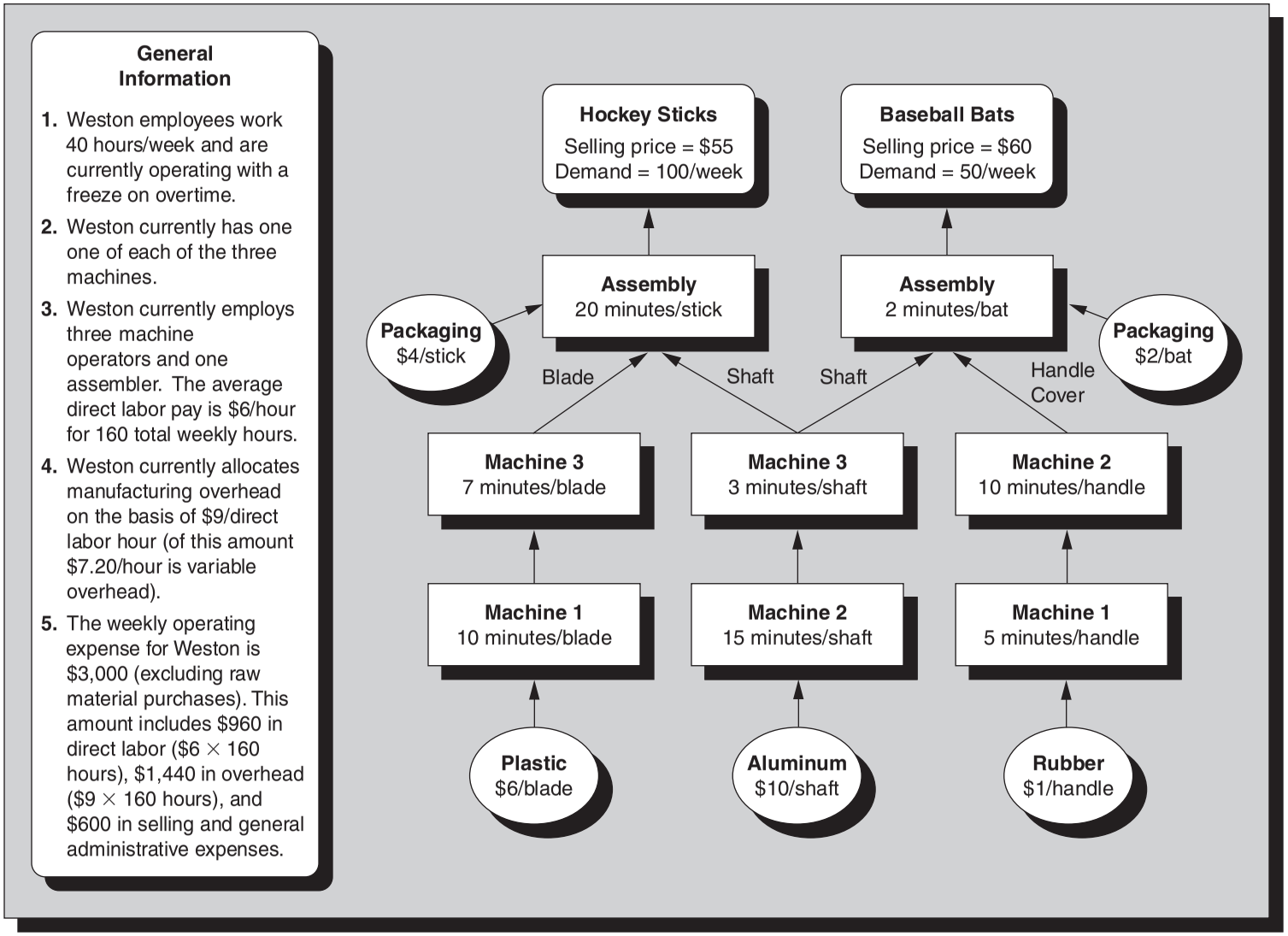

Exhibit 10
Capacity Requirements for Each Work Center at Weston Company

Machine 1				Machine 2			
Product	***Time (minutes)***	***Weekly Demand***	***Capacity Needed***	***Product***	***Time (minutes)***	***Weekly Demand***	***Capacity Needed***
Hockey stick	10	100 sticks	1,000	Hockey stick	15	100 sticks	1,500
Baseball bat	5	50 bats	250	Baseball bat	25[a]	50 bats	1,250
			1,250				2,750
Machine 3				**Assembly**			
Product	***Time (minutes)***	***Weekly Demand***	***Capacity Needed***	***Product***	***Time (minutes)***	***Weekly Demand***	***Capacity Needed***
Hockey stick	10[b]	100 sticks	1,000	Hockey stick	20	100 sticks	2,000
Baseball bat	3	50 bats	150	Baseball bat	2	50 bats	100
			1,150				2,100

(Weekly capacity on each machine: 40 hours × 60 minutes = 2,400 minutes)
[a]15 minutes per shaft + 10 minutes per handle.
[b]7 minutes per blade + 3 minutes per shaft.

Calculate the numbers that would change in Exhibit 10 if it took 15 minutes (rather than 2 minutes) to assemble a baseball bat. Would this create a different bottleneck in Weston's operation?

Exploiting the constraint.

With the bottleneck identified as a policy constraint on Machine 2, management needs to determine how to best exploit this constraint to maximize profitability. Assume that Weston uses traditional contribution margin reports to manage this operation (see Exhibit 7 for an example of this report structure). Exhibit 11 summarizes all the data from Exhibit 9 necessary to compute both contribution margin and throughput per unit of finished goods.

Remember in TOC that the most important part of the overall process is the bottleneck operation. The product (a hockey stick or baseball bat) cannot be completed and delivered before the bottleneck has completed its operation. The basic approach to maximizing profits is to maximize the *profit per unit of constraint on the bottleneck operation*.

Exhibit 11 computes the contribution margin per minute of operation on the bottleneck operation for hockey sticks ($1.53 per minute) and baseball bats ($1.57 per minute). It also computes the throughput margin per minute of operation on the bottleneck operation for hockey sticks ($2.33 per minute) and baseball bats ($1.88 per minute).

These computations present conflicting strategies to Weston management. Based on the contribution margin calculation, baseball bats are top priority. Exhibit 12 shows that baseball

Exhibit 11
Summary of Product Information Based on Exhibit 10

Panel A	***Hockey Sticks***	***Baseball Bats***
Weekly demand	100 units	50 units
Selling price	$55.00/unit	$60.00/unit
Time		
Machine 1	10 minutes	5 minutes
Machine 2	15 minutes	25 minutes
Machine 3	10 minutes	3 minutes
Assembly	20 minutes	2 minutes
Total time	55 minutes	35 minutes
Raw materials		
Plastic	$ 6.00/stick	
Aluminum	$10.00/stick	$10.00/bat
Rubber		$ 1.00/bat
Packaging	$ 4.00/stick	$ 2.00/bat
Total materials	$20.00/stick	$13.00/bat
Direct labor @ $6.00/hour	$ 5.50/stick	$ 3.50/bat
Variable overhead @ $7.20/hour	$ 6.60/stick	$ 4.20/bat
Panel B		
Contribution margin		
(selling price − raw materials − direct labor − variable overhead)	$22.90/stick	$39.30/bat
Time on constraint (Machine 2)	÷15 minutes	÷25 minutes
Contribution margin per unit of constraint	$1.53/minute	$1.57/minute
Production priority	Priority 2	Priority 1
Panel C		
Throughput value		
(selling price − cost of raw materials)	$35.00/stick	$47.00/bat
Time on constraint (Machine 2)	÷15 minutes	÷25 minutes
Throughput margin per unit of constraint	$2.33/minute	$1.88/minute
Production priority	Priority 1	Priority 2

bats can be produced up to the 50 unit market demand. Producing the 50 baseball bats will require 1,250 minutes of processing time on Machine 2. After producing the 50 bats, Machine 2 has 1,150 minutes available to produce hockey sticks. At 15 minutes a hockey stick, Weston can produce 76 sticks (1,150 total minutes available ÷ 15 minutes per stick).

Exhibit 13 calculates that $2,010 in weekly profit would be created and reported using contribution margin analysis.

Think Along

What is the importance of emphasizing throughput per bottleneck minute rather than throughput per hockey stick or per baseball bat?

Exhibit 12
Optimal Product Mix for Weston Company

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7**
Priority	**Product**	**Weekly Demand**	**Processing Time per Unit on Constraint (Machine 2)**	**Capacity Needed On Constraint (Machine 2) [3 × 4]**	**Capacity Available on Constraint (Machine 2)**	**Optimal Quantity Produced [(lesser of 5 or 6) ÷ 4]**
Using Contribution Margin						
1	Baseball bats	50 bats	25 min.	1,250 min	2,400 min. −1,250 min.	50 bats
2	Hockey sticks	100 sticks	15 min.	1,500 min	1,150 min.	76 sticks
Using Throughput Margin						
1	Hockey sticks	100 sticks	15 min.	1,500 min	2,400 min. −1,500 min.	100 sticks
2	Baseball bats	50 bats	25 min.	1,250 min	900 min.	36 bats

*The number in column 7 represents the amount of each finished product produced each week. If the number calculated in column 7 is a fraction, it is truncated based on the assumption that partial units cannot be produced.

Throughput value calculations suggest a different product mix than contribution margin. Returning to Exhibit 11, the throughput value calculations per minute on Machine 2 suggest that Weston first produce all the hockey sticks that the market demands and then use remaining bottleneck capacity to produce baseball bats.

Exhibit 12 demonstrates that producing all 100 hockey sticks demanded each week by the market will leave 900 minutes (2,400 available minutes − [100 sticks × 15 minutes per stick]) available on Machine 2 to produce baseball bats. At 25 minutes per baseball bat, Weston can produce 36 bats (900 total minutes available ÷ 25 minutes per bat).

The new product mix of 100 sticks and 36 bats recommended by the throughput value analysis results in an increase of weekly profit to $2,192 as reported in Exhibit 13. As you can see, contribution margin analysis does not effectively manage the bottleneck to maximize the short-term profit potential of the Weston operation. Essentially, contribution margin analysis assumes that direct labor costs at the non-bottleneck operations can be avoided in the immediate future.

Key Point

Maximizing profit in a TOC-managed company is a function of maximizing the throughput return on the bottleneck operation.

Exhibit 13
Weekly Profit of Weston Company with Each Product Mix

Based on Contribution Margin		
Revenues:		
(76 sticks × $55/stick)		$4,180
(50 bats × $60/bat)		3,000
Total revenue		$7,180
Less raw material costs:		
(76 sticks × $20/stick)	$1,520	
(50 bats × $13/bat)	650	(2,170)
Throughput value		$5,010
Less operating expenses:		(3,000)
Weekly profit		$2,010
Based on Throughput Margin		
Revenues:		
(100 sticks × $55/stick)		$5,500
(36 bats × $60/bat)		2,160
Total revenue		$7,660
Less raw material costs:		
(100 sticks × $20/stick)	$2,000	
(36 bats × $13/bat)	468	(2,468)
Throughput value		$5,192
Less operating expenses:		(3,000)
Weekly profit		$2,192

Subordinating everything else to the constraint.
With Weston producing 100 hockey sticks and 36 baseball bats, it is obviously not satisfying market demand for baseball bats. However, the only way Weston can make more bats (without changing its overtime policy) is to reduce the number of hockey sticks produced. *Weston must subordinate market demand for baseball bats to the profit potential in producing hockey sticks.*

Play with these numbers for a minute. With an optimal product mix of 100 hockey sticks and 36 baseball bats, return to Exhibit 10 and calculate the minutes of excess capacity at each non-bottleneck operation.[13]

Think Along

Weston's management may be tempted by the unused capacity at Machines 1 and 3 and in the assembly work center. What should Weston do with all this excess capacity in its production process? If Weston chooses to use this capacity to produce more units at each non-bottleneck operation, what will happen? Will Weston be able to produce and sell more hockey sticks or baseball bats?

[13] Hint: excess capacity at Machine 1 = 2,400 minutes total capacity − (100 sticks × 10 processing minutes) − (36 bats × 5 processing minutes) = 1,220 minutes

Clearly, Weston cannot use the excess capacity in its non-bottleneck operations to produce more salable hockey sticks or baseball bats. The only thing that Weston can do is produce more work-in-process inventory. Now return to Exhibit 9 and try to envision where the inventory will start piling up if Weston runs Machines 1 and 3 and the assembly work center at full capacity. Plastic blades for hockey sticks will start piling up rapidly in front of the hockey stick assembly work area waiting for aluminum shafts. In addition, partly processed rubber handle covers for baseball bats will start piling up in front of Machine 2 faster than they can be machined.

Essentially, three things will result from this work-in-process inventory (and none of them will be good).

1. Weston will spend money purchasing plastic and rubber that it cannot turn into throughput.
2. As the pile of rubber handles start building, the Machine 2 operator could easily become confused. Rather than maching aluminum shafts, the Machine 2 operator might spend valuable time machining rubber handle covers. These covers will then simply create a pile of work-in-process in front of the assembly work center.
3. Piles of plastic hockey stick blades or rubber baseball bat handles could hide production flaws that remain undiscovered for some time. Once the flaws are discovered, Machine 2 may be forced to sit idle until acceptable rubber handles are produced. In addition, market demand for hockey sticks may go unfilled while Weston scrambles to produce hockey stick blades on machines that originally had plenty of time (capacity) to produce acceptable blades.

To avoid these problems, Weston needs to subordinate the non-bottleneck operations to Machine 2 using Goldratt's drum-buffer-rope system. Weston should first establish a buffer of aluminum (direct material) and work-in-process bat handle covers in front of Machine 2. This buffer should be just large enough to ensure that, in case Weston's supply of aluminum or Machine 1 runs into some temporary problems, Machine 2 can continue production.[14] Second, Weston needs to "throw a rope around" Machine 1 to keep it from producing more work-in-process blades than Machine 2 can support. Essentially, Machine 2 sets the production capacity for the entire operation. Finally, the output rate (drum beat) of Machine 2 is communicated to the assembly work center and to Machine 3 so that these operations can set their own production pace at a rate slower than their potential.

Think Along

Look at Exhibit 9. Once TOC is implemented, where are the buffer inventories? Where is the rope? Which operations are affected by the "drum beat"?

Elevate the constraint.

With TOC and throughput accounting information reports, Weston management will naturally focus on elevating the Machine 2 bottleneck in order to produce more baseball bats (the market demand for hockey sticks is fully satisfied). For example, throughput value computations as displayed in Exhibit 11, panel C demonstrate that a 25-minute increase in processing time on Machine 2 adds $47.00 to weekly profit. Therefore, if the overtime premium is less than $112.80 per hour ([$47.00 ÷ 25 minutes] × 60 minutes), Weston should definitely reconsider its overtime policy.

[14] This buffer is very similar to what traditional managerial accounting would call a "safety stock."

In addition, Weston will also want to consider methods to increase market demand for hockey sticks. The throughput value data on Exhibit 11 shows that increasing weekly market demand from 100 to 105 hockey sticks adds $175.00 to weekly hockey stick profit (75 minutes to produce 5 sticks × $35.00). Note producing five additional sticks will cost $141 in weekly baseball bat profit (75 minutes to produce 3 bats × $47.00). However, the trade-off (if available) makes financial sense.

Think Along

What other constraints might develop as Weston Company elevates the current bottleneck?

Eventually, as Weston elevates its current critical constraints (Machine 2 capacity and market demand for hockey sticks), the bottleneck will be broken and *will shift to a new constraint*. For example, Weston may find itself unable to obtain sufficient plastic to satisfy elevated process capacity and market demand. Now the whole TOC process starts again with new throughput value calculations based on units of direct materials (plastic) serving as the bottleneck resource.

▲ ATTRIBUTES OF THROUGHPUT ACCOUNTING

As TOC and throughput accounting continue to gain prominence as models of management, it is important to understand the technical, behavioral, and cultural attributes of this management system.

Technical Attributes.

By enhancing process understanding within the organization, TOC and throughput accounting provide information that is relevant to making good decisions.

Decision relevance.
Much of the management focus in a TOC operation is on the bottleneck. Because of its central importance to the organization's overall capability to make money, the bottleneck must necessarily receive the lion's share of management attention. Managerial accounting, if properly used, actually plays an important part in the management of bottlenecks by improving capacity use and by avoiding inventory buildup.

TOC improves capacity use decisions. Employees often identify bottlenecks by observing the buildup of work-in-process inventory beside workstations. The capacity of bottlenecked activities must not be wasted. Once employees identify bottlenecks, schedules and budgets for bottlenecked equipment and processes are developed and tightly controlled. Management accountants report and investigate unfavorable operating efficiency and volume variances immediately. If elevating a constraint means investing in additional capacity, then managers request additional capital budget expenditures.

TOC and throughput accounting avoid costly buildup of inventories. TOC focuses on maximizing throughput (sales revenue minus direct materials). It places no asset value on inventory but expenses it in the period in which the company incurs its cost. This approach discourages workers from producing for inventory. Because inventory creates holding costs, may become obsolete, and may contain quality defects, TOC reduces costs and risks for organizations.

TOC and throughput accounting are not the only accounting measures needed. Throughput accounting is not going to provide *all the information* management needs to make all decisions in an organization. Throughput accounting is *not* a cost system. It does not support the allocation of product costs (which an ABC system does). Management will have a very difficult time using a throughput accounting system to assess individual product costs based on investments in and use of materials, labor, and overhead. Further, throughput accounting will not integrate with the GAAP-based general ledger system. Hence, organizations will also need to invest in traditional costing or ABC systems.

Key Point

Throughput accounting is useful for supporting effective constraint management.
Managing product costs will require a separate product cost system such as ABC.

Process understanding.
TOC requires a thorough understanding of work processes: the flow of product from one operation to another, as well as the capacity and throughput time of each. Throughput accounting provides a financial, systemwide view of the organization. The efficiency or effectiveness of any single employee or production operation is important, only to the extent that the employee or operation supports efficient exploitation of a bottleneck to maximize throughput. Throughput accounting, in concert with the five-step TOC management model, allows the organization to design around a bottleneck to maximize the system's capability to make money. It recognizes that producing to capacity at individual operations within a process does not optimize the output from the process as a whole.

Behavioral Attributes.

Whenever information systems change and management introduces new performance measurements, behaviors are affected. Being aware of the behavioral effects a throughput accounting system can have within the organization will help enhance the benefits of the TOC management model, as well as minimize potential conflicts caused by changing the company's information structure.

Benefit: Avoids local optimization.
Throughput accounting encourages cooperation throughout the organization to achieve company profit goals, instead of rewarding employees for optimizing individual processes. TOC uses the capacity of a bottleneck to set standards for all operations. When negative capacity-use variances start appearing in the plant, management promptly determines their underlying causes. If the bottleneck happens to be performing below its capacity, then all other processes must scale back production. Management needs to get the bottleneck processes back up to standard volume levels as soon as possible.

Benefit: Improves communication between departments.
TOC communicates the needs and the capacity of the bottleneck. *The drumbeat* of the bottleneck is the production schedule that non-bottleneck, downstream operations use to schedule the parts and people needed to complete production and deliver products to customers. *The bottleneck rope* is the production schedule for upstream, non-bottleneck operations. It specifies a work schedule such that the bottleneck receives sufficient output from upstream operations without an unnecessary buildup of work-in-process inventory.

Work-in-process inventory is also a communication device in TOC. A dangerously low *buffer of inventory* in front of the bottleneck immediately signals upstream operations to use their excess capacity to expedite (i.e., hurry up) their production to ensure the bottleneck is not "starved" for parts.

Key Point

> The essence of TOC and throughput accounting is communication throughout the organization that helps everyone coordinate and focus on enhancing the profit-making potential of the company.

Potential conflict: Excessive budget cuts.

A poorly used throughput accounting system can create problems. For example, the excess capacity in Machines 1 and 3 and in the assembly work center may tempt management at Weston Company to make severe budget cuts within these non-bottleneck processes, particularly in times of economic stress. Understandably, employees in these non-bottleneck work centers may become concerned that their jobs could be in jeopardy. Before Weston releases workers and scales back production capacity, management needs to bear in mind that it is impossible in most operations to balance individual process capacities.

Like the boys in the opening hiking scenario, every operation within the process has inherently different capacities. Further, a company *needs* to identify a bottleneck to use as the focus for the rest of the organization. Herbie, our slow friend on the hiking trail, is not really a liability to the group's overall progress. By intelligently using him to establish pace, the wise hike leader is able to confidently project an arrival time and to minimize problems resulting from boys getting too spread out on the trail. Releasing non-bottleneck workers in order to reduce capacity can remove the flexibility necessary in the enterprise to implement a TOC system. Further, effective TOC requires cooperation throughout the organization. Employees at Weston Company are not likely to cooperate with the TOC system if they are afraid that creating large amounts of slack in their operations could cost them their jobs.

Potential conflict: Lack of focus on non-bottlenecks.

As you have likely noticed by now, TOC is rather fanatic in the focus it places on management of bottleneck processes. The theory is that only by elevating bottlenecks can the organization save money or improve throughput. Although TOC does address the need to improve existing non-bottlenecks (in terms of supporting the bottleneck operation), there may be a risk that employees will focus very little time on improvement of non-bottlenecks. With the use of other established management approaches (such as ABM, quality costing, or target costing), employees can improve product quality, strengthen process productivity and timeliness, and reduce cost throughout the organization.

Potential conflict: Short-run behavior strategy.

Throughput accounting takes a very narrow view of costs to optimize the system in the very short run. There is a real danger that, like contribution margin analysis, TOC can lead to decisions that can harm the organization in the long-run. Consider the bank loan example. In elevating the loan funds available (materials) constraint, the bank created a new borrowers available (market) constraint. To elevate this constraint, the bank decided to make loans to a new class of customers—college students. Entering a new customer or product market, however, is a strategic decision that should not be made on the basis of short-run constraint elevation. Before elevating this constraint, the bank needs to redefine its product strategy, otherwise, it will enter a market it may not want to be in.

Key Point

The focus of improvement in non-bottleneck processes should be on enhancing quality and throughput, not on reducing capacity or entering new product or customer markets. Otherwise, employees may be hesitant to support a TOC program, or the firm may incrementally commit itself to a new product strategy.

Cultural Attributes.

In addition to right behaviors, introducing and sustaining TOC in an organization requires appealing to and creating a set of shared cultural values, beliefs, and mindsets within an organization.

Creating a receptive culture for TOC.

Introducing a new process in an existing organizational culture is always hard. People have their existing beliefs, values, and mindsets. A new process that does not appeal to shared organizational values is unlikely to take hold. Upper management needs to strongly endorse TOC and demonstrate its power to improve profits. Management should use training, speeches, and internal literature to demonstrate the dollar impact of TOC on a business unit or product line that is familiar. Documenting each additional management success with TOC for all to celebrate helps induce others to change. This approach is much easier in an organizational environment that values continuous improvement and does not fear change.

Mindset change.

Making the shift to a TOC-based operation often requires that management make significant mindset adjustments. Organizations, perhaps reflective of Western culture, tend to value individual and local performance. Traditionally, an effectively managed operation is viewed as one that gets maximum output from each individual worker and process. This mindset permeates both manufacturing and service industries. In TOC the focus is on producing what customers want instead of the maximum output that workers are capable of producing. This concept requires a mindset shift in viewing a well-managed operation. A well-managed TOC operation identifies the products that customers want and then manages the operation to satisfy customer needs with high-quality, on-time products—regardless of the effect on the efficiency of individual workers or processes.

Exhibit 14 outlines more specifically how TOC affects managers' assumptions. Traditionally, supervisors and managers become very concerned when workers are idle; hence the pressure to "keep working." As soon as workers process one pile of materials, they find more materials and restart. With the focus on keeping the workers busy building inventory, often no one asks when, why, or how anyone will buy the stockpiled goods and services. The subtler (and more important) question is, Are we building the correct *amount* of the *right* inventory to make the most money for the organization?"

Key Point

Sometimes an organization can become focused on keeping the production process busy all the time rather than on producing the right inventory at the right time.

Exhibit 14
The Assumptions versus The Facts

Prior Assumption	*Current Fact*
Keeping people busy is the key to making money. busy.	A focus on labor utilization hinders cash flow due to high high inventory and the emphasis on keeping people
By keeping utilization high, employees help the company perform well financially.	High utilization of resources does not correlate to profitability.
High labor-utilization rates ensure high levels of customer satisfaction.	High utilization of resources does not necessarily correlate to high customer satisfaction.
If managers release workers to other areas of the operation, they may not get them back when they need them.	Managers will willingly release workers to go where the work is when the right performance measures are used.
Traditional accounting standards tell managers whether they are effective as a total enterprise.	Traditional standards are subjective, inaccurate, and require constant monitoring.
Maximizing the production output per setup and building inventory is key to making money.	Making only what customers order is the key to making money, and on-time delivery is the critical success factor.

(Adapted from D. Westra, M. L. Srikanth, and M. Kane, "Measuring Operational Performance in a Throughput World,"

Creating cross-functional cooperation.
TOC implementation requires cooperation across functions and processes in an organization. Information has to be shared on customers' wants and on the availability of capacity. Teamwork must be the norm. Everyone in the organization must have a process view of the company. Everyone must work on elevating the constraint. Non-constrained operations must subordinate their needs to the needs of the constraint. This mindset, in effect, creates a community of the organization. Think about the boys hiking in the woods. With Herbie as the focus of the group effort, each boy will certainly become much more aware of the need to get *everyone* to Devil's Gulch. Hence, everyone is more responsive to ideas like unloading some of Herbie's backpack weight to other backpacks. Similarly, TOC and throughput accounting encourage and require team participation in organizations.

▲ LESSONS LEARNED

- ▲ TOC is a relatively new management tool that identifies and uses constraints to maximize the profit potential of a company.
- ▲ Intelligent management of constraints (sometimes called bottlenecks) involves the following five steps: (1) identify the system's constraint, (2) decide how to exploit the system's constraint, (3) subordinate everything else to the preceding decision, (4) elevate the constraint, and (5) if a constraint has been broken, go back to step 1.
- ▲ A drum-buffer-rope approach is used to subordinate all other operations to the bottleneck. The "drum beat" sets the production pace for the rest of the operation. Upstream operations are held in check by a "rope" schedule. A minimal "buffer" of inventory kept in front of the bottleneck keeps it running at full capacity.

- ▲ Throughput accounting is a system specifically designed to support TOC-based management. The system has its own definition of some key accounting terms and its own P&L statement format.
- ▲ Throughput accounting defines throughput value as sales revenue minus the cost of direct materials expenditures (and any out-of-pocket selling expenses). Operational expense refers to all expenditures other than direct materials.
- ▲ Maximizing operating profit means maximizing throughput value per unit of bottlenecked capacity.
- ▲ Unlike GAAP-based P&L statements, throughput accounting does not promote overproduction of inventory.
- ▲ Throughput accounting assumes a shorter time period than the contribution margin P&L statements in defining variable costs. The former typically assumes weeks; the latter assumes 6 to 12 months.
- ▲ Throughput accounting systems focus on the efficiency and capacity of the *entire* process, rather than on individual operations and work centers. Only bottleneck operations are managed to maximize individual efficiencies and output volumes. The performance of non-bottlenecks is measured by how well they smoothly interface with the bottleneck to keep it operating efficiently without unnecessary buildup of work-in-process inventory.
- ▲ Throughput accounting is a short-term operations management tool. Other management accounting tools, such as target costing, product costing and ABC, are needed to address long-range strategic concerns.

APPENDIX—TOC AND LINEAR PROGRAMMING

▲ WHAT IS LINEAR PROGRAMMING?

You may have studied linear programming (LP) in a previous mathematics or business operations class. LP is a fairly rigorous mathematical method of solving practical problems such as allocation of resources by means of linear functions where the variables involved are subject to constraints. LP has been around a long time—much longer than TOC. Both concepts involve maximizing a function subject to constraints. There is a strong relationship between LP and TOC. In fact, LP can be used to help with the first two steps of the TOC process (identify the system's constraint, and decide how to exploit the system's constraint).

Exhibit 15 shows a typical LP solution to the Weston Company problem established earlier in Exhibit 12. See if you can identify where the information originally provided in Exhibit 9 sets up the programming equations in Exhibit 15.

This module does not cover the mathematics involved in an LP solution. Many software programs are available to business professionals who choose to use LP as a first step to designing a TOC system. One popular program (used to compute the solution in Exhibit 15) is Microsoft Excel™. The specific steps required to create the LP solution follow.[15]

Set Up the Problem.

1. Open Excel™ and set up your spreadsheet to look just like the top box in Exhibit 15.
2. Leave cells B6 and B7 blank (remember that we're trying to determine how many hockey sticks and baseball bats to produce).
3. Build formulas for the following cells:

   B10: = B2 * B6
   B11: = B3 * B7
   B12: = −B4 * B6
   B13: = −B5 * B7
   B14: = SUM(B10 : B13)
   B16: = B14 + B15
   G6: = (E6 * B6) + (F6 * B7)
   G7: = (E7 * B6) + (F7 * B7)
   G8: = (E8 * B6) + (F8 * B7)
   G9: = (E9 * B6) + (F9 * B7)
   G10: = SUM(G6 : G9)
4. Test your formula by putting 75 in cell B6 and 25 in cell B7. The B16 cell should equal $800, and cell G10 should equal $5,000.

Solve the Problem.

1. Open Solver from the tools menu.[16] A box will appear titled "Solver Parameters".
2. "Set Target Cell" represents the objective function. Make sure this space is highlighted and then click on cell B16 (Profit) to enter the objective function. This space should now contain $B$16.

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[15] The Excel solution method is adapted from R. Verma, "My Operations Management Students Love Linear Programming," *Decision Line* (July 1997): 9–12.

[16] If you don't see Solver as an option under Tools menu, then this module was not installed during Excel setup. *You must add this component using the Excel setup routine*. Use your Microsoft Office CD-ROM or installation disks to rerun the installation procedure on your computer. Select the option to add or delete components.

3. Check the "Max" button in the "Equal To" area (since we are maximizing profit in this problem).
4. Click on "By Changing Cells" area. You need to input the location of the two decision variables (Sticks Produced and Bats Produced) here. Therefore, highlight cells B6 and B7. This area should now contain $B$6:$B$7.
5. Click on "Add" to begin adding constraints. A box will appear titled "Add Constraint". Remember that there are two types of constraints at Weston—production constraints and market constraints.
6. Add the first production constraint by clicking on the "Cell Reference" area. Next click on cell G6 (Total Minutes on Machine 1). The "Cell Reference" area should now contain $G$6. Make sure the middle column (the mathematical operator) is set on <=. Click on the "Constraint" area. Then click on cell H6 (Ceiling for Machine 1). The "Constraint" area should now contain =$H$6. Click OK.
7. Add the remaining production constraints for the last three operations using the approach just followed for Machine 1.
8. Add the two market constraints using the approach just followed for the production constraints. Set cell B6 <= cell E12. Set cell B7 <= cell E13.
9. In the "Solver Parameters" box, click on the "Options" button. Check the box "Assume Linear Model" and click OK.
10. Click on "Solve" and a box titled "Solver Results" will appear. Note that cells B6 and B7 have been changed by the program to contain the optimal number of hockey sticks and baseball bats.
11. Highlight "Answer" and "Sensitivity" in the "Reports" area of the "Solver Results" box and click "OK". These reports will appear as separate worksheets and should match the Answer Report and Sensitivity Report in Exhibit 15.

The LP solution for Weston Company is provided below the Problem Setup in Exhibit 15. As you can see, the LP solution has identified Machine 2 as the process bottleneck and has calculated the maximum possible throughput values (sales prices minus the cost of direct materials times units sold) of the two products based on both the processing time and market constraints in the operation. The resulting optimal mix (100 hockey sticks and 36 baseball bats) is the same mix we computed earlier.

Notice also that the LP program has computed both the process slack and the market slack in the system. Machine 2 has no slack, which clearly indicates its status as the system bottleneck. In fact, profit will increase by $2.00 for every minute that Weston Company is able to increase the Machine 2 capacity beyond 2,400 minutes (see the shadow price in the Sensitivity Report in Exhibit 15). In addition, the zero market-demand slack for hockey sticks indicates that this market is currently satisfied. If Weston is able to obtain more processing time at Machine 2, then more baseball bats can be produced. In fact, see whether you can calculate how many more minutes of Machine 2 can be obtained before the bottleneck moves outside the organization to the market?[17]

[17] Answer: 50 bats demanded − 36 bats sold = 14 potential bat sales per week. 14 bats × 25 Machine 2 processing minutes = 350 more minutes needed. (This allowable increase on Machine 2 is displayed in the Sensitivity Report in Exhibit 15.)

Exhibit 15
Linear Programming Problem Setup

	A	B	C	D	E	F	G	H
1	**Data**							
2	Stick Price	$ 55.00						
3	Bat Price	$ 60.00			**Constraints**			
4	Stick RM Cost	$ 20.00			Minutes	Minutes	Total	
5	Bat RM Cost	$ 13.00			per Stick	per Bat	Minutes	Ceiling
6	Sticks Produced			Machine 1	10	5	-	2,400
7	Bats Produced			Machine 2	15	25	-	2,400
8				Machine 3	10	3	-	2,400
9	**Objective Function**			Assembly	20	2	-	2,400
10	Stick Revenue	$ -				Total	-	
11	Bat Revenue	$ -			Market Demand			
12	Stick RM Cost	$ -		Sticks	100			
13	Bat RM Cost	$ -		Bats	50			
14	Throughput Value	$ -						
15	Operating Expenses	$(3,000)						
16	Profit	$(3,000)						

Linear Programming Answer Report

	A	B	C	D	E	F	G
6	Target Cell (Max)						
7		**Cell**	**Name**	**Original Value**	**Final Value**		
8		$B$16	Profit	$ (3,000)	$ 2,192		
9							
10							
11	Adjustable Cells						
12		**Cell**	**Name**	**Original Value**	**Final Value**		
13		$B$6	Sticks Produced	-	100		
14		$B$7	Bats Produced	-	36		
15							
16							
17	Constraints						
18		**Cell**	**Name**	**Cell Value**	**Formula**	**Status**	**Slack**
19		$G$6	Machine 1 Minutes	1,180	$G$6<=$H$6	Not Binding	1220
20		$G$7	Machine 2 Minutes	2,400	$G$7<=$H$7	Binding	0
21		$G$8	Machine 3 Minutes	1,108	$G$8<=$H$8	Not Binding	1292
22		$G$9	Assembly Minutes	2,072	$G$9<=$H$9	Not Binding	328
23		$B$6	Sticks Produced	100	$B$6<=$E$12	Binding	0
24		$B$7	Bats Produced	36	$B$7<=$E$13	Not Binding	14

Exhibit 15 (continued)
Linear Programming Sensitivity Report

	A	B	C	D	E	F	G	H
6	Adjustable Cells							
7				Final	Reduced	Objective	Allowable	Allowable
8		Cell	Name	Value	Cost	Coefficient	Increase	Decrease
9		$B$6	Sticks Produced	100	7	34.99999998	1E+30	6.799999983
10		$B$7	Bats Produced	36	-	47	11.3333333	47
11								
12	Constraints							
13				Final	Shadow	Constraint	Allowable	Allowable
14		Cell	Name	Value	Price	R.H. Side	Increase	Decrease
15		$G$6	Machine 1 Minutes	1,180	-	2400	1E+30	1220
16		$G$7	Machine 2 Minutes	2,400	2	2400	350	1E+30
17		$G$8	Machine 3 Minutes	1,108	-	2400	1E+30	1292
18		$G$9	Assembly Minutes	2,072	-	2400	1E+30	328

Critical Limitations of Linear Programming.

When comparing LP and TOC models, you should note that LP is strictly a mathematical formulation of a business setting. It is important to understand, however, that TOC (with the support of throughput accounting) is a comprehensive management tool that addresses many realities of process management that are difficult to incorporate within a strict mathematical model. For instance, the realities involved in applying constraint management include the following:

1. The dependence of operations on one another.
2. The potential for idle times on both constrained and unconstrained operations.
3. The need for buffer inventory stocks to manage dependencies and idle times within the system.

To be specific, simple LP mathematical models, such as the model shown in Exhibit 15, do not incorporate the fact that hockey sticks and baseball bats have to be produced in a particular sequence. For instance, the assembly operation at Weston Company is not a bottleneck, but it is highly dependent on all the proceeding operations. Hence it may be unnecessarily idle while waiting for another operation to complete its work on in-process inventory. In fact, the potential for excessive idle time at the assembly operation could actually create a real problem in the system. Notice in the LP solution in Exhibit 15 that assembly has only 328 minutes of slack. This slack time represents the total number of minutes that assembly can be idle during the week. Otherwise, the LP solution becomes invalid as the bottleneck shifts to the assembly operation.

Essentially, the challenge in using LP solutions is one of scheduling. Implementing the LP solution at Weston Company requires the use of buffer stocks and careful scheduling to avoid expensive idle time. The TOC management system addresses these issues using the drum-buffer-rope scheduling system.

The drum-buffer-rope concept of TOC is critical to implementing, managing, and realizing the solution described in Exhibits 12 and 15. Reconsider the production process at Weston Company as displayed in Exhibit 9. Clearly, Weston needs to establish a buffer of

aluminum inventory in front of Machine 2 to ensure that fluctuations in ordering and receiving direct materials do not cause the bottleneck to be idle. Further, Weston needs to establish a good rope schedule with its aluminum supplier to ensure that aluminum is received in enough time to keep the buffer inventory from becoming either too large (expensive) or too small (risky). However, creating a production schedule (the drum) in the company that will keep the assembly operation from becoming a bottleneck is most critical.

Note in Exhibit 9 that each machine works on parts for both hockey sticks and baseball bats. Should Weston Company produce all 100 hockey sticks first and then produce the 36 baseball bats? Alternatively, should baseball bats be produced before hockey sticks? Is it best for the machines to alternate between producing bats and sticks? Determining the correct production order prevents assembly from exceeding its slack time limits and impeding Weston's goal of producing 100 hockey sticks and 36 baseball bats each week.

What if Weston decides to produce 36 baseball bats before beginning production on the 100 hockey sticks? Do you see how it will take 25 minutes for the baseball bat work-in-process inventory to arrive at assembly (Machine 2 works for 15 minutes on a shaft and then for 10 minutes on a handle cover)? Once the in-process inventory arrives, assembly works for two minutes to complete the baseball bat. Assembly must then wait for 23 minutes before it has the materials needed to assemble another bat.[18] Hence producing 36 bats will result in approximately 828 minutes of idle time in the assembly operation (36 bats x 23 minutes per bat idle time). Remember that the LP solution in Exhibit 15 indicates that assembly has only 328 minutes in idle time available. Producing all the baseball bats first will not allow enough time for Weston to complete production of 100 hockey sticks. The amount of overtime required when Machine 2 is dedicated to producing only baseball bats clearly suggests that Weston cannot simply switch the production schedule to produce the 100 hockey sticks before producing the 36 baseball bats.

What if Weston decides to rotate production of hockey sticks and baseball bats on Machine 2 (the bottleneck operation)? Specifically, Weston will use Machine 2 to produce a hockey stick and then use Machine 2 to produce a baseball bat. In this manner, assembly will be able to switch back and forth, assembling hockey sticks and then baseball bats. This idea makes sense because assembly may be able to use idle time waiting for baseball bats to assemble hockey sticks. Testing this potential schedule (a challenge requiring a complicated simulation analysis either in Excel™ or in some other software program) is beyond the purposes of this module. Nevertheless, a separate analysis of this proposal reveals that Weston would able to produce all 36 bats using this schedule. However, the end of the week would arrive just as assembly begins work on about the 85th hockey stick.

It appears that the LP solution is invalid. In fact, because of interdependencies of operations and potential idle times, LP-based solutions for some processes are not valid. However, further study reveals a number of potential scheduling solutions that will allow the Weston to produce all 100 hockey sticks and 36 baseball bats. Successfully implementing one of these schedules requires the management of buffer inventories and careful adherence to the drum production schedule by all non-bottleneck operations in the system.

In contrast to TOC, LP does not act as a management tool. Determining the mathematical solution to a constraint problem is one thing; implementing that solution into an actual organization is an entirely different matter. With throughput accounting as its information system, TOC uses the five-step model to implement a solution to process constraints and then manages the process with the drum-buffer-rope system.

[18] Assembly has to wait only 23 minutes (rather than 25 minutes), since Machine 2 began working on a new bat while Assembly completed the current bat.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what is done such as the several things needed to load a truck with goods to be shipped, or responding to a customer complaint. (See Process diagram.)

Activity-Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost needed to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object Any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Competitive Analysis Tools that enable companies to quantify how performance and costs compare against competitors, understand why performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Culture The collective values, beliefs, ethics, and mindsets of the members of an organization, clan, or society which is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

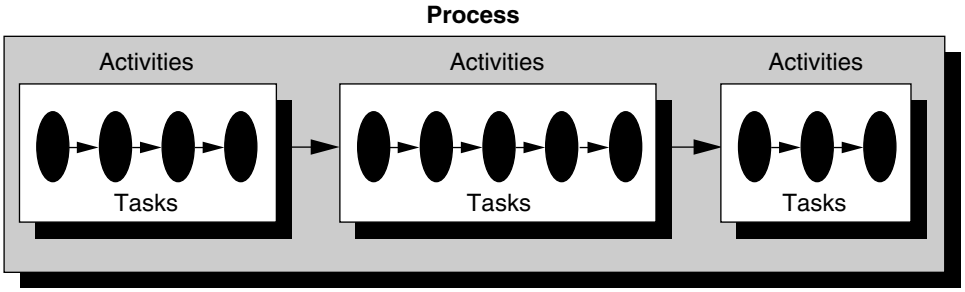
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. The property taxes on a factory building is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Value Chain (See Extended Enterprise.)

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES

1. Self-test questions.

a. Define a constraint and list several factors that can cause fluctuations in production.
b. List the three bases of competition for an organization that may be challenged by constraints and process fluctuations. Describe a potential problem for each.
c. What is the drum-buffer-rope system? Describe the function of the three components and discuss the importance of each.
d. What are the five steps in the TOC process?
e. List the different types of constraints and give at least two examples of each.
f. How does one elevate a constraint?
g. Is it possible to be free from constraints? Why or why not?
h. What is throughput accounting? Where is the focus in this type of accounting (short term, long term, etc.)?
i. How does TOC define throughput and operational expense? How is this different from the traditional accounting definitions?
j. Can throughput-focused statements be used for GAAP purposes? Explain.
k. What are some of the possible consequences of piling up work-in-process inventory?
l. Should GAAP-based statements be used for managerial purposes? Explain.
m. How can slack time be beneficially used in a "lean" manufacturing situation?
n. What are the two main technical aspects of TOC accounting, and how can an organization benefit from them?
o. What are the four critical behavioral aspects of TOC accounting, and why are they critical?
p. What adjustments are necessary to an organization's culture for TOC accounting to be successful?

Short Exercises.

2. Risenmight Woodcrafters, Inc., manufactures desks. Each desk sells for $400 and contains materials totaling $100. Salaries, insurance, and payroll taxes are $750, supplies expense is $200, and miscellaneous expenses are $2,200. Risenmight sells 50 desks.

Required:

Calculate throughput, operating expense, and profit for Risenmight.

3. "I thought JIT was the way of the future," Paulo grumbled as he looked down at the production floor that he managed. "But we still have piles of inventory building . . . no matter how hard we try to eliminate them!" Swen, Paulo's assistant manager, racked his brain for a solution that had not yet been tried. Then he remembered a conversation he had with Kjirsten, the division manager, at the last division meeting. "Paulo, do you remember Kjiersten talking about that book . . . *The Goal*?" Swen asked. "Yes, something about bottlenecks and drums. What about it?" "I think she might be able to help us solve our inventory problem."

Required:

As Kjiersten, explain to Paulo and Swen why JIT may not be working in their plant. Be sure to explain the merits of JIT, as well as compare and contrast JIT and TOC.

4. "Anya, we have to manage our inventory better!" Trevon, plant manager at Durhamite Co., said to one of the floor supervisors. These high levels of inventory have to be hurting our profitability. We are not concentrating on throughput."

"Well," Anya replied, "I talked to Collin in accounting, and he showed me the numbers—look. Our sales are constant at 40 units a month, and for the last three months we have produced 40, 50, and 80 units. Our revenue is $2,800 per unit, our materials costs are $1,000 per unit, and our conversion costs are stable at $80,000 per month. The numbers work out so that we do better, profitwise, when we increase inventory."

Required:

As Anya, prove to Trevon (by preparing a GAAP-based P&L statement) that building inventory is profitable. As Trevon, prove to Anya that building inventory is detrimental to Durhamite. Prepare a P&L statement based on throughput and explain the contradiction with GAAP-based results. Assume that selling, general, and administrative expenses are constant at $7,500 per month.

5. Classify the following as process, policy, material, or market constraints. In addition, categorize each constraint as internal or external.

a. Oil embargo.
b. Freeze on overtime.
c. A false press report curtails consumer desire for the product.
d. A key bank service starts becoming obsolete.
e. Consumers are unaware of a product's capability.
f. Company restrictions on equipment purchases.
g. One machine works slower than the rest.
h. Parts must be treated before they can be installed.
i. Frost in Florida (to an orange juice producer).
j. Management has preestablished batch sizes on all machines.
k. Extensive special training is required to work on certain types of consulting contracts.
l. State regulations limit the number of driving hours for heavy-equipment operators.
m. Union contracts strictly limit the categories of equipment that workers can operate.

6. Why do we need all these different accounting systems? Marcus asked himself as he left the accounting department of Ohrano Theater Supply, Inc. As manager of the production floor, Marcus is responsible for providing the accounting department with the monthly figures from his department. He had just learned that Ohrano was going to implement a new constraint management system, and he now has to keep track of even more numbers than before. He decided to talk to Marina, Ohrano's controller, to see whether there was a simpler way. All this number chasing is taking away from his time on the floor.

Required:

As Marina, convince Marcus that one system is not a replacement for the other. Explain the differences between throughput accounting and conventional accounting, as well as the needs for each.

7. "You mean to tell me that these machines are supposed to just sit there?!! And those machine operators—what do they do while their machine is down for two hours?" Jake Michaels, plant supervisor for GreenCo, was meeting with the vice-president of production, Karen Wendell. Wendell had been assigned by the board of directors to implement TOC in production—starting with Michaels' plant. So far, it was not going well.

Required:

As Karen Wendell, explain to Jake Michaels why it is not beneficial to have all resources operating at full capacity. Provide some alternative performance measures that can replace the traditional efficiency variances.

8.

Pizanno Enterprises
GAAP-Based P&L Statement
For the Month of January 2001

Sales Revenue		$100,000
Cost of Goods Sold		(50,000)
Gross Margin		$50,000
Period Costs		
Selling Costs	$15,000	
Gen. Admin. Costs	20,000	
Total Period Costs		(35,000)
OPERATING INCOME		$15,000

Additional Information:

a. Sold 1,000 units (assume inventory levels and product costs per unit are constant between the current month and last month).
b. Cost of Goods Sold includes direct materials costs of $25 per unit, direct labor costs of $10 per unit labor, variable overhead of $5 per unit, and total fixed overhead of $10,000.
c. Other than a 5 percent commission on sales revenues, selling costs are all fixed.
d. General Administrative costs are 80 percent fixed.

Required:

Prepare a P&L statement following traditional contribution margin format. Prepare a second P&L statement according to TOC concepts.

9. Li Teng, CEO of Xing Xin Information Systems Consulting Group, has recently implemented TOC in his company. As soon as the program began, Li realized that the traditional performance measures were no longer consistent with company goals.

Xing Xin specializes in database system installation. A typical engagement consists of six major tasks as follows:

1. Establish specific needs of client.
2. Analyze current system.
3. Design new system.
4. Implement new system.

5. Transfer old data to new system.
6. Test and evaluate new system.

Through TOC, Li discovered the process bottleneck at step 5. Only one of Xing Xin's consultants, Yinlien Zhou, is qualified to test new systems. Hence, Yinlien must be involved in step 6 for all client engagements. In addition, Yinlien has her own clients with whom she works throughout the engagement.

Required:

Devise some performance measures that will improve throughput performance at Xing Xin. Also give recommendations as to what can be done to increase the effectiveness of the system installation process.

10. DoubleSet Company is a manufacturing organization that produces two products, Trinidad and Maser. The manufacturing process for each product is basically a two-step operation involving three employees. Bob performs a preliminary manufacturing step on Machine A for each of the two products produced in the DoubleSet Company. It takes him five minutes to complete a product on Machine A. Naomi then operates Machine B for 20 minutes to complete each Trinidad product. Similarly, Luis operates Machine C for 20 minutes to complete each Maser product. All three employees work eight-hour days. Thus, they each have 480 minutes of daily processing time available to them (8 hours × 60 minutes). Assume now that both products provide $100 of throughput per product. The table below describes the setup necessary to perform an LP solution for DoubleSet Company.

			Minutes per Trinidad	Minutes per Maser	Total Minutes	Daily Ceiling
Trinidads produced						
Masers produced						
Trinidad throughput	$100	Machine A	5	5		480
Maser throughput	$100	Machine B	20	0		480
Total throughput		Machine C	0	20		480

Required:

Input the data above into an LP software such as Microsoft Excel™ and compute the optimal answer and sensitivity analysis. Identify the bottleneck(s) from the LP solution.

11. For each of the following situations, answer these three questions:

a. What is a likely constraint in this situation?
b. How would you manage this costraint using a buffer, a rope schedule, and a drum schedule?
c. How might you elevate the constraint?

Situation 1: Issuing drivers' licenses at the county traffic office (think about how the process worked when you received your first driver's license).

Situation 2: Compiling tax returns for clients at a local H&R Block company (compiling client tax returns includes operations such as client meetings, record compilations, and work review by supervisors).

Situation 3: Teaching long division to a class of eight-year-olds (assume the general procedure is to teach the class, individually work with students, assess the class, and work with the remaining students who do not adequately understand the material).

Comprehensive problems.

12. Bogeeta, Inc., manufactures two products—bicycles and skateboards.[19] For each bicycle sold, the company receives $95. For each skateboard sold, it receives $65. Each bicycle requires 10 minutes of Gordy's time, 15 minutes of Kelly's time, 8 minutes of David's time, and 10 minutes of Beckie's time. Each skateboard requires 10 minutes from Gordy, 20 minutes from Kelly, 15 minutes from David, and 20 minutes from Beckie. Each worker at Bogeeta works 40 hours per week, and no overtime is allowed. Raw materials cost $40 for each bicycle manufactured and $25 for each skateboard. Demand is unlimited, as is the supply of raw materials. Factory overhead for the plant is $6,000 per week, including the wages for Gordy, Kelly, David, and Beckie.

Required:

How many bicycles and skateboards should Bogeeta manufacture this week assuming there is unlimited demand for bicycles and skateboards? What is the optimal profit provided by this schedule?

13. Consider the Bogeeta, Inc., manufacturing situation presented in the preceding problem. Assume that the production requirements for its two products—bicycles and skateboards—are unchanged. However, assume that Bogeeta is able to sell only 110 bicycles and 50 skateboards each week. Further, Bogeeta's marketing manager has recently received a request from an exporter to purchase all the bicycles the company can provide at a reduced price of $50.00 per bike. Since these bicycles will be shipped overseas, the sale to the exporter will not affect Bogeeta's current local market demand of 110 bicycles weekly.

Required:

Part 1: Before considering the overseas bid for a special purchase, compute the optimal solution for Bogeeta given the limited local market demand for bicycles and skateboards. What is the net profit of the firm with this strategy?

Part 2: In light of your solution to Part 1, analyze the overseas bid. Should the company accept the bid? If Bogeeta accepts, how many bicycles should be produced for domestic sales, how many bicycles should be produced for the exporter, and how many skateboards should be produced? What is the net profit of the firm with this new strategy?

14. Part 1: The Rochester plant manufactures three miniature television products that are distinguished by their screen sizes: 3, 5, and 6 inches. Market demand over the next week, unit sales prices, and costs of direct materials per unit are provided in the following diagram. Weekly labor costs are estimated to be $62,000. Weekly manufacturing overhead costs are budgeted at $130,000. Selling and general administrative costs are $75,000 each week. Rochester runs a 80-hour work week (two 40-hour shifts per week) and tries not to schedule any facilities to work overtime.

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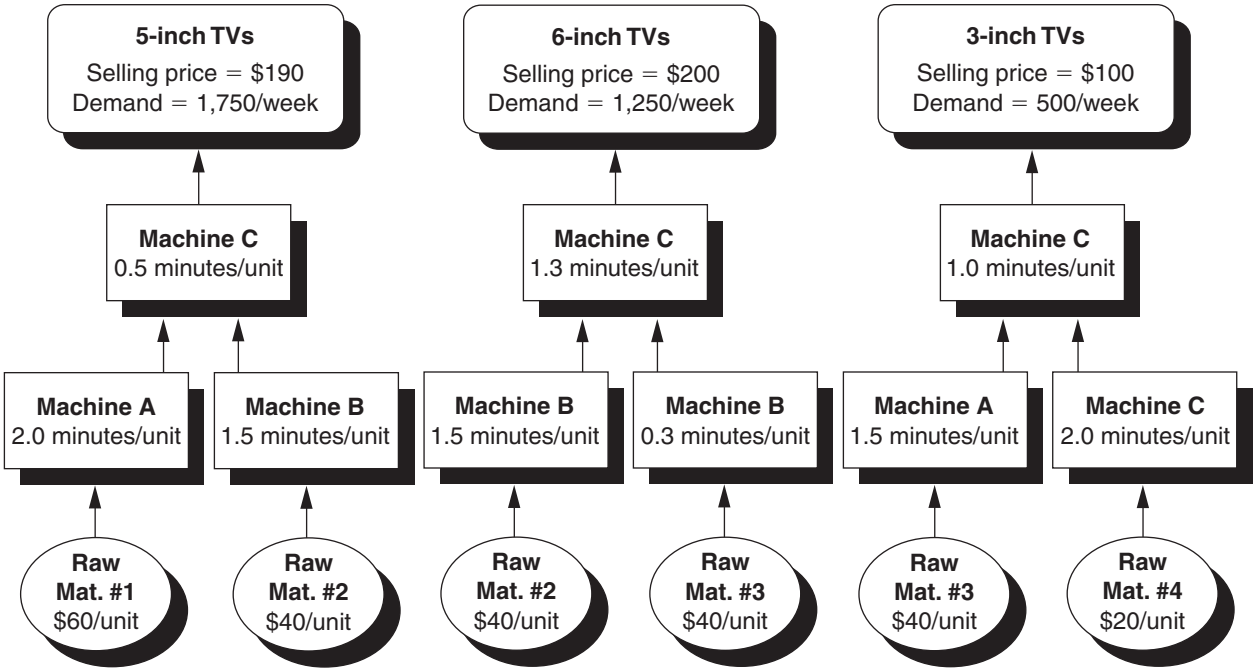
[19] The authors gratefully acknowledge material provided by Professor Sid Sytsma of Ferris State University in the preparation of Problems 12, 13, and 14.



Required:

Determine the optimal production mix to maximize profit over the next week at Rochester.

Part 2: Assume that the production mix you establish in Part 1 is achieved over the next week. As a result of realistic issues involving production sequencing and scheduling, actual operating minutes for each machine during the one-week period are as follows:

	Machine A	**Machine B**	**Machine C**
Actual Operating Minutes (for two weeks)	4,572 minutes	4,856 minutes	4,402 minutes

Required:

First calculate an efficiency variance for each machine using the following formula:

Total actual production in units
× Standard minutes per unit
Total standard minutes allowed
− Total actual minutes
Efficiency Variance

Plant management at Rochester is concerned that each machine should always be operating at peak efficiency. Management is also concerned about the fact that Machines A and C are not operating at their capacity of 4,800 minutes per week (i.e., they appear to have excess capacity). Using your insight regarding how TOC is used to separately manage

bottleneck and non-bottleneck operations, how would you help the Rochester management adjust its assessment of each machine operation to be consistent with throughput accounting? Be sure to discuss specifically how to interpret the efficiency variance calculated on each machine, as well any excess capacity.

15. Fashionable Bikes, Inc. (FBI) has the hottest new product on the upscale toy market—high quality boys' and girls' bikes in bright fashion colors. Due to a seller's market for high-quality toys for the newest baby boomers, FBI can sell bikes at the following throughput margins: boys' bikes—$30, girls' bikes—$50. To maintain market share focus, the marketing department recommends that at least 250 bikes of each type be produced per day. A boy's bike requires four labor hours in the fabrication department and one labor hour in the assembly department. A girl's bike requires four labor hours in the fabrication department and two labor hours in the assembly department. Currently, FBI employs 200 workers in the fabrication department and 100 workers in the assembly department in each shift. There are three 8-hour shifts per day (overtime is not permitted).

Required:

Formulate the preceding information as an LP problem. How many boys' bikes and girls' bikes should FBI produce per day to maximize throughput? Be sure to interpret any shadow prices reported by the LP software you use.

16. The U.S. Patent Office receives literally millions of requests each year to issue patents on various inventions that may be generally classified into four categories:

- ▲ *Machines* such as engines or tools.
- ▲ *Manufactured items* such as kitchen utensils or window sun shades.
- ▲ *Matter composition* such as fertilizer or toothpaste.
- ▲ *Processes* such as methods of preparing synthetic proteins.

Analyzing these patents is typically a twofold process involving application examination and patent search. The process of application examination is done essentially to determine whether the invention is *useful and nonobvious*. For example, a pen that writes in lime-green ink is probably too obvious to pass the application examination process. In addition to the examination, a patent search process is completed to determine that the inventions is *novel*. That is, an invention must be reasonably distinct from previous patents filed at the U.S. Patent Office.

Assume, for example, that inventions involving *machines* generally require two hours to complete an application examination and three hours to complete a patent search. Conversely, application examinations and patent searches on *processes* require three hours and two hours, respectively. Assume also that the U.S. Patent Office employs a specialist to handle the examination process and a database researcher trained to perform the patent searches on machines and processes. The weekly salary for the examination specialist is $1,200, and the weekly salary for a database researcher is $1,000. Each of these two professionals is available 40 hours per week. Finally, given that there is always a backlog of applications and that a high percentage of applications are rejected by the U.S. Patent Office, the management has determined that patent searches and application examinations

[20] Problem adapted from R. Verma, "My Operations Management Students Love Linear Programming," *Decision Line* (July 1997): 9–12.

must be carefully managed. Hence, in order to not waste the more expensive time of the specialist, the researcher always completes the patent search before handing off the application to the specialist for the application examination. Overall, the goal is to maximize the number of patents getting through the system each week in a context where professionals employed in the U.S. Patent Office do not work more than 40 hours per week.

Required:

1. Set up and solve this constraint using standard LP procedures.
2. Consider carefully whether the LP solution you generated is valid. What is the effect of having the researcher perform his work before the specialist is allowed to begin her work on the patent application? Would it affect the validity of your LP solution if management decided to reverse the processing order to require that the examination specialist had to complete her work before the researcher could begin his work on the application?
3. Provide some type of "what if" analysis to numerically demonstrate your position on the issue of scheduling effects on the LP solution.

Team projects.

For each of the organizational scenarios listed as team projects, discuss and determine the following questions as a group:

a. What is the goal of the organization?
b. What constraints exist? Classify each constraint.
c. How can you be sure that the critical constraint has been identified?
d. What data is needed to implement TOC?
e. What type of information would a throughput accounting system provide to measure organization's progress toward the goal?
f. What additional information and performance measures will be needed to support implementation of TOC in this scenario?

1. Organizational Scenario: The hub of a major airline.
2. Organizational Scenario: A community church or synagogue.
3. Organizational Scenario: A commercial building construction company.

Case 1: The Denver Drive Company.[21]

The Denver Drive Company is an established producer of large hard drives for use in commercial computers. Hard drives are produced in large quantities for delivery to large-scale computer assemblers or to computer parts distributors. Despite the presence of a "middleman" between the company and the ultimate end user of its product (e.g., commercial customers purchasing its hard drive units or purchasing computers containing its hard drive units), Denver Drive directly guarantees the reliability of its product.

The repair division.

The top-of-the-line drives produced by Denver Drive are typically based on the SCSI interface except for a small number that are manufactured with a proprietary interface. Basically, a disk drive consists of two major subassemblies:

[21] The authors gratefully acknowledge field-research material provided by James W. Kwiecien in the preparation of this case.

1. A head disk assembly or HDA. This assembly contains the drive motor, the heads, the disks, the actuator, and preamps. HDAs are very precise devices and must be assembled in a climate-controlled clean room to avoid any contamination that might later cause a head crash.
2. A circuit board that controls the functioning of the drive and allows it to communicate with the controller card in the computer. Given that these are high-end drives, the circuit board is powerful enough that if you simply added a keyboard, video output, and some RAM, you would have a basic computer.

Based on the highly technical nature of hard drive manufacturing, it is expected that customers will experience a small number of drive failures. As a result of Denver Drive's commitment to its customers, a dedicated repair operation was established to handle all hard drive returns. With the increasing number of drive shipments, even the tiny percentage of drives that failed soon resulted in significant levels of returns. To manage the costs of supporting the hard drive product, the terms of the warranty offered to its customers allowed replacement of failed drives with repaired and refurbished, rather than brand new, units. Also, the large number of good drives with which no problem could be found provided a financial incentive to scale up the screening and repair process. Additionally, the failure modes experienced usually resulted in a defective HDA mated with a perfectly good board, or vice versa. To discard good components just because they were mated with a defective part would not make financial sense in an industry characterized by razor-thin profit margins.

To build motivation and discipline, Denver Drive executive management used transfer pricing to establish the repair division as a profit center in the company. For every driver actually repaired in the division, it was "paid" $200. For drives determined to be NTF (that is, No Trouble Found) and simply tested and shipped back to the customer, the division received $75. Monthly operating costs (including costs of all employees) is approximately $175,000.

Failure analysis.

Hard drive failures, as reported by customers, can be categorized as one of four types (approximate percentage of instances are also noted):

1. HDA Failure—25 percent.
2. Board Failure—25 percent.
3. HDA and Board Failure—15 percent.
4. No Trouble Found—35 percent.

Failure analysis is important so that designs could be refined and future failures reduced. It was also found that many failures are customer induced, rather than being rooted in the drive itself. For example, the customer may have dropped the drive or subjected it to electrostatic discharge. In other cases, when customers had problems integrating the drive into a system, they would attempt to fix the drive themselves, sometimes even opening the HDA without the benefit of a clean room. Sometimes a drive model would not function properly with a customer's firmware, and in some instances customers just did not know what they were doing. It was also not unknown for a customer to find out that a new revision to his or her drive had been introduced and purposely damage the existing drive so it could be returned for replacement by the latest and greatest model.

The initial repair process.

The initial repair process was originally centered around experienced disk drive repair technicians. Most of these people have been working with disk drives for years and are

intimately familiar with disk drive operating characteristics and failure modes. The basic analysis and repair process was as follows:

- ▲ Disk drive arrives, is checked against outstanding repair and maintenance agreements, and is entered into the database. At this point the drive is inspected for misuse or physical damage.
- ▲ Technicians are scheduled to work on specific drive models by production control.
- ▲ Technician diagnoses drive.
- ▲ If no problem is found with the drive (i.e., NTF status), it is sent forward to have test code loaded into memory.
- ▲ If the technician diagnoses a board problem, the drive is sent another department to have the board replaced by a lower-level employee. After board replacement, the referring technician again diagnoses the drive.
- ▲ If the technician diagnoses an HDA problem, the board is removed and the HDA sent, along with repair instructions provided by the technician, to the clean room for rework on the read/write head, platter, or actuator. Alternatively, the technician may send the HDA to the non-clean room for repair work such as redoing the servo writing on the unit. When the HDA rework and repair is completed, it is mated up with an available board and retested.
- ▲ Once the technician feels that the drive is functioning properly, it is sent forward to have test code loaded into memory. If it fails to properly accept and hold the test code, it is returned to the technician for more diagnostic work.
- ▲ The drive is then mounted on a large computer cabinet where it tests and calibrates itself using the test code. This test can take from 12 to 40 hours to complete depending on the performance level and capacity of the drive. Currently the division has three self-test cabinets (each cabinet holds 70 units).
- ▲ If the drive passes the self-test and calibration on the cabinet, it is sent forward to be loaded with customer code. If it fails to properly accept and hold the customer's code, it is returned to the technician for further diagnostic work.
- ▲ After being loaded with customer code, the drive is labeled, packaged, and shipped back to the customer.

Other than new circuit boards, there is actually very little substantive materials cost in the repair process. The repair division is charged $50 for each circuit board it uses.

The initial efforts to increase production at the repair division.

The initial repair process described above was slow, inefficient, and expensive. The 21 technicians were able to process through an average of two drives per day, four if they were lucky. Turnaround times were so long that often the products became obsolete before they could be repaired and returned to the customer (this obviously was a source of constant irritation between Denver Drive Company and its customers). Average shipments ranged between 30 and 50 units a week. The backlog of drives waiting for technician analysis sometimes ranged as high as 1,000 units. Hence the repair division sometimes purchased new drives from the manufacturing division for emergency replacements for priority customers. Since the production line was straining to fill new customer orders, this practice sometimes had major effects on the company's ability to meet production schedules.

It was at this point that Todd Kinney was hired as a specialist to work on the problems in the repair process at Denver Drive. His initial assignment was to hire more technicians. He did, and output went up a bit, just a little bit. The learning curve for new technicians proved to be very steep. Throwing people at the process just did not increase output very

much. Further, the monthly cost to employ a technician was $3,200. A new engineering manager for the division was transferred in from another division to work with Todd. The new engineering manager was serious about improving production.

It was obvious to Todd and the engineering manager that one of the division's problems, in large part due to the circular nature of the process, was the flow of units under repair. The engineering manager decided that this was a major problem (it was) and that they should revisit the layout of the production area to improve efficiency. Todd was given the responsibility of getting it done and was removed from his fire-fighting role so he could take a closer look at the process. Although he inherited the mindset that the technicians were the key to the process, after a few days of observation and study, Todd realized that there were really two bottlenecks in the system. The obvious one was the technicians. The other one was the self-test and calibration process. Every time a technician diagnosed a drive, it would eventually end up at the test cabinets. These cabinets occasionally fell behind the analysis and repair process. Hence, even if Todd and the division manager could substantially increase the output from the technicians, the three self-test cabinets were insufficient to handle an increased volume of units. This situation reminded Todd of a book he had intended to read several years earlier, *The Goal* by Eliyahu Goldratt and Jeff Fox. He went home that night and started reading the book.

Required:

1. Create a diagram of the initial repair process based on the preceding description. Does Todd Kinney appear to have a reasonable grasp of the constraint issues in this process?
2. Using the transfer price and cost data in the case, try to reasonably piece together some type of a monthly throughput margin P&L statement for the current process. You will likely need to make some approximations and assumptions here.
3. Consider the five-step TOC process (identify the constraint, exploit the constraint, subordinate all non-constraint operations, elevate the constraint, and identify the next constraint). The first step is already illustrated in the case. If you were Todd Kinney, how might you redesign the repair process to exploit, subordinate, and elevate?
4. Create a new diagram of the repair process that incorporates your ideas.
5. In light of the bottleneck operation(s) you have identified and attempted to exploit and elevate, how would you identify performance measures to subordinate non-bottleneck operations? Would performance measures need to be different for an operation that was upstream versus downstream from the bottleneck operation(s)? Why?
6. Assume that you must now present your recommendation to the controller for Denver Drive Company. This controller is an excellent accountant, but is not trained in TOC or throughput accounting. What objections might the controller have to your solution? How would you convince the controller that your solution is optimal despite some of the negative performance measures it could generate in a traditional budget system?

Case 2: Lindo's Restaurant.

"Well," thought Danilo Rictor, "I guess we find out tonight if all that work is going to pay off." Danilo stepped out of the backroom that he uses as his office, took one last turn around the his restaurant, and gave some final instructions to the line chief in the kitchen before stepping out to help the host greet some early dinner guests.

Lindo's is a favorite local restaurant offering a standard menu of southwestern cuisine. In the 12 years since it first opened its doors, Lindo's has become one of the more popular

restaurants in the city. Danilo Rictor, the restaurant's owner/manager, has built a successful business around a tasteful menu and a firm policy of absolute customer service and satisfaction. In addition, Danilo focuses a lot of attention on making sure his staff is happy and enjoying their work. Paying his servers and kitchen workers a bit more than the market wage rate helps. However, Danilo found that the real key to employing an effective and enthusiastic staff is to provide good training, allow workers to manage themselves whenever possible, and create excitement with frequent productivity contests.

Essentially, there are two categories of employees at Lindo's—the guest staff and the kitchen staff. The guest staff includes hosts, servers, expediters, cashiers, and busers. Hosts greet the guests, assign seating, and introduce the server. Servers take orders, deliver food and beverages, and take care of guest payments. Expeditors stand ready to assist servers. If tables need to be rearranged, if large trays of food need to be delivered, or if the server falls behind in any way, an expeditor is expected to jump in and assist. Cashiers prepare the guest invoice (i.e., the check) for the servers. Servers then return with guest payments, and cashiers enter payments into the register and prepare the receipts. Busers clear and prepare the table after guests depart and then notify the hosts when tables are available.

The kitchen staff includes preparers, line cooks, fajita cooks, restockers, and dishwashers. Preparers work from 6:00 A.M. to 11:00 A.M. each day to complete most of the food preparation work. Preparers make ready large containers of fresh sides and garnishes such as chopped lettuce, grated cheese, and sliced tomatoes. More important, preparers create most of the entrees (main dishes) and hot appetizers. These items (such as enchiladas, burritos, and rellenos) are cooked to near completion and placed in a large walk-in cooler. One dishwasher works along with the preparers to ensure that the kitchen is in order when the rest of the kitchen staff begins arriving at 11:00 A.M. to service the day's customers, beginning with the lunch crowd. The process of servicing customer orders revolves around the three line cooks, with one of the line cooks acting as kitchen supervisor. Servers bring orders from the customers to the kitchen, and the line cooks fill the orders by removing appetizers and entrees from the cooler and quickly finishing the cooking process in large ovens. Fajita's cannot be precooked effectively. Hence, a fajita cook is dedicated to assembling all fajita orders as they come to the kitchen. As hot food items are completed, they are garnished with cold items (such as lettuce, tomatoes, and sauce). Two restockers stand ready in the kitchen to ensure that all the fresh sides and garnishes are available to the line cooks. In addition, restockers are in charge of preparing all sodas and specialty drinks ordered by customers. (Lindo's does not have a liquor license and, therefore, a bartender is not employed.) Three dishwashers work with the rest of the staff to keep clean utensils and dishes available to the rest of the kitchen staff.

As a result of Danilo's focus on customers and his successful work with his staff, Lindo's weekday lunch hours and weekend evenings are extremely busy. Analysis of the revenue flows indicates that 80 percent of revenues comes into the restaurant during these time periods. Hence, effective management of revenue resources is critical to improving profits. It is clear to Danilo and his management accountant that table turnover (measured as the number of tables cleared by the staff and available for guest seating each hour) is an important indicator that guests are being served promptly and that limited seating is being used effectively to generate restaurant revenue. Danilo's management accountant identified five critical operations in the process of serving the guest: (1) greeting and seating, (2) order taking, (3) dinner service, (4) check and payment, and (5) table cleanup and preparation.

It is clear to Danilo that there are a number of potential constraints on getting guests served. Danilo recently read *The Goal* as the result of attending an executive lecture at the local community college. He involved his chef, his head server, and the supervising

receptionist to help him implement a TOC system at Lindo's. After quite a bit of effort, Danilo's team was able to make some significant improvements in the business. The results of their efforts to implement the five-step TOC process are as follows:

1. *Identify the constraint.* Danilo and his management accountant were able to quickly identify the line cooks as the bottleneck in the operation. The constant pile of unfulfilled orders in front of the kitchen during the lunch hour and on weekend evenings, coupled with frequent complaints from customers about wait time, made this first TOC step rather obvious.
2. *Exploit the constraint.* Hiring and training more line cooks is difficult and expensive to do. Besides, Danilo was convinced that he should first fully exploit this constraint before spending a lot of money to elevate it with additional line cooks staff. By involving the line cooks in the analysis, Danilo learned that they were often forced to wait because the restockers did not have garnish and side items available. A little more analysis revealed that restockers were spending too much time working on specialty drinks and did not pay enough attention to supporting the line cooks. Some training and new kitchen policies were enough to keep the critical line cooks constantly busy.
3. *Subordinate all nonconstraint processes.* Danilo's management accountant set up a drum-buffer-rope schedule to emphasize the importance of the line cook operation. It was quite clear to the accountant that endlessly piling up lunch and dinner orders in front of the line cooks was, at least, pointless and too often resulted in confusion in the kitchen. With a little experimentation, an appropriate buffer of kitchen orders was established to ensure that line cooks were not overwhelmed without risking unnecessary down time. A rope scheduling system was established to hold back the servers from bringing in orders too fast to the kitchen. Essentially, the kitchen would turn on a small subtle light in the restaurant to indicate that its buffer was full. When the light was on, servers were expected to slow down the flow of orders by using free specialty drinks to keep the seated customers happy. When the light was off, servers were free to bring orders to the kitchen. A drum system was established to ensure that an order never sat undelivered for more than one or two minutes once it was ready. The signal for this system was the presence of prepared orders on the order-out counter. Because servers could be anywhere in the restaurant when the kitchen completed an order, the expediters were assigned ultimate responsibility to watch this signal. If orders were ready, expeditors were expected to serve. This drum system eventually required a small increase in the number of scheduled expeditors during busy times.
4. *Elevate the constraint.* Once the capacity of the line cooks had been fully exploited and all non-bottleneck operations completely subordinated to the needs of the line cooks, Danilo found it unnecessary to elevate the kitchen capacity. Even during the busiest times, Lindo's always served its guests promptly.
5. *Identify the next constraint.* With the kitchen process now optimally working, Danilo and his management accountant thought their TOC efforts were completed. However, Danilo continued to be bothered by the all-too-familiar backlog of guests waiting to be seated for the business lunch hour and for weekend dinner. The result of kitchen process improvement further enhanced the reputation of Lindo's, creating an even larger demand for seating during critical busy time periods. Danilo knew that he was serving his customers as fast as possible and that it didn't make sense to somehow pressure his customers to eat faster. Danilo's accountant observed that it appeared that customers often had to wait for their checks or for their receipts. Danilo wondered if perhaps there was another bottleneck in his restaurant.

Questions.

1. Diagram the restaurant process. Are there one or two processes in the restaurant? If there are really two processes, show the interdependencies in your diagram.
2. What could be the source of the next bottleneck now appearing in the restaurant? Describe how to use the five-step TOC process to improve (i.e., "break") this new bottleneck operation.
3. Assume that you are able to break the new bottleneck and the constraint shifts back to the line cook operation. What are some possible things Danilo could now do to elevate this constraint? Try to prioritize your ideas according to ease of implementation.
4. Assume that all the TOC-based improvements have resulted in a significant increase in the average number of customers served. However, the standard cost accounting system that Danilo's management accountant had installed when the restaurant first opened is now generating some negative efficiency variances. Specifically, it shows large increases in hours paid for expeditors and cashiers, as well as a smaller increase in hours paid for restockers. This percentage increase is larger than the percentage increase in customer volume, resulting in negative efficiency variances. Danilo is wondering whether the TOC system is creating an unanticipated problem in the process. Respond to this concern in light of the effect of TOC on traditional accounting systems.
5. The restaurant business has some unique aspects respecting personnel scheduling, specifically with respect to servers. Typically, servers make the bulk of their income based on tips. As the flow of customers declines and tables are empty, then servers have a significant decrease in their average hourly wage. Hence, Lindo's, like most restaurants, will release servers to go home as customer flow declines. Could this aspect of the restaurant industry affect the way throughput margin is measured in a throughput accounting system? Why?

NOTES

M O D U L E

Activity-Based Budgeting*

Version 1.0

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*This module is best used with a spreadsheet titled True Sound. Users can download a free copy of this spreadsheet from the modules homepage: http://www.mhhe.com/business/accounting/modules. A disk copy is available on request.

Module Contents
Activity-Based Budgeting

Activity-Based Budgeting

DYING OF SUCCESS

It was a small story on the inside page of the business section of the local newspaper that caught Imran Ali's attention. The short headline read: "Medical Tools files for bankruptcy." Ali was surprised and shocked. He knew Dr. Hussain Malik, the physician who had founded Medical Tools. They were high school friends who had immigrated to the United States for higher education. Ali had joined Electronic Peripherals, a major manufacturer of computer components, after finishing his engineering degree. He was currently the general manager of its speaker division. Dr. Malik got his degree in medicine and worked for several years as a surgeon. He invented and marketed the XPZ bone spreader through his company, Medical Tools. The spreader won the "New Medical Product of the Year in 1995" and got rave reviews from surgeons.

Later that day Ali called his old friend. He wanted to know what had gone wrong. Ali's concern was sparked by the similarity he saw with his own situation. Like Medical Tools, his own division's current success was due to a new product—computer speakers. His conversation with Dr. Malik was very instructive. Dr. Malik told Ali: "The real tragedy is that Medical Tools died from success. I did not understand the need to develop a plan or a budget. Sales were growing rapidly, and we could not keep up with new orders. My accountant kept telling me, 'Dr. Malik we need to do some budgeting or you could have problems.' But I was just too busy. Then last month the bottom dropped out. I realized too late that in my enthusiasm for what seemed to be our growing success we had not planned our cash needs. Our cash collections were not timely. We had tied up cash in areas that were not productive and had spent cash for activities that were not central to our future growth and profitability."

▲ BUDGETING AND THE STRATEGIC TRIANGLE

A budget is a quantitative and financial plan that forces organizations to focus their work activities and resources on achieving their strategic goals of providing customers with quality products, at a reasonable cost, in a timely manner. It is a vehicle for obtaining agreement and commitment to pursue common objectives and for directing future spending on items essential to meeting these objectives.

- ▲ **Quality.** A good budgeting system ensures that organizational units plan to have the necessary resources available and use them to meet the features and performance levels customers want from their products and services.
- ▲ **Cost.** Most organizations have limited resources. The budget process helps organizational units to tradeoff between alternative uses of resources and to manage work activities in a cost-effective manner.
- ▲ **Time.** The budget process coordinates organizational actions. It forces organizations to consider the rate and timing of activities and actions. This process assures that resources are available when needed.

▲ PURPOSE OF THIS MODULE

This module focuses on the annual budget, which is an important element of the overall budget process. The discussion illustrates the strategic importance of budgeting and identifies the technical, behavioral, and cultural properties of the annual budget.[1] After studying this module, you should understand:

- ▲ The strategic context of the annual budget.
- ▲ The overall annual budget process in organizations.
- ▲ The detailed processes of building an annual budget.
- ▲ The conversion of budgets into financial statements.
- ▲ The properties of a good budget process.

▲ STRATEGY AND ANNUAL BUDGETING

Annual budgets link an organization's long-term strategy and its daily activities. Long-term business strategy defines the markets a firm plans to enter and the customers it plans to target. Annual budgets focus on operating activities and decisions in the next 12 months that implement the long-term plan.[2] The annual budget provides a specific set of expectations that are the basis for comparisons with actual results.

Exhibit 1 shows the annual budget process as part of an organization's strategic process.

Business strategy.
The most fundamental element of strategic planning is selecting a business area. It is an organization's long-term vision and conception. Toyota, for example, defines its business as transportation. Currently, that means producing high quality cars. Hughes Electronics defines itself as the world's best defense electronics company. Basic business choices change, but only infrequently. Toyota may decide to enter the air transportation business, and Hughes has left the defense business and now focuses on commercial electronics.

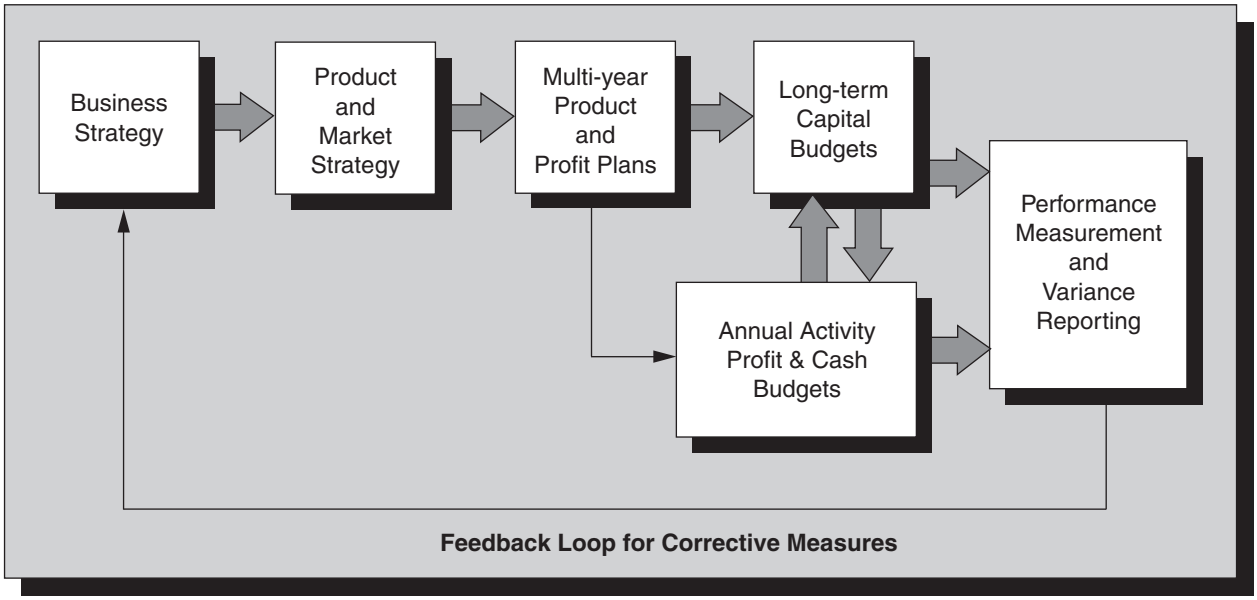
Product and market strategy.
An organization translates its general business strategy into specific markets and customers it intends to serve. Product and market strategy uses knowledge of competitors to define how a firm plans to distinguish itself from its competitors. Organizations typically make product strategy choices by understanding their environment and choosing an appropriate response to that environment. An environmental scan typically involves SWOT analysis—that is, a systematic evaluation of the strengths, weaknesses, opportunities and threats facing an organization.

Multi-year product/profit plans.
This plan translates an organization's product and market strategy into a timetable for introducing and discontinuing products. The plan also establishes expected financial returns from each product. The multi-year plan covers when to introduce new products or

[1] Other modules in this series extend the budgeting discussion to other elements of the planning and budget process such as multiperiod profit planning, long-term capital budgeting, and variance reporting.

[2] Annual budgets can be fixed for a period of time, such as a year, or they may be prepared on a rolling basis, looking out 12 months at a time. Rolling budgets are updated monthly. As each month rolls off the 12-month calendar, another is added to the budget.

Exhibit 1
The Strategic Context of Annual Budgets



new features or technology in existing products. It translates this product strategy into market share and revenue and cost projections to determine whether the chosen product strategy provides adequate profits. Modifications to the plan reflect changes in long-term strategy or changed circumstances facing a firm.

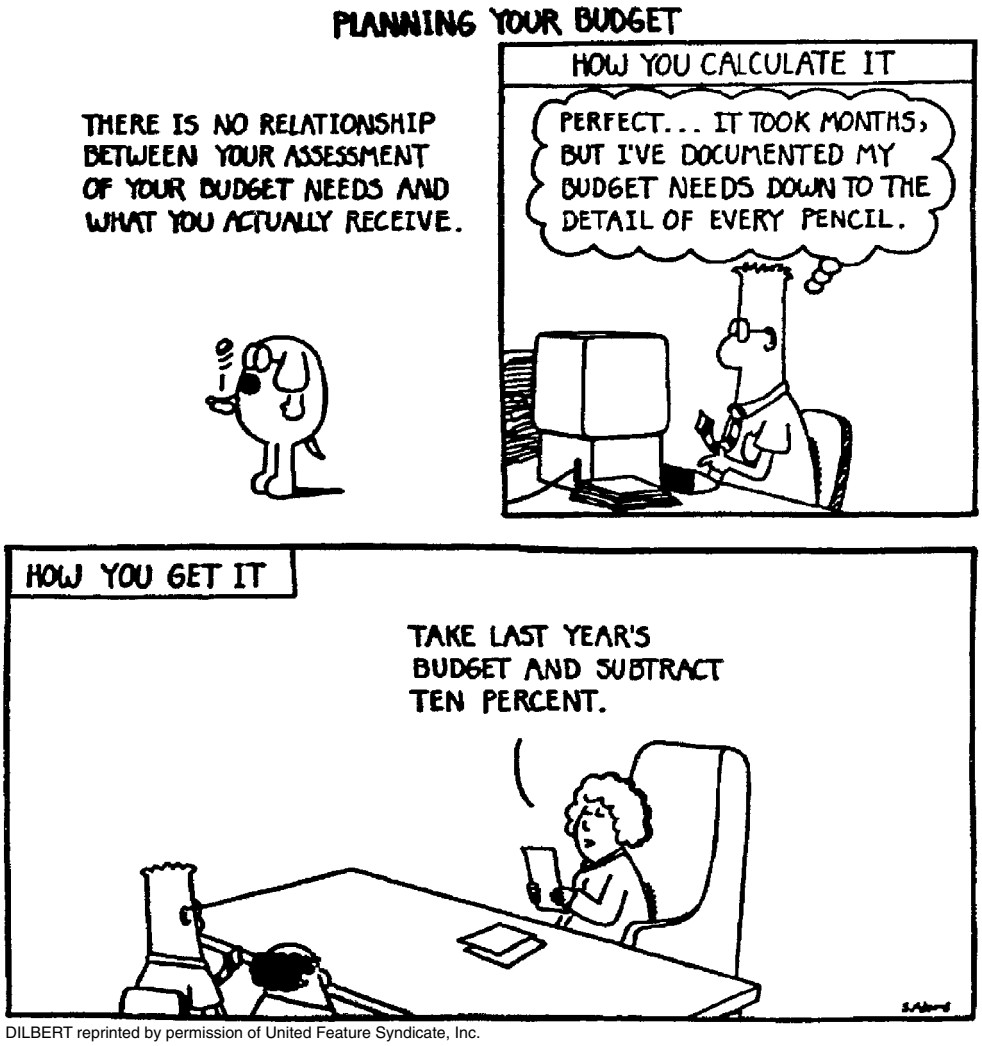
Long-term capital budgets.
Capital budgeting helps an organization evaluate and select the long-lived assets necessary to carry out its multi-year product and profit plan. Capital budgets contain funding requests for items essential for introducing new products and programs. Capital budgeting involves evaluating investments in physical assets, such as land, plant, and equipment, as well as investments in soft assets, such as training programs and research and development.

Annual budgets.
Annual budgets break down the multi-year plan into yearly targets. By dovetailing these targets with the multi-year plan and capital budgets, annual budgets keep an organization moving on its long-term strategic path. They ensure funding for goals that are consistent with the long-term product and profit objectives of a firm. The sales forecast starts the annual budget cycle. Support departments, such as production, distribution, and administration, use the sales forecast to project their own activity levels, resource and financial needs.

Performance measurement and variance reporting.
To stay on their long-term strategic path, organizations must periodically compare actual performance against budgets. The differences, called *variances* in accounting terminology, help them assess how well they are meeting their strategic goals. Variances highlight deficiencies in current operations or signal changes in the fundamental operating assumptions and conditions. The former can lead to steps to improve future results. The latter is the basis for revising future goals and objectives.

Key Point

The annual budget process is linked to the larger process of formulating and implementing strategy in an organization. Annual budget goals are part of an organization's multi-year product and profit plan.



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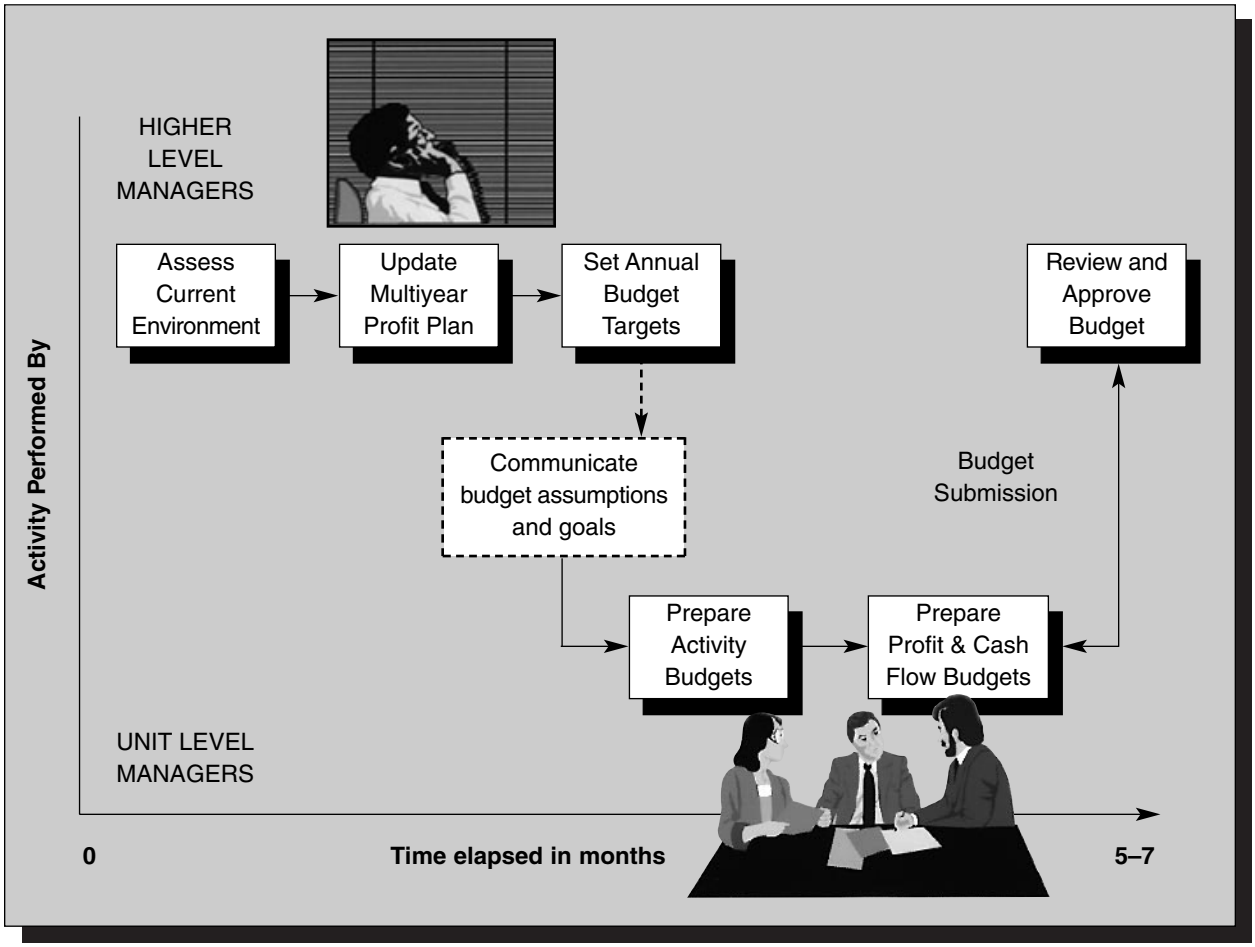
▲ ANNUAL BUDGET PROCESS—AN OVERVIEW

The annual budget process involves a series of activities that occur over a period of several months. In large organizations, it usually takes five to seven months for a full budget cycle. The process involves all functional or unit managers including marketing, engineering, production, and service. Some organizations involve all members of the organization in the budget process. The budget process has three distinct phases.

Exhibit 2
Steps in the Annual Budget Process



The **context** phase establishes common assumptions about the environment to guide budget preparation. For example, if an organization expects a low rate of inflation in the next year, all units must prepare their budgets based on this common assumption. The **preparation** phase requires detailed analyses and estimates of work activities, unused and additional capacity needed, resources required for activities, and resource prices. Detailed budget preparation also requires a consolidation of individual unit budgets into a financial statement format. Although based on historical data and future expectations, the numbers generated in the preparation phase are "soft." The **review and approval** phase consists of testing budget assumptions, identifying potential problems, devising action plans, and approving formal spending limits.

Exhibit 2 summarizes the various activities that occur in the three phases of the annual budget process, the time it takes to complete these phases, and the management level that initiates a particular phase. Students should appreciate that preparing the annual budget is an *art, not an exact science*.

Budget context.
Four activities are part of setting the budget context.

- ▲ Assess the current operating environment of an organization.
- ▲ Update the multi-year product and profit plan to reflect any changes in the environment.
- ▲ Set annual budget targets based on the revised multi-year plan.
- ▲ Communicate budget assumptions, goals, and required formats to individual managers with budget responsibility.

Budget preparation.
The budget preparation phase involves two main activities—preparation and consolidation.

- ▲ Prepare a sales (activity) forecast and use it to prepare activity budgets for all support functions. These activity budgets include estimates of resources required to carry out support activities.
- ▲ Consolidate activity budgets into profit and cash flow budgets.

Review and approval.
This phase begins with budget submission.

- ▲ Review budget assumptions and results against strategic objectives.
- ▲ Identify problems and devise action plans as needed.
- ▲ If necessary, ask for budget revisions; otherwise, approve budget.

▲ BUDGETING AT TRUE SOUND—AN ILLUSTRATION

True Sound, the speaker division of the firm Electronic Peripherals, illustrates the budget process shown in Exhibit 2.

True Sound is a two-year old division of Electronic Peripherals. The division assembles and sells computer speakers for multimedia systems. The high-quality sound is the result of a signal-processing chip designed by Electronic Peripherals engineers. These are three top officers. Imran Ali is the general manager and also oversees production. John Smith is the vice president of sales. Julie Gystner, an accountant with broad business experience, is True Sound's controller. She is responsible for general accounting, payroll, risk management, and other financial-support activities. Each officer has a good understanding of all aspects of the business.

True Sound's production is an assembly operation. The division buys and assembles four basic components (speaker cone, magnet, plastic housing, and patented amplifier) into a finished speaker using wires, attachment screws, and solders. Assembly is labor-intensive and requires simple equipment. Speakers are tested for quality and defective units are reworked.[3] Exhibit 3 shows True Sound's speaker assembly diagram.

True Sound sells and delivers its products directly to PC manufacturers, computer wholesalers, and retailers.

During True Sound's first two years, the firm worked through the teething problems of refining the assembly process, educating customers and building a distribution network. Now in its third year, it is poised for a takeoff.[4]

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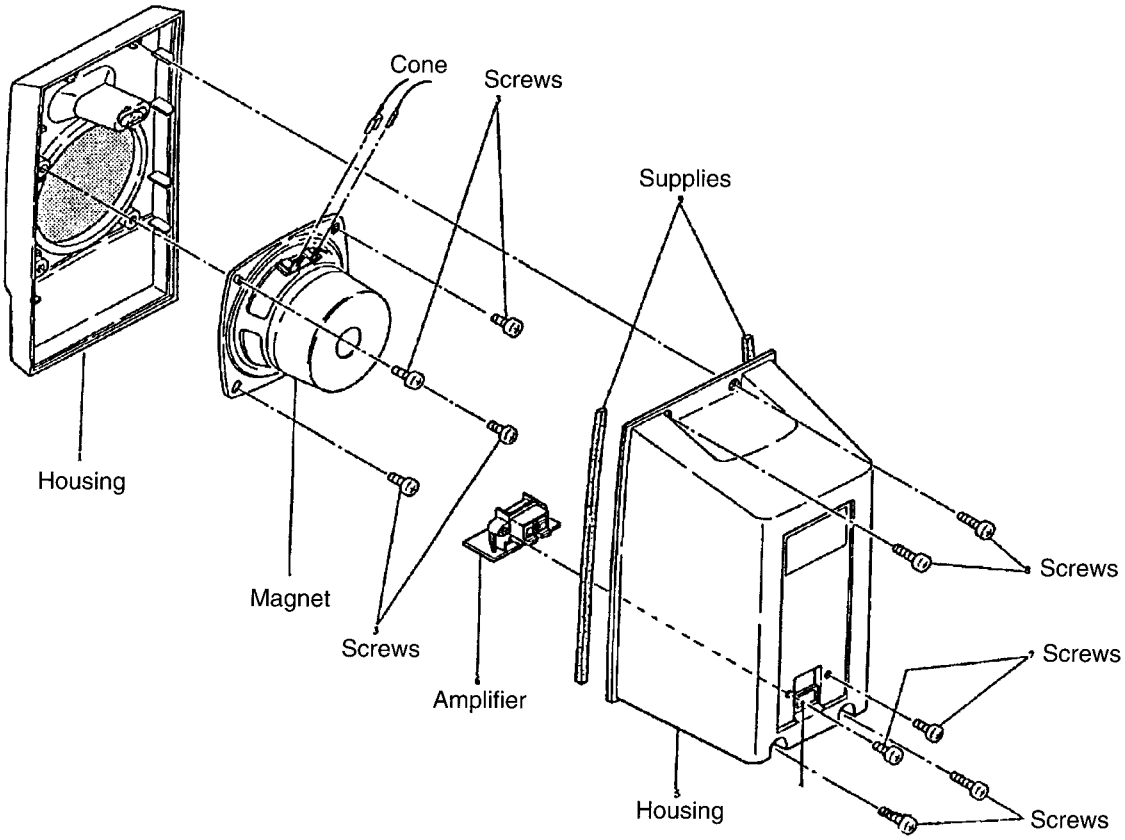
[3] This rework is part of the nonproductive labor time. New components are never needed.

[4] Market research shows that most new products typically take 18 to 24 months before sales volumes increase dramatically. This time period is known as the *S-curve* for new product sales.

Exhibit 3
Components of True Sound's Speakers



▲ SETTING THE BUDGET CONTEXT

The annual budget process at Electronic Peripherals begins with an assessment of True Sound's current environment. Together with the management of Electronic Peripherals, True Sound's officers update the multi-year profit plan, set budget targets for the current year, and communicate the major environmental and operating assumptions to True Sound's managers.

Assess current environment.
True Sound's main *strength* is its signal-processing technology that enables it to produce better sound from otherwise routinely built speakers. Accordingly, it has chosen the high-end market for speaker systems as its market niche. Nothing has changed to question this fundamental market positioning. The company's main *weakness* is its inability to organize and deliver products at the rate needed by customers. Its main *opportunity* stems from an unanticipated exploding growth in the sales of multimedia PC systems with good speakers. Forecasts for the PC industry project 20 percent sales growth. Prices are expected to be stable. Forecasts for supplier prices project average increases less than the general rate of inflation. On the *threat* side, competition has successfully introduced lower-quality, lower-cost speakers. In particular, True Sound's 4-watt and 8-watt product lines are under considerable competitive pressure.

Think Along

What changes must True Sound make to its plans based on the changes in its current environment?

Update multi-year profit plan.

Exhibit 4 shows True Sound's multi-year product and profit plan at the beginning of this budget cycle. The shaded area shows the original budget plan for the year 1999. True Sound must update this original 1999 plan to reflect environmental changes. To meet competitive threats, True Sound has decided to accelerate the introduction of 16-watt speakers. Instead of introducing them in the last quarter of 1999, product launch is scheduled for the first quarter. In addition, it will introduce 16-watt speaker compatible with other platforms such as Macintosh and 'workstations.' Furthermore, given the strong market growth, True Sound's market-share target may be increased. Finally, action plans must address the company's weakness and speed up both production and delivery of products.

Exhibit 4
True Sound's Original Multi-year Product and Profit Plan

Targets for year	*1997*	*1998*	*1999*	*2000*	*2001*
Product line changes	Introduce 4-watt and 8-watt speakers for the IBM PC	Introduce 4-watt and 8-watt speakers for the MAC platform	Introduce 16-watt speakers in September.	Introduce proprietary sound card; discontinue 4-watt line	Introduce proprietary Sound Card for MAC
Market share	—	1%	10%	15%	23%
Return on sales	–3%	1%	5%	9%	12%
Other strategic objectives	Establish assembly facilities and meet sound quality target	Develop distribution network and market awareness	Focus on rapid sales growth and market position	Introduce new audio products; move to just-in-time manufacturing	Introduce new audio products; consolidate market position

Think Along

How will the changes in the multi-year plan affect year 3 budget targets?

Set annual budget targets.

Based on the strong acceptance of its speakers and the anticipated growth in that market, True Sound increased its market share targets in year 3 (1999) from 10 percent to 13 percent.

Communicate budget assumptions and goals.

Top management must communicate these revised assumptions, decisions, and goals to lower-level managers so they can prepare their budgets. This communication is critical for two reasons. First, it is a way of obtaining *agreement* and *commitment* on budget goals by the entire organization. Second, it is a means for *coordinating* individual unit budgets for sales, production, distribution, and financing. Many people participate in and prepare parts of the total budget package, often working in cross-functional teams. In

Exhibit 5
Sample Budget Guidance Memorandum

DATE: May 15, 1998
TO: All True Sound Unit Managers
FROM: Imran Ali, General Manager
SUBJECT: Budget assumptions and goals for 1999.

In the last two years, we have enjoyed better-than-anticipated sales growth and profits. A great deal of credit for this goes to the extraordinary effort many of you have put in producing, marketing, and supporting our new line of speakers.

We expect the general economic environment for the PC industry to be positive this next year. Sales of PCs are likely to grow at 20 percent next year. Estimates by industry analysts suggest that approximately 80 percent of these new PC sales will be for multimedia systems with a sound card and speakers. This means we can expect industry speaker sales to be 7.5 million units. On the cost side, most reputed economic forecasts agree that the Federal reserve will keep inflation at around 3 percent. We have a commitment from our suppliers to keep the costs for cones, glue, and magnets at the same level as the last quarter 1998 prices.

Based on the positive economic outlook, our goal is to capture a 13 percent share of the speaker market. One strategy for this is to move the introduction of the 16-watt speaker line to the first quarter of 1999. The larger number of high-end speaker sales means we should be able to generate a 5 percent profit margin on sales. Other key goals for 1999 are (1) speed up production and delivery of product to customers and (2) enhance the quality of our speakers by moving to four-sigma quality. Julie Gystner (controller) is available to help you during the budget preparation process. She will send you a budget manual, submission forms, and a timeline for initial budget submissions.[5] Please adhere to the timetable. Remember that others in the organization depend on your information to complete their task.

organizations with *empowered employees, budget responsibility may rest with line workers to coordinate their activities*. All budget participants need to understand and share the assumptions upper management is making.

Most organizations use a budget guidance memorandum to communicate budget assumptions and goals. Exhibit 5 shows excerpts from True Sound's budget guidance memorandum.

▲ DETAILED BUDGET PREPARATION

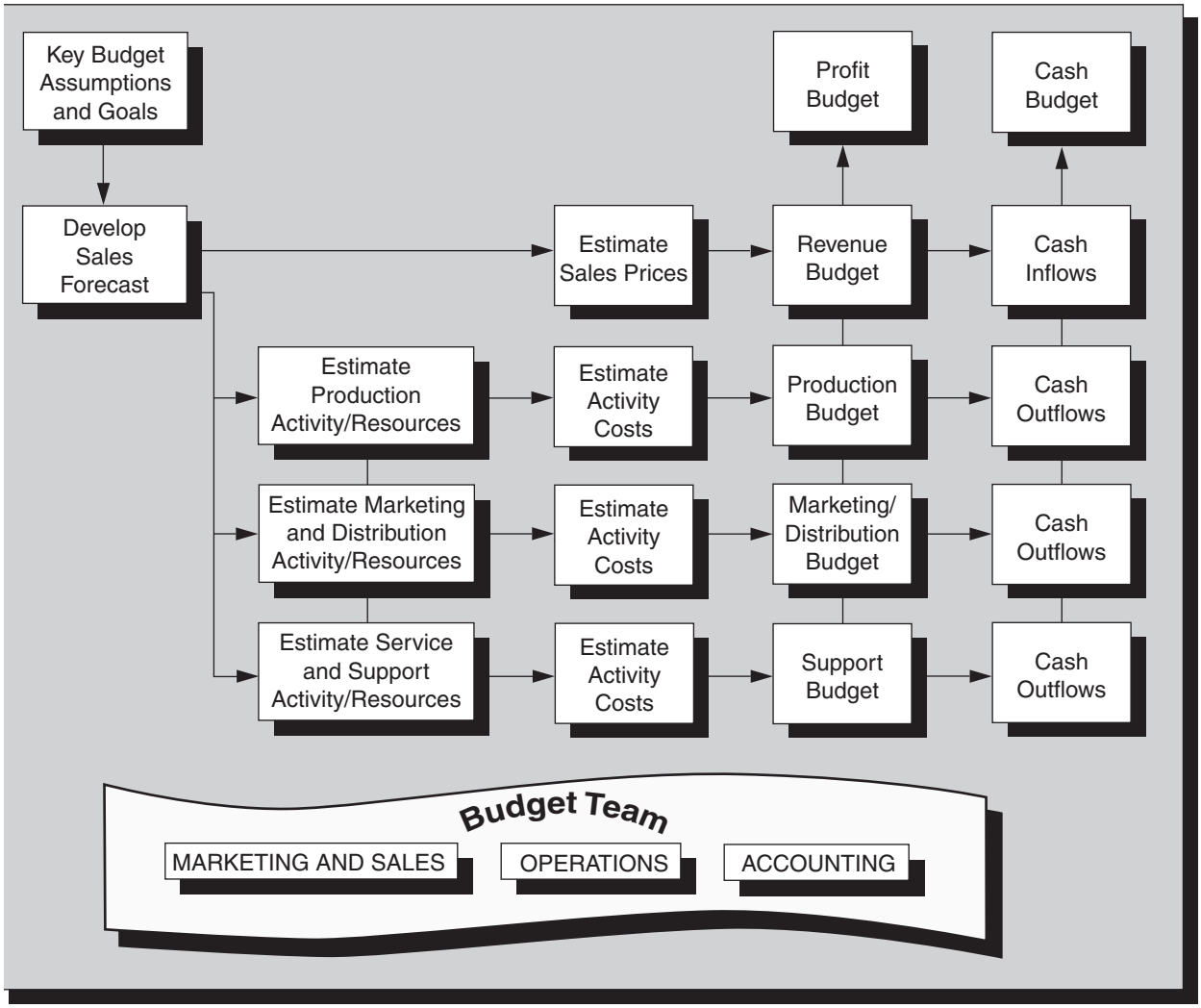
Putting together an annual budget is an iterative process, somewhat like piecing together a jigsaw puzzle. Each manager with budget responsibility prepares a budget for his or her unit. All follow the same two-part process. The first part consists of forecasting necessary activity levels and preparing activity budgets. The second part is to translate the activity budgets into financial (revenue, expense, and cash flow) budgets. Unit budgets combine to create a financial budget for the entire organization.

[5] Most organizations provide detailed forms for budget submissions.

Exhibit 6 shows that detailed budgets are prepared after the communication of budget assumptions. Detailed budgets start with a sales forecast. The sales and marketing groups have the primary responsibility for developing a quantitative sales forecast. Operating managers in production, sales, marketing, distribution, and other service and support areas then estimate the level of work activity they must perform to support the sales forecast and to meet other strategic goals of the organization. From the activity level, they estimate the resources, such as people, materials, supplies, space, and equipment, needed. Finally, they convert these resource estimates into financial terms.

To prepare a budget for his or her unit, each manager must ask and answer four questions: What information do I need? What work activities does my unit have to perform to meet budget objectives? What resources will these activities consume? What is the financial (revenue, cost, or cash flow) impact of these resources?

Exhibit 6
Budget Preparation—A Closer Look



Key Point

Activity budgeting precedes financial budgeting. Understanding activities and their financial impact is the essence of unit-level budget development.

All support areas must wait for the sales forecast before they can proceed with their budgets. However, once a sales forecast is available, production, sales support, distribution, and other support budgets proceed simultaneously. A budget process is both sequential and interactive. Production cannot finalize its material purchase budget without a sales forecast. Similarly, business support units cannot estimate their accounts payable activity without the purchase budget and credit terms. Timely sharing of information between areas is crucial. Budget templates and timelines developed by the management accountants facilitate this process. These templates allow the financial group to quickly test assumptions and calculations and to review budget submissions for consistency with the organizational goals. The templates also facilitate the operating adjustments needed when budget estimates differ from actual activity levels.

The Sales (Revenue) Budget.

Note Pad

Prepare a spreadsheet that allows you to reproduce our budget calculations for January and extend them to other months. Use the Excel spreadsheet that came with this module to verify your calculations.

Sales and marketing managers project next year's expected sales activity in a sales forecast. A sales forecast is an estimate of the quantity of products that an organization expects to sell or the amount of services it intends to provide. In a university the sales forecast is the estimated number of students served (as measured by class sections offered or full-time equivalent (FTE) students served). For a consulting firm it is the hours of consulting time the firm plans to bill. For True Sound the sales forecast reflects the quantity of each speaker type it expects to sell.

Determining forecasted sales is a complex process that requires an understanding of the external market conditions and internal capacity available.[6] Firms use several methods to develop sales estimates. Some of the more popular methods used are macroeconomic forecasting models, correlation or time series studies of past sales, and analysis of market research data obtained from customer surveys or focus groups. In recent years, many world-class firms have begun to use sophisticated customer databases as marketing tools. These databases contain information about customer preferences and other demographic variables that enable the market research staff to forecast future sales. Most firms typically use more than one forecasting method. Comparing the various forecasts allows an organization to develop a more reliable sales forecast.

Key Point

Sales budget estimates are critically important to the overall annual budget process because these estimates influence other activities and financial results.

[6] More details on this specialized process are part of an advanced budget module in this series.

To prepare True Sound's sales forecast, the marketing staff uses assumptions in the budget guidance memo and various statistical and econometric techniques. The analysis shows that the total industry sales (market size) will be 7,500,000 speakers and 80 percent of these will be multimedia speakers. In addition, the marketing staff believes that True Sound's sales will grow 6 percent a month.

To convert its sales forecast into a sales revenue budget, True Sound sets unit selling prices. In December speakers sold for $48 a set; prices typically decline in this industry. To increase market share, True Sound plans to lower the selling price to $44 per set for January through May and then lower the price again to $40 in June for the remaining months of the year.

Exhibit 7 shows the monthly and annual sales forecast in units and in dollars.

Exhibit 7
True Sound's Sales Revenue Budget

	January	*February*	*...*	*Annual*
Prior month's sales (in units)	37,816	40,085	...	
Expected growth rate	6%	6%	...	
Sales quantity forecast	40,085	42,490	...	676,211
Price	$ 44	$ 44	...	
Gross sales revenue	$1,763,740	$1,869,560	...	$27,952,280

Compute sales for the month of March. Compare your answer to the sales sheet in the Excel worksheet.

The Cash Inflow Budget.

Cash inflow from sales depends on the credit terms and discounts that a firm offers. Established industry practice often sets credit terms. True Sound currently offers no discount for prompt payment; total invoice amounts are due within 30 days. Based on history, True Sound typically collects 40 percent of its sales within the month of sale, 45 percent following the month of sale, 10 percent within two months, and 2 percent three months after the sale. True Sound writes off 3 percent of sales as uncollectible. Exhibit 8 shows the cash inflow budget for January and for the year.

Exhibit 8
Cash Inflow Budget

	January	*...*	*Year*
Sales revenue	$1,763,740	...	$27,952,280
Cash flows			
January collected in January (40%)	705,496		
December sales: $1,815,168 collected in January (45%)	816,826		
November sales: $1,728,720 collected in January (10%)	172,872		
October Sales: $1,646,400 collected in January (2%)	32,928		
Budgeted cash inflow	*$1,728,122*		*$26,255,145*

Note Pad

Compute cash collections for the month of February. Compare your answer to the sales sheet in the Excel worksheet.

Developing a Production Budget.

A production budget has several important cost components. Manufacturing companies have traditionally grouped these costs into three main categories—*direct materials and parts, direct labor,* and *manufacturing support* or *overhead costs*. Manufacturing companies that are highly automated combine direct labor and support costs into a single category called *conversion costs*. Since True Sound is a labor-based assembly operation, its production budget will have the three traditional components—materials, labor, and manufacturing support.

The quantity of speakers to produce is the most important piece of information for preparing the materials and labor budgets. Production volume *drives,* or causes, these costs. Some manufacturing support costs, such as utilities, also depend on production activity.

Inventory policy is a critical piece of information for preparing production budgets. If a firm uses a lean or agile manufacturing system, there will be little or no difference between units sold and units produced. True Sound, however, operates with inventories of materials and finished speakers.[7] Its policy is to maintain an inventory of finished speakers equal to 40 percent of the next month's sales forecast.

Production quantity is determined by combining information about expected sales with information about beginning and ending inventories. The following simple formula is used for calculating production quantity:

$$\begin{array}{l} \quad\text{Expected sales in units} \\ +\,\underline{\text{Units required in ending inventory}} \\ \quad\text{Units required this period} \\ -\,\underline{\text{Units in beginning inventory}} \\ \quad\text{Units to be produced this period} \end{array}$$

Exhibit 9 shows the calculation of production quantity for True Sound.

Exhibit 9
Speaker Production Quantity (Activity) Budget

Formula	*January*	*February*	*...*	*Annual*
Expected sales in units (Exhibit 7)	40,085	42,490		676,211
Plus units required in ending inventory (40% of next month's sales quantity)	+16,996	+18,016		+32,262
Less units in beginning inventory (from prior month)	−16,034	−16,996		−16,034
Units to be produced this period	*41,047*	*43,510*		*692,439*

[7] Lean or agile manufacturers use "just-in-time" (JIT) manufacturing and, therefore, do not have any significant difference between units sold and units produced. For a complete discussion of the differences between mass, lean and agile manufacturing, see the *Management Accounting In the Age of Lean Production* module in this series.

Think Along

What happens to the production budget for February if True Sound sells only 39,000 speakers in January but expects February sales to meet the budget target?[8]

Direct materials/parts budget.

Production managers prepare a *bill of materials* that lists all materials and parts needed to produce a single pair of speakers. Purchasing personnel provide information about material prices. Multiplying the price by the purchase quantity yields the purchase budget in dollars.

True Sound currently keeps an inventory equal to 30 percent of the following month's production for each of the four main parts (cones, magnets, housings, and amplifiers) used for speakers. Since each speaker requires one each of these four components, the purchase quantity will be the same for all components. Exhibit 10 shows the estimated purchase quantity for each part. Notice that the approach is identical to that used in Exhibit 9 except the focus now is on components and not finished speaker production.

Exhibit 10
Parts (cone, magnet, housing, and amplifiers) Purchase Quantity Budget

Formula	*January*	*February*	*...*	*Total*
Budgeted speaker production (From Exhibit 9)	41,047	43,510	...	692,439
Plus ending inventory	+13,053	+13,836	...	+24,777
Less beginning inventory	−12,314	−13,053	...	−12,314
Purchase quantity (each component)	*41,786*	*44,293*	...	*704,902*

To convert the purchase quantity into operating and cash flow budgets, we need to combine price and payment policy. True Sound currently pays for half of its material purchases in the month of purchase and the other half in the following month. Therefore, January's cash outflow will be 50 percent of January purchases and 50 percent of December purchases. Exhibit 11 shows the cash outflow for January.

Note Pad

Compute True Sound's February purchase operating budget and cash outflow. Compare your answers to the Excel spreadsheet's materials sheet.

Direct labor budget.

The direct labor budget, or the assembly budget, requires an estimate of the number of workers needed next year, their pay rates, and their benefits. The number of assembly workers needed depends upon the number of units produced, the time it takes to assemble each unit, and the expected nonproductive (downtime) of the assembly process.

[8] Changes in sales quantities directly influence True Sound's production. If January sales are 1,085 units lower than expected, ending inventory increases by 1,085, from 16,996 to 18,081. If February and March sales estimates remain unchanged, February production would be 42,425, or 1,085 fewer speakers.

Exhibit 11
Materials Purchase Cost and Cash Outflow

December Purchases	*January Purchase Cost and Cash Outflow Budgets*				
	Part Name	*Quantity*	*Unit Cost*	*Purchase Budget*	*Cash Outflow*
	Magnets	41,786	$9.20	$384,431	
	Amplifiers	41,786	15.00	626,790	
	Cones	41,786	0.90	37,607	
	Housing	41,786	1.65	68,947	
	Total		$26.75	**$1,117,775**	$558,888
$1,015,091					507,546
				January	**$1,066,434**
				Annual	**$18,302,796**

An analysis of True Sound's production process shows that a production employee assembles, on average, a speaker in 4 minutes (or .066 of an hour). If every minute is used productively, January's production of 41,047 units requires 2,736 assembly hours [(4 minutes × 41,047 units) ÷ 60]. Since each person works for 160 hours a month, True Sound needs 17.10 people (2,736 hours ÷ 160 hours).

Think Along

How many people does True Sound really need to hire to satisfy this budget estimate?

Organizations do not acquire exactly the resources that they need for current productive use. One reason is that most processes have *unused capacity* that is unavoidable.[9] For example, workers have lunch and breaks, they often have to wait for work, and machines break down leaving workers with nothing to do. Another reason has to do with the *indivisibility of resources,* which refers to resources available only in units of a given size. For example, if part-time workers are not available or it the use of overtime is not feasible, then True Sound cannot hire 17.10 workers. It can hire 17 or 18. Finally, managers also acquire additional capacity to gear up for production increases before their occurrence. True Sound may want to hire and train workers in anticipation of increased production later in the year.

[9] For a complete discussion of unused capacity and its causes see the *Measuring and Managing Capacity* module in this series.

Exhibit 12
Direct Labor Budget

	January	*December*	···	*Total*
1. Production quantity (from Exhibit 10)	41,047	77,916	···	692,439
2. Assembly hours needed (4 minutes/unit)	2,736	5,194	···	46,163
3. Add nonproductive time (30%)	821	1,558	···	13,849
4. Total labor hours needed (lines 2 + 3)	3,557	6,753		60,011
5. Workers needed (line 4 ÷ 160 hours/month)	22.23	42.2	···	
6. Total work force (from Excel spreadsheet)	24	43	···	387
7. Overtime hours needed (remainder line 5)	0	0	···	0
8. Labor cost regular (line 6 × $2,160 per worker monthly, or $13.50 per hour)	$51,840	$92,880	···	$835,920
9. Labor cost overtime (line 7 × $13.50 × 1.5)			···	
10. Total labor cost (lines 8 + 9)	$51,840	$92,880	···	$835,920
11. Labor cost per unit (line 10 ÷ line 1)	$1.26	$1.19	···	$1.2072

Exhibit 12 shows the direct labor cost budget for True Sound. The budget starts with the labor hours needed to produce speakers (assuming a 480-minute workday). True Sound's work rules allow workers a 60-minute lunch and two 15-minute breaks. In addition, workers lose approximately 20 minutes checking in, standing by for work, and for equipment breakdown. Nonproductive time is approximately 30 percent of productive time [(60 + 15 + 15 + 20) ÷ (480 − (60 + 15 + 15 + 20)] and must be added to productive time to estimate workers needed. For January this means that 821 nonproductive hours are added to the 2,736 productive hours to yield 3,557 total work hours needed.

Dividing the total of both productive and nonproductive time by 160 (the work hours in a month) yields the number of assembly workers required. For January the number is 22.23 workers. True Sound's management has requested 24 workers in the January budget to prepare for the upcoming monthly 6 percent growth in sales and production.

Supporting increased production requires a larger workforce. Exhibit 12 shows that by the end of the year True Sound must almost double its workforce.[10]

Multiplying the number of workers in any month by a wage and benefit rate of $13.50 per hour yields the labor cost budget. Since True Sound pays workers at the end of each month, *direct labor cost and cash outflow amounts are identical*.

Key Point

Because of *long-term plans, indivisibility* of certain costs, and various types of *unused* capacity, organizations often must acquire more resources than they actually use productively in the short-term. Making this information visible helps to manage these resources.

[10] The monthly amounts for labor and all other budget categories for True Sound are found on the Excell spreadsheet that comes with the module.

Exhibit 13
Manufacturing Activity and Resources Budget

Support Activity	*Activity Driver*
Inspect quality	# of inspections
Receive and store components	# of receipts
Maintain inventory	Receipt hours & value of inventory
Move components	# of batches
Maintain equipment	Hours used
Supervise and support assembly workers	# of speakers produced

Manufacturing overhead support budget.
Many other manufacturing activities support the assembly operation at True Sound. All these activities use resources that are part of the production cost budget. To prepare the manufacturing overhead support budget, True Sound must undertake the following seven tasks:

1. *Document all the major activities* that support manufacturing. Column 1 of Exhibit 13 lists the activities that support manufacturing. Currently, True Sound performs six major support activities.
2. *Identify the "activity drivers,"* or causal factors, that cause an increase or decrease in the volume of these activities. Column 2 of Exhibit 13 shows the activity drivers.[11] The drivers determine the budgeted cost for the next period. For instance, quality inspection cost depends on the number of quality inspections in the next budget period. Fewer inspections means less cost; more inspections means more cost. Similarly, the budgeted cost for the activity "receive and store components" depends on the number of raw material receipts expected next year. Note that unlike parts and assembly labor, the quantity of activity drivers depends only partially on the quantity of speakers produced. For example, quality inspection depends on the number of inspections and the sampling procedure used. Similarly, the number of material moves depends on the number of batches produced since materials are only moved when a batch is produced.
3. *Estimate the amount of each activity driver* needed for next year's production. We will use the activity "inspect quality" from Exhibit 13 to illustrate. True Sound inspectors currently randomly select and test 10 percent of the speakers produced. Each speaker goes through three inspection tests—wiring, assembly, and sound fidelity. Together these inspections take a total of 7 minutes per speaker. Therefore, the number of inspections is

▲ January's production of speakers (see Exhibit 9)	41,047
▲ Inspection rate	10 percent
▲ Number of speakers inspected (41,047 speakers × 10 percent)	**4,105**

[11] For details on how to do activity analysis and use it to analyze manufacturing activities see the *Activity-Based Management and Manufacturing Overhead Allocation* modules in this series.

Exhibit 14
Resources Needed for the Inspect Quality Activity

Resources	*Description of Items*	*Productive Capacity*	*Nonproductive Capacity*	*Total Capacity*	*Available Capacity*	*Capacity Shortfall*
Employee hours	Items produced	41,047				
	Items inspected	10%				
	Total inspections	4,105				
	Inspection minutes per unit	7				
	Inspection hours	479				
	Ratio of nonproductive to productive time of workers		33%			
	Additional inspection hours		158	637		
	Number of inspectors	2.99	0.99	3.98		
	Future growth	90%		3.58		
	Total inspectors needed			8.00	4.00	4.00
Supervision	Estimated portion of time	10%	0	10%	0	
Space	Square feet per inspector	150				
	Total needed (existing inspectors)	600				
	Aisles, hallways, etc.		15%	90		
	Future needs	100%	600	690		
	Total space needed			1,380	1,500	Excess
Supplies	Cleaners					
	Screws, wires, tapes, etc.					
Equipment—existing	Test equipment	19%	4%	23%	77%	Excess
Equipment—new	Test equipment	19%	4%	23%	77%	Excess

4. *Identify resources needed to perform activities*. We will again use the "quality inspection" activity to illustrate. Quality inspection requires five major resources: inspector time, managerial time, space, supplies and equipment. Exhibit 14 shows the estimates. The explanation for each item follows.

Inspector time

- ▲ Each inspection takes seven minutes.
- ▲ For 4,105 quality inspections we need (4,105 inspections × 7 ÷ 60) = 479 inspection hours.
- ▲ Each inspector works 160 hours so we need (479 ÷ 160) = 2.99 inspectors per month if the inspectors work continuously and productively, and inspector time is a divisible resource.
- ▲ Normally, the ratio of productive inspector time to nonproductive inspector time is about 33 percent due to lunches, breaks, and so on.
- ▲ Therefore, we need another (2.99 × .33) = .99 inspectors.
- ▲ Sales are expected to grow by 90 percent during the year.
- ▲ Therefore, we need an additional [(2.99 + .99) × .90] = 3.58 inspectors.

▲ Total inspectors needed are 7.56. However, since they are an indivisible resource, we need to have eight inspectors.

Manager time

▲ The manager spends approximately 10 percent of his time supervising inspectors.

Space and occupancy costs

▲ Each inspector needs 150 square feet

▲ Total space needed is (150 × 8) = 1,200 square feet.

▲ Another 15 percent, or 180 square feet, is required for passageways and hallways.

Supplies

▲ Each year True Sound consumes various types of supplies. The cost of supplies is estimated from recent catalog prices. A shortcut for estimating supplies is to compute them as a percent of salaries.

Equipment

▲ Each inspector needs test equipment. Currently equipment is used for approximately 6.5 hours a day, five days a week for 50 weeks. This is approximately 19 percent productive use [(6.5 hours × 5 days × 50 weeks) ÷ (365 days × 24 hours)].

▲ Nonproductive use for setup and scheduling is 1.5 hours a work day or 4 percent of available time. During the remaining time (77 percent), equipment is idle.[12]

▲ The test equipment need is based on a one-shift operation. Since each inspector requires new equipment, adding four more inspectors will require the purchase of new equipment.

Think Along

Why does True Sound need new test equipment, even though the utilization of existing equipment is only 23 percent?

5. *Estimate the costs of providing the resources*. The last step in preparing the manufacturing overhead budget is to estimate the cost of resources used. For True Sound the cost of the five resources for January is calculated as follows.

▲ Inspector salaries include salaries paid plus fringe benefits such as health insurance, pension contribution, and payroll taxes. Because of seniority, an existing inspector's salary and fringe benefits is $3,125 monthly, while a new inspector's salary and fringe benefits is only $2,500 per month. Salaries for the four existing inspectors total $12,500 per month.

▲ Manager salary, including fringe benefits, totals $6,500 per month. Since inspection requires 10 percent of the manager's time, $650 is charged to the inspection activity.

[12] The equipment is available for 365 days × 24 hours a day. It is currently being used 6.5 hours a day for five days a week for 50 weeks a year or 6.5 × 5 × 50 = 1,625 hours. The productive use, therefore, is 19 percent (rounded). The 1.5 hours a day or 4 percent (calculated) as shown here represents nonproductive capacity use. The rest, 77 percent is idle.

- ▲ Space costs include rent, insurance, property taxes, maintenance, and utilities. True Sound estimates that next year it will pay approximately $3 per square foot for these costs. Since inspection uses 1,500 square feet, the activity budget for space is $4,500 per month.
- ▲ Supply costs are based on delivered catalog prices. However, as a budgeting shortcut, True Sound uses 10 percent of salaries as an estimate of these costs.
- ▲ Equipment costs include purchase price, delivery, and installation. If needed, training costs and spoiled units should be included in equipment costs as well. The cost of test equipment currently used in production is $120,000. The depreciation rate is 20 percent per annum or 1.67 percent per month. The manufacturing support budget therefore includes $2,000 for equipment depreciation per month. Depreciation is a noncash cost. Doubling the number of inspectors will also double the equipment cost, since each inspector requires his or her own test equipment. This means another $120,000 in equipment purchases in increments of $30,000 each time an inspector is hired. These equipment purchases will affect the cash flow budget this year because they require a cash outflow.

Exhibit 15 summarizes the cost of the quality inspection activity.

Exhibit 15
Quality Inspection Cost Budget

Description of Resource	*Cost*	*January Quantity*	*January Budget*	*Annual Budget*
Inspector salaries–existing	$3,125	4	$12,500	$150,000
Inspector salaries–new	2,500	1	2,500*	75,000
Manager salary	6,500	10%	650	7,800
Space occupancy costs	3	1,500 sq ft	4,500	54,000
Supplies (% of salaries)	10%		1,500	22,500
Equipment depreciation—existing (rate 1.67% per month)	120,000	1.67%	2,000	24,000
Equipment depreciation—new (rate 1.67% per month)	30,000	1.67%	500*	15,000
Total quality inspection cost			*$24,150*	*$348,300*

*One inspector and one testing machine are added in January.

The budgeted cost of the activity for January is $24,150. Of this, $21,650 is a cash outflow payable in February ($24,150 less $2,500 depreciation). Also, note that the January cash outflow includes $30,000 for the purchase of new test equipment for one new inspector. The annual cost of this activity is $348,300.

Think Along

Why is the annual total greater than 12 times the January amount (12 × 24,150) = $289,800?

The annual cost includes the cost of additional inspectors and equipment needed for this activity. A review of the budget for this activity in the spreadsheet shows that new inspectors and equipment are added in January, April, July, and October.

6. *Develop a spending request*. The annual cost for the quality inspection activity is not the same as the amount True Sound will spend on the activity next year. The cash outflow required for operating activities is $300,343 ($348,300 minus depreciation charges all lagged by one month).[13] Depreciation does not require any cash outflow so it is not part of the spending request. The spending request includes additional spending of $82,500 for hiring four new inspectors and purchase of additional supplies ($82,500 = $75,000 + 7,500). The remaining $217,843 ($300,343 − $82,500) is for existing inspector salaries, the manager's salary, supplies and space currently under lease. The budget request is to continue the spending on these items. There is also an additional funding request for new equipment costing $120,000. Although we have shown this in our final budget, most companies typically fund capital items separately from operating items. Capital items require additional justification and calculations. Organizations typically use the capital budgeting process to approve capital items.[14]

   Many organizations refer to last year's spending as the **base budget** and this year's increased spending as the **incremental budget**. For the quality inspection activity, the base budget is $217,843 and the incremental budget is $82,500. Approval of the incremental budget ties the amount to a management **action plan.** The plant manager is obligated to hire four new inspectors and contract for additional supplies if the $82,500 incremental budget for this activity is approved.

Think Along

In your opinion, should organizations distinguish the base budget from the incremental budget?

The concept of a base budget often hides inefficiencies. This is particularly true for organizations that use production volume as a basis for budgeting. In these situations, an increase in production automatically justifies an increase in the base budget. There is no information to determine how well an organization is performing existing activities and, or even if the activities are necessary. In an activity-based budgeting environment, the distinction between base and incremental budgeting is not that important. Organizations can compare and benchmark their activities against other organizations. For example, True Sound knows that the budgeted cost of the quality inspection activity is $348,300 and the number of inspections is 4,105. It can compare the cost per inspection, $84.85, to other organizations to evaluate and benchmark how well this activity is being performed. The base budget cannot hide this data.

In addition, the focus on activities makes it easier to question whether current activities in the base budget actually add value to an organization. If they do not, they

[13] The actual cash outflow includes $20,944 for last December and does not include this December.

[14] A future module on "Capital Budgeting" will address this issue in greater detail.

Exhibit 16
Manufacturing Support Cost and Cash Flow Budgets

Manufacturing Support Activity	*Budgeted Costs*		*Cash Flow*		
	January	*Annual*	*January*	*February*	*Annual*
Inspect quality	$24,150*	$348,300*	$20,943	$21,650	$300,343
Receive and store materials	5,530	66,360	2,254	2,530	30,084
Maintain inventory	104,971	1,749,024	98,723	103,971	1,643,449
Move components	5,595	67,140	3,815	4,095	48,860
Maintain equipment	6,734	92,808	4,397	4,734	65,471
Assembly support	45,384	664,572	33,115	35,384	471,242
Subtotal, operating outflows			163,247	172,364	2,559,449
Capital outflows			30,000		720,000**
Total	$192,364	$2,988,204	$193,247	$172,364	$3,279,449

*See Exhibit 15.
**Includes $120,000 for purchase of new test equipment.

should be eliminated. If they do add value, employees can brainstorm ways to improve the activities.

7. *Consolidate activities into a single manufacturing overhead budget*. To complete the manufacturing support budget, True Sound must perform the same multiple step analysis (steps 2 through 6) that we have just illustrated for the support activity—inspect quality. Exhibit 16 shows the results of applying the same process (activity analysis, resource needs and cost estimation) for the other manufacturing support activities. Together, all these activity budgets constitute the consolidated initial manufacturing support cost budget. In the next section we examine whether the budget should be approved as submitted or should be revised.

The last three columns of Exhibit 16 show the cash outflows required for manufacturing support activities. Cash outflows depend on payment terms. True Sound pays all its overhead costs after 30 days. January's cash outflow is for December's manufacturing support activities. February's is for January's costs. Review the details behind this budget by comparing the cash flow line given for each activity budget to the summary provided in the Excel spreadsheet. Remember that depreciation expense is not a cash outflow, while new equipment purchases are.

Many firms prepare their budgets using traditional line-item account or expenditure categories. The budgets report amounts for salaries, supplies, utilities, and so on. This is easy to do for True Sound. If you go to the Excel spreadsheet, you will note that the information for converting activity to account budgets is provided in that spreadsheet. Exhibit 17 recasts the activity budget into an expenditure based line-item budget. Note that both Exhibit 17 and Exhibit 16 have the same final totals.

Exhibit 17
Manufacturing Support Cost Budget

Manufacturing Support Cost Item	*Budgeted Costs*	
	January	*Annual*
Employee salaries and fringe benefits	$22,750	$328,000
Manager's salary	6,500	78,000
Inventory holding cost	97,211	1,637,904
Space cost (rent, utilities, insurance)	30,900	388,800
Supplies	15,003	246,500
Equipment depreciation	20,000	309,000
Total	*$192,364*	*$2,988,204*

The Consolidated Activity Budget.

True Sound must follow the same seven-step process to prepare the activity budgets for their other support areas. Employees must document all marketing, distribution, and administrative support activities. They must then identify their drivers, estimate usage for each driver, identify resources needed by the activities, and assign costs to the resources. Exhibit 18 shows the marketing and distribution activities budget for True Sound. The Excel spreadsheet provided with the module gives the details on the "market" sheet.

Exhibit 18
Marketing and Distribution Activity and Cash Flow Budgets

Activities	*Operating Budget*		*Cash Flow Budget*		
	January	*Annual*	*January*	*February*	*Annual*
Sales support	$49,281	$772,384	$46,317	$48,781	$731,522
Advertising	26,456	419,284	27,228	26,456	400,858
Purchase and monitor advertising	16,600	204,600	15,270	16,100	196,870
Train sales staff	19,150	229,800	15,693	16,650	198,843
Customer support	5,545	66,540	5,268	4,545	54,263
Fill and ship orders	6,111	103,040	4,806	5,111	86,335
Deliver products	22,902	381,306	21,257	22,402	355,320
Subtotal, operating outflows			*$134,839*		*$2,024,011*
Capital outflows			12,000		12,000
Total	*$146,045*	*$2,176,954*	*$146,839*	*$140,045*	*$2,036,011*

Exhibit 19
Activity and Cash Flow Budget for Administrative Support

Activities	*Activity Budget*		*Cash Flow Budget*		
	January	*Annual*	*January*	*February*	*Annual*
Bill and collect receivables	$12,460	$183,320	$9,837	$10,460	$145,897
Purchasing	3,330	39,960	2,664	2,830	33,794
Financial reporting	57,147	745,950	51,790	54,647	702,017
Research and development	24,850	298,200	19,608	20,850	248,958
Human resources	25,100	346,050	21,845	23,100	308,395
General administration	70,825	970,261	65,284	68,825	920,568
Subtotal, operating outflow			*171,028*	*180,712*	*2,359,629*
Capital outflows			—	—	90,000
Total	*$193,712*	*$2,583,741*	*$171,028*	*$180,712*	*$2,449,629*

Exhibit 19 provides the activity budget for administrative support. Again the details are not discussed here, since they follow the same methods discussed for manufacturing support activities. The "admin" sheet of the Excel spreadsheet provides the details of activities, their resource requirements, and operating and cash flow budgets.

Converting Activity Budgets Into Traditional Financial Budgets.

Budget teams or accountants provide managers with templates to use when submitting their budgets. For example, the activity information in the Excel spreadsheet uses the same format (template) for all activities. Templates facilitate the review and combination of individual budgets to yield organization-wide profit and cash flow budgets.

The combined operating and cash flow budgets for True Sound are presented in Exhibits 20 and 21. Those exhibits reference the original exhibits where details were developed.

Think Along

How do we evaluate the initial budget of True Sound shown in Exhibits 20 and 21? What questions should top management ask?

▲ REVIEW AND APPROVAL OF BUDGETS

Upper-level managers review both individual budget submissions and combined budgets for consistency with strategic goals and targets. They test the assumptions and calculations used to build unit-level budgets, as well as the consistency of those assumptions and calculations across the organization. Upper-level management returns the activity budgets for revisions if they are not satisfied with the initial submission. The revisions may take several cycles. After revision, accountants combine the individual budgets into an organization-wide budget. Top management approves and communicates the final budget package to all members of the organization after they are satisfied that the total package meets all of the strategic criteria.

Exhibit 20
True Sound Budgeted Income Statement for the Year Ended December 31, 1999

	Budget Item	*Exhibit Reference*	*January 1999*	*For Year Ending December 1999*
1.	Gross sales revenue	Exhibit 7	$1,763,740	$27,952,280
2.	Less: uncollectible amounts (3%)*		−52,912	−838,568
3.	Net sales revenue		$1,710,828	$27,113,712
4.	Cost of goods sold	Row 19	−1,310,757	−21,823,153
5.	Gross margin	Row 3 − 4	400,071	5,290,559
6.	Marketing and distribution activities	Exhibit 18	−146,045	−2,176,954
7.	Administrative support activities	Exhibit 19	−193,712	−2,583,741
8.	Profit before tax	Row 5 − (6 + 7)	60,314	529,864
9.	Tax at 25%	Row 8 × 25%	−15,079	−132,466
10.	*Net Income*	*Row 8–9*	*$45,235*	*$397,398*
11.	*Cost of sales computation*			
12.	Beginning inventory**	Excel "rollup" sheet	508,269	508,269
13.	Direct materials	Excel "material" sheet	1,098,010	18,522,752
14.	Direct labor	Exhibit 12	51,840	835,920
15.	Manufacturing support activities	Exhibit 16	192,364	2,988,203
16.	Cost of goods produced	Row 13 + 14 + 15	$1,342,214	$22,346,875
17.	Goods available	Row 12 + 16	$1,850,483	$22,855,144
18.	Less ending inventory	Excel rollup sheet	−539,726	−1,031,991
19.	*Cost of goods sold*	*Row 17 − 18*	*$1,310,757*	*$21,823,153*

*Reductions are shown with a minus (–) sign
**True Sound has no beginning or ending work in process inventories.
Note: There may be rounding differences in amounts.

Exhibit 21
True Sound Annual Cash Budget for 1999

	Exhibit Reference	*January*	*February*	*...*	*Annual Amount*
Cash collections	Exhibit 8	$1,728,122	$1,757,598	...	$26,255,145
Cash payments for:					
Materials	Exhibit 11	1,066,434	1,151,307		18,302,796
Assembly labor	Exhibit 12	51,840	56,160		835,920
Manufacturing support	Exhibit 16	163,247	172,364	...	2,559,449
Marketing & distribution	Exhibit 18	134,839	140,045		2,024,011
Other administrative support costs	Exhibit 19	171,028	180,712	...	2,359,629
Taxes paid*	Exhibit 20	2,000		...	134,466
Change in cash from operations		*138,734*	*57,010*	...	*38,874*
Capital outlays	Exhibits 16,18, & 19	42,000			822,000
Beginning cash balance		300,000	396,734		300,000
Ending cash balance		*$396,734*	*$453,744*		*($483,126)*

*Taxes are paid quarterly in March, June, September, and December.

Exhibit 22
True Sound Key Budget Measures for 1999

	Budget Target	*Initial Budget*
Market share	13%	11.27%
Before tax return on sales	5%	1.95%
Cash required to maintain minimum balance		$ (783,126)

The review and evaluation of the initial budget must focus on three important issues: Is the budget consistent with True Sound's strategic goals? What problem areas does it highlight? What actions must be taken to achieve the budget?

Consistency with strategic goals.

You will recall that True Sound had specific targets regarding market share, profit margins, and a six-month acceleration in the introduction of the 16-watt speaker line. Exhibit 22 shows the expected market share, return on sales, and cash flow from the initial budget. The overall market share, currently 11.27 percent, is 1.73 percent less than the strategic target of 13 percent. The before-tax return on sales ratio is only 1.95 percent, which is also lower than the 5 percent strategic target. Finally, we have negative cash flow. Assume that True Sound has a minimum cash balance requirement of $300,000. The company would have to raise $783,126 in capital or loans to support this budget. It is clear that True Sound's initial budget fails to meet the company's most important strategic targets. True Sound must reevaluate its budget.

Problem evaluation.

True Sound managers must evaluate the budget assumptions and calculations to determine why they are failing to reach their objectives and how they might modify the budget to reach these objectives. The current budget assumes a 6 percent per month growth in sales. This rate is clearly not enough to reach the target market share of 13 percent. True Sound must achieve a higher growth rate. What happens if it is able to grow sales by 9 percent rather than by 6 percent a year? If you go to the Excel spreadsheet for True Sound, you can verify that a 9 percent a month growth rate will result in a projected market share of 13.84 percent and a return on sales of 4.89 percent. The revised results are summarized in Exhibit 23. Although the 9 percent growth rate allows True Sound to reach its market share objective and return on sales targets, the cash flow deteriorates to ($907,460)! Having this negative cash flow raises doubt about True Sound's ability to finance rapid growth. In addition, it is unlikely that a 9 percent growth rate will result unless the company lowers prices further. Lowering prices would further jeopardize cash flow and profits.

Use the Excel spreadsheet to confirm the financial impact of these changes in assumptions. Test the effect of other changes.

A cash shortage can not only jeopardize sales growth but also endanger the strategic goal of launching the new 16-watt speaker line. You can now understand how Medical Tools, the company in our opening vignette, could grow so fast and yet go bankrupt. Unless its cash problem is addressed, this scenario is likely to happen to True Sound. To

Exhibit 23
Key Budget Measures with 9 Percent Growth Rate

	Budget Target	*Initial Budget*	*Revised Budget*
Market share	13%	11.27%	13.84%
Before tax return on sales	5%	1.95%	4.89%
Cash flow		$ (783,126)	$ (907,460)

avoid a fate similar to Medical Tools, True Sound should focus on its cash shortage when considering alternative budget strategies.

Since increased market growth is only creating a larger cash shortage, True Sound must address the source of its cash problems. If you look at True Sound's budget, you will notice at least three major causes for True Sound's cash shortage. First, it has a very large investment in finished goods and raw materials inventory—40 percent and 30 percent of next month's production (Exhibit 20, lines 12 and 18). Second, True Sound has to invest $822,000 in capital expenditures (Exhibit 21), to sustain the high sales growth. Finally, True Sound's cash collections span a three-month period (Exhibit 8).

Think Along

What possible actions could True Sound take to modify the initial budget?

Possible actions.
First True Sound should consider cutting its investment in inventory. Next, it should consider using a two-shift operation instead of buying new equipment. A two-shift operation will use existing equipment and save $600,000 for the firm. Finally, it should review its collection policies and see whether a faster collection rate is possible.

To understand the impact of these actions assume that True Sound goes to a just-in-time inventory system for purchases and receives inventory each day.[15] It adds a shift and speeds up its cash collection on receivables so that 50 percent is received in the month of sale and 40 percent, 5 percent, and 2 percent the following months. Exhibit 24 shows the combined results from all these actions.

Note that True Sound now has positive cash flow. It is also close to its return-on-sales target. True Sound can generate additional profit by reducing expenses. One way to

Exhibit 24
Key Budget Measures with Revised Strategic Plan

	Original Budget Targets	*Initial Budget*	*Revised Budget*
Market share	13%	11.27%	11.27%
Before tax return on sales	5%	1.95%	4.75%
Cash flow		$ (783,126)	$809,725

[15] For simplicity we assumed that inventory of components dropped to zero. Practically, there would be some level of inventory, and the increase in the number of receipts would require additional resources. Other modules in this series consider JIT, strategic sourcing, and other tools in more detail.

reduce expenses is to eliminate non-value-added activities. A key part of the budget process is to evaluate whether all budgeted activities are necessary.[16] For example, True Sound budgeted a large amount for sales travel. There might be more cost-effective ways of providing this support, such as using the Internet, without actually having people travel.

The budget process also questions the wisdom of rapid market share growth. The original market share goal is unrealistic unless additional cash financing is readily available.

▲ PROPERTIES OF A GOOD BUDGET PROCESS

A good budgeting system has desirable technical, behavioral, and cultural properties. It improves management decision making, provides management with an understanding of work activities and their inter-relationships, leads to desired behaviors, and creates or reinforces desired organizational values.

Technical Attributes.

Technically, a budgeting system should provide management with information for decision making and help personnel develop an understanding of work activities, cost drivers, and cash flow.

Decision Relevance.
Annual budgets improve management decisions by forcing managers to plan for financial and operational uncertainties that might impede the attainment of business strategies. The future is uncertain and is constantly changing. The budget process forces firms to consider the unknown and plan daily actions without losing sight of long-term strategic goals. For example, in the True Sound illustration we identified a shortage of cash as an impediment to reaching strategic targets. The budget process enables True Sound to consider alternatives for dealing with a projected cash shortfall and take action before a crisis occurs.

Annual budgeting improves strategic and operational decisions. It forces management to consider whether the tasks and activities planned are consistent with the goals and objectives of the organization. Decisions become strategically driven. In True Sound's case the decision to increase assembly with a one-shift operation and additional equipment can be evaluated against its cash flow goals. A well-designed budget system minimizes the danger that True Sound will misspend resources.

Annual budgets also improve resource allocation decisions. Firms have limited financial and physical resources. The budget process can help the firm identify priority areas and align resource allocation decisions with these priorities.

Finally, capacity-use decisions are greatly improved by explicitly considering resources needed and resources acquired. Since the gap represents unused capacity, a good budget process can improve capacity-utilization decisions by asking managers to consider existing capacity available before asking for new resources. True Sound may consider using personnel who are partially idle on more than one activity; it may want to add second-shift workers to utilize more fully equipment capacity.

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[16] See the *Activity-Based Management* module in this series for additional discussion. Technology tools, such as those available from SAP, enables organizations to coordinate activities.

Process understanding.
Traditional budgeting focuses on departments and line item expenditures such as rent, salaries, and depreciation. This approach reflects the influence that responsibility accounting has had on management accounting thinking. The departmental approach focuses on which manager is responsible for incurring what costs. It then holds the managers responsible for costs within his or her department.

Activity-based budgeting highlights the importance of work activities as building blocks for budgets. Instead of where we do work, an activity-based budget focuses on what work is being done and why. It also highlights the linkages and interdependencies among activities within an organization. An activity-based budgeting system can be a great tool for showing people how a projected action influences activities (and costs) in subsequent departments or is affected by activities in prior departments. Further, it pinpoints the key drivers (such as volume, batch size, and order size) that cause costs. Understanding the resource requirements needed to perform activities helps decision makers to evaluate budget requests.

An activity-based budgeting process promotes a deeper understanding of work processes. It provides an opportunity to evaluate why certain activities are performed and whether they can be performed at less cost. Annual budgets can further enhance process understanding by including linkages with suppliers and customers. These links highlight areas in which synchronization and teamwork are critical and can focus attention on opportunities for lowering cost and reducing process time throughout the value chain.

Behavioral Attributes.

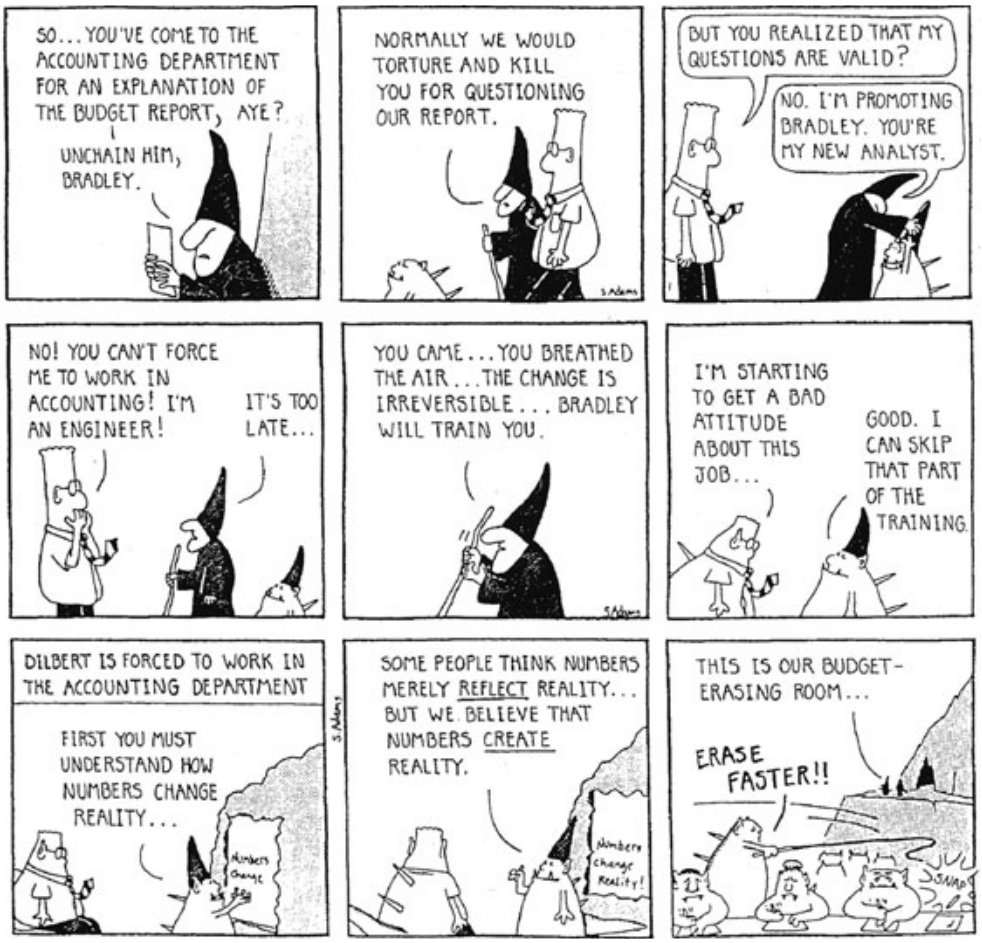
A well-designed budgeting system should lead to behaviors that support an organization's strategic quality, cost, and time goals. The budget process can have a positive impact on perceptions, aspiration levels, morale, and satisfaction of employees affected by budgets. However, if used carelessly, the budget process can also encourage negative or dysfunctional behaviors. Here are some examples of the positive and negative behavioral effects of budgets.[17]

Budgeting makes strategy visible.
The budget process requires top management and operating personnel to document basic strategic goals and assumptions. This action not only makes the goals visible but also helps to reinforce the perception that resources will be awarded to those who can tie their actions to such goals. For example, the True Sound annual budget was tied to the meeting a market share goal. A department wishing to get funds will have to justify its need by linking the use of the funds to the achievement of the growth target.

Attainment of budget goals and aspiration levels.
Research shows that when individual accept specific and challenging goals, they exert greater efforts than if they have easy or vague goals. Employee participation in goal setting also leads to commitment and achievement. Overly ambitious goals can have a negative impact. They increase the potential that individuals will take actions that are inappropriate or too risky. In addition, if goals are too high and not achievable; failure will lower

[17] An extensive body of research deals with the behavioral effects of budgets. It is impossible to cover even the most salient studies in this limited space. Many of these papers have appeared regularly in major accounting journals for the last 30 years. Students interested in learning more about this topic can find a list of additional references on our homepage www.mhhe.com/business/accounting/modules.

employee aspiration levels and will lead to lower goal achievement over time. Employees may strive for lower targets and these lower targets may further reduce their aspiration level and their performance—a kind of vicious cycle. Empowered employees fully participating in the goal setting and budgeting process achieve better goal attainment, but not all employees like to be empowered or care to participate in goal setting.[18]



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Budget games people play.

Many organizations tie achievement of budget goals to employee evaluation and rewards. For example, True Sound can use the budgeted market share and profit goals to evaluate the sales force and to compensate them. Consequently, individuals often play a variety of budget games. Sales people may underestimate sales if they are rewarded for meeting or exceeding sales targets. This widely observed phenomenon is called *budgetary slack.* It involves managers using different gaming strategies to get slack built into their budgets.[19] Many managers pad their budget requests so when they are cut, they get approximately what they originally needed. Activity budgeting for expenses can reduce this game playing

[18] "Not All Workers Find Idea of Empowerment as Neat as It Sound," *Wall Street Journal,* September 8, 1997.

[19] For a humorous discussion of strategies for creating budgetary slack, see Sigmund G. Ginsburg, "Negotiating Budgets: Games People Play," *INC. Magazine,* September 1981, pp. 89–91. We are grateful to Professor Mark Young for bringing this article to our attention.

if management accepts activity analysis as justification for expenditure requests in the budget review process.

Short run behavior.
Pressure to meet profit targets may cause short-run behavior. Managers may reduce or postpone "discretionary expenses" such as quality programs, equipment maintenance, or after-sales customer support. The immediate budget impact is lower costs and higher profits, but the long-term impacts can be very harmful. Corners cut today, such as for quality or environmental issues, may result in large failure costs many years later. Broader performance measurement systems that monitor these critical success factors can discourage short-term behavior.[20]

The failure of budgeting to have a positive impact on perceptions, aspiration levels, morale, and satisfaction of employees may occur because of excessive monitoring. If management monitors costs continuously against the budget and ignores improvements in things such as cycle time, quality, or activity redesign until they result in cost reduction, too much performance pressure results. Employees may view budgeting as a disciplinary tool of management rather than as a tool for planning and improving operations.

Cultural Attributes.

Budgeting affects, reflects, and reinforces corporate culture. It influences culture by creating and sharing a common language, a set of issues and goals, and an accepted way of making decisions. It also establishes an annual budget ceremony and can create ethical problems for employees.

Budgets are also symbols of fiscal responsibility that help an organization gain external acceptance as a legitimate organization. External legitimacy results when external constituents such as shareholders, creditors, regulatory agencies, and others view an organization to be acting in accord with the norms and values of societal culture.

Budgets create a common language, goals and decision-making norms.
A budget process creates a common language for discussions of strategies, objectives, and values. For instance, True Sound's employees must justify the decisions and actions they take, the objectives they seek, and the values they want to preserve in terms of budget priorities. The common language of the budget frames issues and sets the limits within which these issues are discussed. It provides a forum for communication, participation, and involvement. A well-designed budget process can help create a value system where planning for, rather than reacting to, events becomes a way of life. The communication of budget linkages allows each employee to understand how his or her efforts contribute to achieving strategic goals and thus foster continuous improvement.

Budgets as ceremony and symbol of rationality.
Western culture values rational calculated action over impulse or instinct. In fact, it is not an exaggeration to say that in Western societies it is sometimes more important to appear rational than to be rational. A budget process is a perfect vehicle by which an organization can demonstrate that it considers actions logically and rationally. It is a process, repeated

[20] For example, *Management Accounting*, August 1997, contains two articles illustrating broader performance measurement systems. See Chee Chow, et. al., "Applying the Balanced Scorecard to Small Companies," and Mark Epstein and Jean-Francois Manzoni, "The Balanced Scorecard and Tableau De Bord. Translating Strategy into Action."

annually, that celebrates rationality. The ceremony reminds everyone of the organizational commitment to rationality.

Beware! Budgeting may lend an aura of respectability to actions that have political or other motives. In evaluating budgets, one must always be alert to the possibility that what is presented may be cloaked or hidden in rationality. If True Sound's management makes decisions based on political, personal or other motives, the budget may successfully cloak such actions with an aura of rationality in the short-term and damage the corporation in the long-term.

Ethical issues in budgeting.

Because the actions of one part of the organization influence other parts, budgeting can create ethical issues. Salespeople striving to meet budget targets make promises to customers that cause other employees to compromise their performance. For example, salespeople may demand that the factory fill a rush order to make product modifications. These actions create higher production costs, result in quality problems, and make filling orders on a timely basis difficult. Should inferior products be shipped to satisfy marketing's demands? Should promises to customers be ignored? Should all orders be delayed? Another example of an ethical delimma arises when an employee knows how to improve a process. If budget pressure is intense, employees might not share these improvement ideas; rather they may use them only if they are failing to meet their budgets. This situation creates an ethical conflict between the employees' desire to help improve the organization and their natural instinct to protect themselves.

▲ LESSONS LEARNED

- ▲ Annual budgets are part of an organization's long-term strategic and profit plans. Budgets link short-term management decisions to long-term strategic objectives of an organization.
- ▲ Annual budgets serve as an early-warning system for identifying problems that may derail efforts to achieve strategic goals.
- ▲ Annual budgets take 5 to 7 months to prepare and involve many organizational participants at all levels.
- ▲ The sales forecast is the driver that starts detailed annual budget preparation.
- ▲ Budget preparation requires activity analysis, estimation of resources needed for activities, and translation of resources into costs.
- ▲ Budgets reflect resources acquired and not resources needed. Organizations acquire excess resources to meet long-term needs, because of cost indivisibility, or because of an inability to operate at full capacity.
- ▲ Budgets help achieve effective resource allocation by funding strategically necessary activities.
- ▲ Well-designed budgeting systems can motivate desired behaviors and reinforce ethical values of information sharing.
- ▲ A budget process can encourage dysfunctional behaviors, such as budgetary slack, and create ethical dilemmas by overemphasizing budget accomplishment.

▲ APPENDIX A—COMPETITIVE STRATEGY AND SWOT ANALYSIS[21]

Competitive strategy is a broad formula for how an organization is going to compete. It is a statement of the specific economic and non-economic goals for an organization and the business policies needed to achieve these goals. For a business firm, the specific goals generally include targets for profitability, growth, market share, product innovation and so forth. Goals must be logical extensions of the definition of how an organization will compete. For example, a competitive strategy for a computer company may be to become the primary provider of computer-based enterprise networks for small companies. Specific goals may include the number of networks to be installed, the profit margin on these installations, and the rate at which new software and hardware components will be upgraded.

SWOT analysis is a systematic evaluation of the strengths, weaknesses, opportunities and threats facing an organization. SWOT analysis is a strategic tool that many organizations use in establishing competitive strategies. It serves the most general level of strategy formulation. When used properly SWOT forces an organization to review its internal strengths and weaknesses. It also focuses attention on the external opportunities and threats that face an organization. The objective of SWOT analysis is to allow an organization to take advantage of its strengths, while neutralizing its environmental weaknesses.

In the example of the computer company, the strengths and weaknesses are the organization's assets and skills relative to its competitors. It may feel that it does not have the resources (manpower and capital) to go after the large companies or that it makes computers that cannot handle large network applications (technology weakness). SWOT analysis also requires a firm to understand its internal culture. SWOT analysis identifies the values, motivations, and needs of key company players who must implement strategy. The identified strength and weaknesses combined with these values provide an internal framework for the competitive strategies that an organization can adopt successfully.

SWOT analysis identifies the external limits on strategy imposed by the industry and the broader environment. It causes management to identify economic and technological opportunities as well as threats that define the competitive environment in which the company operates. Opportunities may arise from industry, government, social, or political sources. For each opportunity, SWOT analysis identifies rewards and risks. Threats may come from competitors, government regulation, or the broader environment. SWOT analysis identifies the capabilities and probable future actions of existing and potential competitors. It also includes a systematic evaluation of governmental action and social expectations that may adversely affect the organization.

This tool helps a firm take advantage of perceived opportunities while sidestepping or mitigating threats. Managers can assign priorities more logically following evaluation of when and why opportunities and threats exist. A SWOT analysis often helps signal the need for a strategic change.

SWOT analysis is most useful when focused on a carefully defined area of interest. Within the context of this module, True Sound used SWOT for the high-end speaker market. The analysis allowed True Sound to reach a consensus on revised goals and objectives which then became the basis for the annual activity and financial budget.

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[21] This information draws heavily on a number of strategy textbooks and especially on Michael Porter, *Competitive Strategy,* Macmillan Publishing Co, Inc., 1980.

▲ COMMON TERMS

Activity The series of related tasks that are part of work performed in an organization. It represents what we do such as loading a truck or responding to a customer complaint. (See Process diagram.)

Activity-Based Costing (ABC) A method of costing in which activities are the primary cost objects. ABC measures cost and performance of activities and assigns the costs of those activities to other cost objects, such as products or customers, based on their use of activities.

Allocation The apportionment or distribution of a common cost between two or more cost objects. In accounting, allocation is usually a way of assigning a cost between cost objects (products, departments or processes) that share that common cost. An allocation involves dividing the cost we want to allocate by some physical quantity (ideally a cost driver).

Benchmarking The process of investigating and identifying "best practices" and using them as a standard to improve one's own processes and activities.

Budget A quantitative plan of action that helps an organization coordinate resource inflows and outflows for a specific time period. Budgets are usually financial but may also include nonfinancial operating information.

Capacity The physical facilities, personnel, supplier contacts, and processes necessary to meet the product or service needs of customers.

Competitive Analysis Tools that enable companies to quantify how their performance and costs compare against competitors, understand why their performance and costs are different, and apply that insight to strengthen competitive responses and implement proactive plans.

Continuous Improvement A program to improve the strategic variables of quality, cost or time in small incremental steps on a continuous basis.

Cost A monetary measure of the resources consumed by a product, service, function, or activity. It also refers to the price paid for acquiring a product or service.

Cost Driver An event or factor that has a systematic relationship to a particular type of cost and causes that cost to be incurred is called its driver.

Cost Management The systematic analysis of cost drivers for the purpose of understanding how to reduce or maintain costs.

Cost Object A cost object is any item (activity, customer, project, work unit, product, channel, or service) for which a measurement of cost is desired.

Culture The collective values, beliefs, ethics, and mind-sets of the members of an organization, clan, or society that is subconsciously used to interpret events and take action. It is often called the collective programming of the subconscious mind.

Extended Enterprise The extended enterprise includes an organization's customers, suppliers, dealers, and recyclers. It captures the interdependencies across these separate organizations. It is also referred to as the value chain.

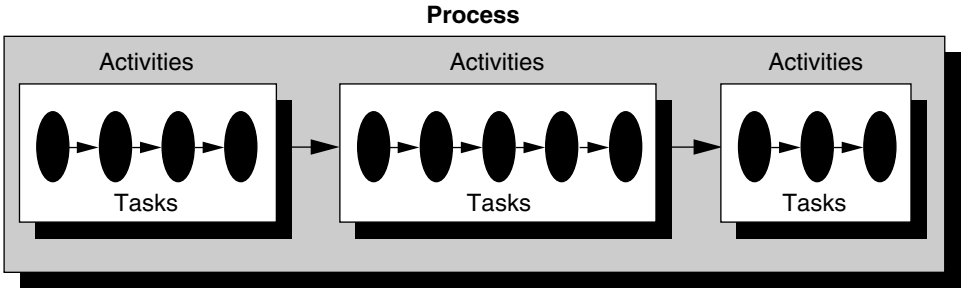
Fixed Cost A cost element that does not vary with changes in production volume in the short-run. Property taxes on factory buildings is an example of a fixed production cost.

Incremental Cost 1. The cost associated with increasing the output of an activity or project above some base level. 2. The additional cost associated with selecting one economic or business alternative over another, such as the difference between working overtime or subcontracting the work.

Indirect Costs Costs that are not directly assignable or traceable to a cost object.

Life-Cycle Costs Accumulation of costs for activities that occur over the entire life cycle of a product from inception to abandonment.

Process A series of linked activities that perform a specific objective. A process has a beginning, an end, and clearly identified inputs and outputs.



Quality A customer's total experience with a product or service. It includes features and the performance dimensions of those features such as reliability, usability, safety, and repairability.

Strategy The way that an organization positions and differentiates itself from its competitors. Positioning refers to the selection of target customers. Distinctions typically are made on the dimensions of quality, cost, and time.

Time The time it takes a firm to develop and produce new products or to provide existing products when customers need them.

Value Chain (See Extended Enterprise.)

Variable Cost A cost element that varies directly and proportionately with changes in production volume.

▲ PROBLEMS AND CASES—INTRODUCTORY LEVEL

1. Self test questions.

a. What is a budget?
b. The annual budget is part of an organization's strategic process. List each element of this strategic process.
c. How does the annual budget relate to the multi-year profit plan?
d. Briefly explain the context, budget preparation, and the review and approval phases of annual budgeting.
e. List the four major activities that are part of setting the budget context.
f. List the three major activities that are part of budget review and approval.
g. Assessing the current environment requires a SWOT analysis. Briefly explain a SWOT analysis.
h. What is the purpose of the budget guidance memorandum?
i. List four key questions each budget manager must ask and answer when preparing an annual budget.
j. Describe the basic budget preparation process.
k. Identify several methods of estimating sales.
l. Why doesn't sales revenue equal cash inflow for each budget period?
m. What is the basic formula for determining the units to produce or assemble in a budget period? How does the components-purchased computation differ from the production budget?
n. What factors determine the number of assembly workers an assembly process needs?
o. List the steps necessary to prepare a manufacturing or sales support budget.
p. Why do cash outflows differ from the related activity-based cost?
q. What are budget templates? Why are they useful?
r. What is the role of upper-level management after individual budgets are prepared?
s. Identify the key issues in the review and evaluation of the initial budget.
t. What gives a budget the technical attribute of decision relevance?
u. Contrast activity-based budgeting with traditional budgeting.
v. How does an activity-based budget promote continuous improvement?
w. List several behavioral attributes of a good budgeting system.
x. What are the primary cultural attributes of a good budgeting system?

Basic Budgeting Problems.

2. The White Glow Company sells a special no-skid bath mat. Expected sales for the first portion of the current year are: January, 32,000 mats; February, 35,000 mats; March, 45,000 mats; April, 38,000 mats. White Glow has 6,400 completed mats on hand on January 1 and wants to maintain a beginning mat inventory each month equal to 20 percent of the expected mat sales for the following month.

Required:

a. Prepare a mat purchase budget for the months of January, February, and March. Use White Glow's sales budget estimates when preparing this budget. Show computations.
b. Assume that the actual number of mats sold in January, February, and March, respectively, was 34,000, 41,000, and 48,000. Calculate the required level of purchases for each month. (Assume that White Glow did not revise any of its sales estimates.)
c. White Glow's production depends primarily on the sale of mats. List several factors that would influence how many mats White Glow can sell.

3. The White Glow Company has accumulated the following budget and actual sales information for the first quarter of the year. (Use actual data for the prior quarter.)

Month	*Budgeted Sales Volume*	*Budgeted Sales Price*	*Actual Sales Volume*	*Actual Sales Price*
October	n/a	n/a	22,000	$3.05
November	n/a	n/a	24,000	3.10
December	n/a	n/a	29,000	3.30
January	32,000	$3.40	30,000	3.35
February	35,000	3.40	41,000	3.45
March	45,000	3.50	48,000	3.40

Required:

a. Prepare a sales revenue budget for the first quarter.
b. Compare actual sales to the sales budget. Explain the difference.
c. What variables should White Glow use to prepare the sales revenue budget?

4. Refer to the data in problem 3. The White Glow Company sells 90 percent of their no skid bath mats on credit and 10 percent for cash. The company offers a 1 percent discount for cash sales and also on credit sales collected the month after the sale. The table below shows the expected collection pattern on credit sales.

Collection Pattern	*%*
Month after sale	60
Second month after sale	25
Third month after sale	13
Never collected	2

Required:

a. Prepare a cash inflow budget for the first quarter of the year.
b. What were the actual cash inflows? (For this computation assume that White Glow's actual collections followed the collection pattern shown above and actual data from the prior year was used in preparing the budget.)
c. Discuss the difference between actual and budgeted cash flows. How does a company operate with such differences?
d. Make suggestions for reducing the time lag between sales and cash collection.

5. Wet Plug, a bath-mat supplier for White Glow, asked for help in preparing a production and raw materials purchase budget for the first quarter of the coming year. A careful analysis of Wet Plug's operations and extensive discussions with the owner allowed you to accumulate the following information.

Raw Material	*Data about raw material*
Rug fiber	3 pounds per rug; cost per pound = $1.20
Rubber form and back	1 per rug; cost per form and back = $.75
Raw material inventory	20% of next month's estimated production, December inventory is 41,200 rubber backs and 123,600 pounds of fiber
Production time	Same day, no work in process inventory
Finished rugs	30% of next month's estimated sales, December inventory is 60,000 rugs
Sales estimates	*Estimated sales volume*
January	200,000 rugs
February	220,000 rugs
March	250,000 rugs
April	210,000 rugs

Required:

a. Prepare a production budget for January and February.
b. How much fiber and rubber backing should Wet Plug buy each month?
c. What is the total purchase budget in dollars for January and for February?
d. Assume that one-half of purchases are paid in the month of purchase and one-half in the following month. If the balance owed from December was $358,000, calculate the budgeted cash ouflows for purchases in January and February.
e. Discuss how the individual in charge of Wet Plug's production should prepare a production budget.

6. Production workers at Wet Plug feed the rubber form through a piece of equipment that attaches the proper amount of fiber to the form. After it undergoes a visual inspection the rug goes through a heat-treatment process that bonds the fiber and rubber form. The following table summarizes the resources used in these production activities.

Activity	*Resources*
Attachment	One minute of processing time for each of two workers; base rate $7 per hour
Heat treatment	Three minutes for one worker; base rate $10 per hour
Production manager	$30,000 per year
Indirect labor	Two material runners; $1,200 per month each
Equipment and building rent	2,000 feet available at $7 per foot, depreciation on equipment $1,800 per month
Repairs	$300 per repair; average repairs per month is eight
Utilities	$.40 average per rug

The company pays approximately 30 percent of salaries and wages in fringe benefits. Each worker works approximately 180 hours/month. The current contract does not allow any part-time work, and workers do not work overtime. The average nonproductive time

for each work category is 25 percent. January production is estimated at 206,000 rugs and February production at 229,000 rugs.

Required: Show all computations.

a. How much should Wet Plug budget for direct labor in January and February?
b. What is the estimated January and February overhead cost? Provide cost estimates by item of expenditure.
c. Your computations should show that Wet Plug needs additional workers for attachment and heat treatment in February. Comment on any cost differences that might arise if new workers are hired.

7. "What do I think about the budget? It's a process that has me spending several hours a week for months putting together annual estimates that always turn out to be wrong by the end of January. If Joe misses the sales estimate, everything seems to fall apart and none of the planned numbers work. Meanwhile I get blamed for spending too much because my people have to work overtime to get everything done, and my ability to help them deal with their everyday problems suffers."

Required:

a. Discuss why a budget may be useful even though it quickly become inaccurate.
b. What does this quote suggest about problems that may exist in this organization.
c. How might an activity budget help avoid the type of problems that this quote suggests exists? What problems would an activity budget not help mitigate?

8. Ronald Merry, the teenager who lives next door, has asked for your advice on starting a lawn service this spring. Ron feels that this work would enable him to earn some of the money he will need for college. You are meeting Ron for a pizza later this afternoon to discuss how he should proceed and what types of plans he needs to make.

Required:

a. Develop a list of questions for Ron that cover each stage of the comprehensive budgeting process model.
b. Identify a list of activities that Ron must perform as part of establishing and providing lawn service.

9. Consider each of the following statements. Does the statement relate primarily to the technical, behavioral, or cultural attributes of a budgeting process?

a. Identifies the tasks and activities needed to meet output levels.
b. Makes strategy visible.
c. Focuses attention on cross-functional linkages.
d. Avoids rewarding individuals simply for meeting budget targets.
e. Creates a value system built around planning.
f. Provides a commitment to rationality.
g. Forces consideration of future uncertainties.
h. Transforms operating information into financial measures.
i. Provides a common language.
j. Can create budgetary slack.

10. The following situations are independent. Discuss the probable ramifications each situation would have on the annual budget.

a. A tight raw material supply is expected to force a key supplier to lengthen its delivery schedule.
b. The sales staff, the credit department, and the accountants now meet on a regular basis to review the past and project new sales volumes and prices.
c. Last year the new plant manager was forced to work large amounts of overtime, and costs were much higher that the planned level. This situation occurred at least partially because the sales staff underestimated the amount of product they would sell. They deliberately underestimated so they would exceed their sales targets.
d. All employees in the organization now constantly monitor sales changes and anticipate the impact on their area.
e. A preliminary budget indicates that the firm can not complete projected activities and maintain a desired cash balance.

11. To earn the money you need for a spring trip, your family has asked you to prepare a quarterly cash budget for the family business. This morning, an hour before you must present the budget to the family, you discover that one of your practical-joking relatives has substituted question marks for your numbers in the budget. Now you must recreate the budget using the available information.

You recall that the minimum cash balance for any month was $4,000. If the business is short of cash, it borrows from another family business in $750 increments. Repayments (without interest) are also made in $750 increments whenever there is excess cash.

	January	***February***	***March***	***Total***
Beginning cash balance	$4,500	$?	$4,300	$?
Cash from customers	37,600	?	?	?
Total cash available	?	?	38,300	
Cash disbursements				
Paid to suppliers	19,000	18,900	15,700	?
Salary paid	?	7,100	?	29,200
Other cash costs	8,400	7,600	?	?
Cash expenses	39,700	?	32,200	?
Cash balance before borrowing or investment	?	?	?	?
Borrowings	?	2,250	?	?
Repayments	?	?	1,500	?
Ending cash balance	?	?	4,600	?

Required:
Compute the missing cash amounts.

12. You are doing an internship in the accounting department at Happy Toys. Your supervisor wants you to understand the details of the budget process. She asks for an analysis of whether the distribution manager requested the right number of distribution associates for the year. The budget request is to start the year with three associates and add an associate at the beginning of March, June, and September. Your review of the activity assumptions inherent in the distribution budget gives you the following information. Happy Toys pays $.65 a mile for a rental van and $200 an order to use a common carrier. Distribution associates are nonproductive 25 percent of the time. Supplies are anticipated to be 10 percent of each associate's salary. Loading equipment and other equipment is rented for $500 a month per associate. Happy Toys does not permit distribution associates to work overtime.

Distribution Associates Activities	***Salaried—$1,800 per month***	***Other Details***
Paperwork and shipment prep	15 minutes per order	Same for all orders
Loading trucks	300 toys per hour	Average load for common carrier
Loading rental van (small orders)	30 minutes per order	Average load 40 toys
Small order delivery	60 minutes per 40 miles	Average distance 30 miles per order in January
Special projects	As needed	Uses any available extra time
Hours per month	180 per person	
Shipments—January		*A monthly estimate is part of the operating budget detail (see table below)*
Truck orders	90 percent of sales	Average order size 300
Small orders	10 percent of sales	Average order size 40

The sales forecast in units (selling price $10) and estimated van miles driven by distribution associates are as follows:

Month	***Unit Sales***	***Miles***	***Month***	***Unit Sales***	***Miles***
January	40,000	3,000	July	56,205	8,300
February	42,400	3,300	August	59,016	9,200
March	44,944	4,700	September	62,557	10,200
April	47,641	5,200	October	66,936	12,400
May	50,023	5,800	November	70,952	14,700
June	53,024	6,500	December	75,918	17,100

Required:

a. Prepare a schedule that shows how many distribution associates Happy Toys needs each month. Assume delivery associates complete all the listed activities.

b. Prepare a (1) functional and a (2) activity budget for the Happy Toys distribution function for January and February.

c. Develop some suggestions for making the Happy Toys distribution process more cost-effective while maintaining quality and timely delivery.

13. Happy Toys wants to make certain that the resources they are committing to the marketing effort are adequate to support the annual sales forecast and the multi-year plan. Peter Grover, the marketing vice president, asked you to evaluate the support the current sales budget provides to the sales staff.

▲ Happy Toys currently pays each sales associate a 5 percent commission on sales revenue and $2,000 month for sales support. There are eight sales associates at the start of the year, and the budget envisions adding one new salesperson in March, July, and October.

The associates are expected to perform at least the following sales and sales support activities each month. The sales associates pay all the costs related to these activities.

▲ Visit each distributor at least twice a month to review orders, sales, and customer issues. Average time per visit is four hours, including an hour drive time. Sales associates have an average of five distributors in their sales territories. A distributor visit typically involves driving 50 miles and spending $100 on lunch.

▲ Visit at least 40 retail (or potential retail) sellers of Happy Toys. Average visit, including drive time, is two hours. If the sales associate can visit four retail sellers in a day, he or she will typically drive approximately 100 miles and spend about $30 for coffee, snacks, and lunch.

▲ Help resolve any customer problems. The quality of Happy Toys is good so each sales associate has only three problems a month. The typical problem takes about three hours to resolve and involves out-of-pocket cost of about $40.

▲ A typical sales associate spends two days a month in training or meetings at company headquarters. The cost of these trips and/or training is about $300 a day for travel and other expenses. This cost includes 100 miles of driving.

▲ The average sales associate spends 30 hours a month on the phone. Happy Toys has a long-distance contract that costs $.10 a minute plus a base rate of $50 a month per sales associate.

▲ Happy Toys leases each sales associate a car for $400 a month. The associate's only additional cost is $.15 a mile for gas and other expenses.

Required: Show computations.

a. Document the resource needs of each sales associate, by activity.
b. Determine the cost of the needed resources.
c. Do the resources Happy Toy is providing the sales associate seem adequate?
d. What are the likely consequences if the resources are not adequate?

▲ MORE ADVANCED OR DETAILED PROBLEMS

You might prefer to use a spreadsheet program to answer many of these questions.

14. The accounts receivable balance of J.B. Ant is $931,200 on October 1. A larger part—$672,000 of this amount is from September sales. During October the firm expects to bill $1,008,000. The historical collection pattern for J.B. Ant is 30 percent in billing month, 40 percent the month after billing, 29 percent two months after billing, and 1 percent of the billings are never collected. The firm has not written off any of the August or September sales as of October 1.

Required:

a. How much did J.B. Ant bill in August?

b. How much did J.B. Ant bill in September?

c. How much cash does J.B. Ant expect to receive in October?

d. Why is understanding the cash collection cycle important for J.B. Ant?

15. WVC Electronics assembles electrical components for three product lines. In recent years new products have been introduced in each of these lines and the number of products produced has increased greatly. WVC's manufacturing facility, which produces all the products, has three production departments: machining, plating, and assembly. It also has several departments that provide services within the manufacturing facility, but do not assemble products: purchasing, warehousing and inventory control, setup and scheduling, maintenance, and testing.

As part of the budget preparation process, a team of representatives from marketing, accounting, engineering, and setup and scheduling studied the activities performed and the cost of the resource inputs needed by the setup and scheduling department. The team gathered the following information:

Resource/Activity	***Activity Information***	***Resource Cost***
Manager		$4,500 a month
Supervise workers	70% setups	Includes 20% nonproductive
	30% scheduling	Includes 20% nonproductive
Employees		$3,200 a month; 180 hours a month
Total activity data	2,000 schedules; 8,000 setups each year	
Production scheduling	75 minutes per production schedule (average)	
Doing setups	30 minutes per setup (average)	
Vacations, holidays, training	20% of available time	
Building space		$18 a foot; includes utilities
Manager's office	400 square feet	
Production scheduling	300 square feet per office	
Setup space	1,400 square feet–total	
Halls, etc.	10%	
Office		
Desk, telephone, cabinets	One per employee	$400 per work station; life two years
Computers	One per production scheduler	$2,000 each computer; life two years
	One per manager	
	One-third per setup person	
Training		$800 per course; each course is one full day
Manager	Four courses each year	
Production schedulers	Two courses each year per person	
Setups	Three courses each year per person	

Required: Show computations.

a. Use the information provided to determine the resources needed in (1) scheduling and (2) setups. (If you need 2.2 people, round up to 3 people.)

b. Determine the annual cost of the resources needed for (1) scheduling and (2) setups. Include the appropriate share of the manager's cost in each departmental budget.

16. Krystal Company is just beginning operations and will sell a product (the identity of which remains a secret at this time). Krystal Gee, the company founder, has set as a basic strategic goal of earning 5 percent on each sales dollar. She also wants a rising volume of sales each month and doesn't want to borrow any money. The founder recognizes that achieving these goals immediately may be difficult, but wants the first six months to indicate whether these goals are feasible. With the help of a local accountant, Krystal put together the following information for the initial budget. This budget data assumes that Krystal's owner can buy, rather than make, the basic product it will sell. Krystal has also negotiated contracts for sales and other support services that call for these service providers to receive a percentage of sales dollars as payment.

	Purchases	***Sales***
January	$79,000	$122,000
February	64,000	105,000
March	94,000	142,000
April	56,000	82,000
May	84,000	119,000
June	86,000	124,000

Krystal expects to get a 3 percent discount on 55 percent of its product purchases. To get the discount, payment must be made in the month of purchase. Krystal plans to take all discounts that apply. The remaining purchases are paid for, in full, the following month. Krystal expects to sell its product to customers and have the supplier ship directly to the customer. Krystal therefore will carry no inventory. All of Krystal's sales are on credit. The collection pattern is 35 percent in the month following the sale, 50 percent two months after the sale, and 13 percent in the third month after the sale. Two percent of sales are estimated to be uncollectible. Monthly sales support expenses are equal to 12 percent of sales plus $23,000. The $23,000 includes $8,000 of depreciation, which involves no cash flow. Sales support expense amounts are paid one month after they are recognized as expenses. Assume Krystal pays no taxes. Krystal started business on January 1 with $100,000 of cash on hand.

Required:

a. Compute the cash collections by month and in total for January through June.

b. Compute the cash disbursements by month and in total for January through June.

c. Compute the expected cash balance each month. (Assume for this computation that Krystal can carry a negative cash balance.)

d. Prepare an income statement for Krystal by month and in total for January through June.

e. Is the proposed budget consistent with the founder's basic strategic goals? Are any change actions necessary? Explain.
f. Identify any activities and resource needs that the budget does not seem to consider properly. Explain briefly why the needs may not be properly considered.

17. Krystal also has the option to manufacture its basic product, rather than buy it. Krystal Gee knows that this step requires an additional initial cash investment. She is willing to take on the additional risk of manufacturing if she can anticipate a return on sales of 8 percent, rather than only 5 percent. The information about the production cost follows. Assume that all other information remains the same as shown in problem 16.

Category	***Additional Information***
Materials quantity used	Material A—3 lb; material B—1 lb
Material cost	Material A—$0.60 per lb ($1.80 total); material B—$0.42 per lb
Raw material inventory	All purchases are made in the month of production so there is no raw material inventory
Finished goods	Maintain a quantity equal to 40 percent of the next month's sales volume; no inventory on hand the month operations begin
Direct labor	Twelve minutes per unit using workers paid $8 an hour including benefits; add 25% for estimated unproductive time
Overhead	$3,000 a month in fixed fees in January; fees increase $500 a month; $600 in setup costs for each 2,000 of unit sales (round up); $0.90 a unit for each unit produced
Payment terms	Labor and overhead in month incurred; raw materials same as purchase items in problem 16; Sales support is the same as in problem 16

	Sales Volume	***Sales***
January	12,200	$122,000
February	10,500	105,000
March	14,200	142,000
April	8,200	82,000
May	11,900	119,000
June	12,400	124,000
July	13,000	130,000

Required:

a. Prepare the production and purchase budgets by month and in total for January through June.
b. Prepare budgets for materials, labor, and overhead by month and in total for January through June.
c. Compute the expected cash balance each month. (Assume for this computation that

Krystal can carry, if needed, a negative cash balance.)

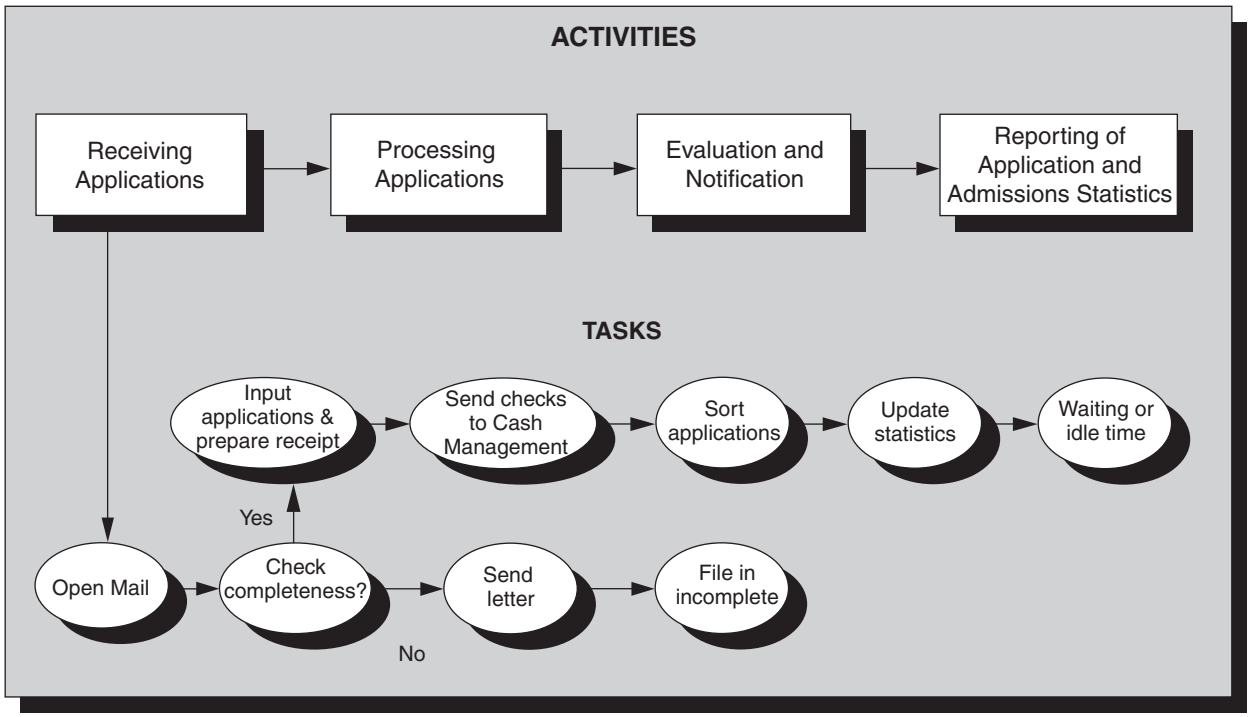
d. Prepare a modified income statement for Krystal by month and in total for January through June. Hint: for cost of goods sold, calculate the average product cost over the 6 month period.

e. Is this budget consistent with the founder's basic strategic goals? Are any change actions necessary? Explain.

f. What activities are different if Krystal makes, rather than buys, the basic product?

18. The admissions office of a local university provides a number of support services. One of those is receiving applications. This activity involves collecting an application fee and notifying students that the university received the completed package. The admissions office would like to generate next year's budget request using an activity-based budget system. It has asked for you help and has given you the following information.

Major Activities and Tasks in the Admissions Process



1. During the coming year the university expects to receive 60,000 applications. The basic tasks performed in receiving applications are listed here. All employees are cross trained.
2. The activity starts when the admissions staff in the student services department receives the applications. Employees open and date stamp the mail. Opening each application requires two minutes.
3. Applications are checked to see if all forms are intact and the application fee has been submitted. This step takes approximately four minutes for each application.

4. Incomplete forms are separated and applicants are sent a letter informing them of the missing items. These applications are filed in an incomplete or pending file. About 20 percent of the forms are incomplete. Writing the letter and filing the incomplete application takes approximately five minutes for each application.
5. Information from completed applications is input into a software program that prepares a form letter that notifies applicants of their application status. The program also generates a fee receipt. Data input takes about eight minutes per application.
6. All checks are endorsed on the back and put in batches of 30, a tape total is run, and the checks are sent to the cash management office. Preparing each batch takes about seven minutes.
7. The next task is sorting applications alphabetically and by applicant's status (first time freshman, transfer student, graduate, etc.). Sorting occurs twice each day and takes one individual about 30 minutes each time.
8. Information on the day's applications is input into a statistics file maintained on a computer. Information takes about five minutes per applicant.
9. The input activity stops several times because sorted applications are not available. The average total stop time during a day is about 90 minutes.
10. Each employee works eight hours and takes two 15-minute breaks. Each person also spends an average of another hour on meetings and miscellaneous tasks not identified in the time analysis of tasks.
11. The university always staffs the department with one additional individual to fill in during breaks and other activities. The supervisor also fills in on occasion.
12. Each individual needs a desk and a computer.

A review of historical information shows that computers cost $2,500 per machine each year. For occupancy costs such as utilities and building, the cost is $3.75 per square foot. Each employee currently has 620 square feet. For desks the cost is $180 a month, which includes a charge for the desk, lamp, chair, telephone, and janitorial service. Clerks earn $2,000 a month, and the supervisor earns $4,500 a month. Clerks also get a two-week vacation and 20 holidays a year, so the department works 230 days a year.

Required:
Use the preceding explanation to prepare an operating and dollar budget for the receiving-applications process for the coming year. Show all computations and list all assumptions. How much does it cost to process an application?

19. You are helping several clients review strategies and prepare budgets for their organizations. Discuss appropriate actions based on the following scenarios. Indicate the effect each action might have on specific budgets and strategies. Comment on whether an activity-based budget would help your clients deal with these situations.

a. One client is a small home builder in a midsized community. His long-term strategy is to consistently have 6 to 10 homes under construction, which enables him to keep quality subcontractors working on a fairly consistent basis and facilitates timely completion of individual homes. A large regional builder has started a major development in the client's home community. This large competitor is offering building subcontractors a premium wage in return for having the subcontractors available when jobs need their expertise.

b. One client is a parts supplier for the automobile industry. This client has grown rapidly because the company provides quality parts to customers at a cost considerably lower that it would cost customers to make the same parts. The union at a major customer has called a strike in an effort to keep the automobile company from outsourcing any more parts.
c. One of your clients makes golf clubs from titanium. The company strategy is to be a leader in innovative golf clubs and charge a premium price for these products. The firm has grown approximately 30 percent for the last five years. The military has announced that it will requires a much larger percentage (compared to prior years) of the world's titanium supply to build a new stealth fighter plane.

Required:

Prepare a short explanation for each client that explains the likely budget process impacts of these scenarios. Are strategic adjustments needed? Explain briefly.

20. Sitting at lunch you suddenly realize that the individuals at the next table are discussing budgeting at their firms. Unfortunately, you can hear only bits of the conversation. This is what you do overhear:

a. Individual 1. "We rolled out the sales force's projection of a 300 percent growth in sales next year. George in production simply asked when we bought the new factory? Pete in purchasing asked me where we found the new supplier and the new kid in finance wondered if we robbed a bank. It really shook up the boss."
b. Individual 2. "This morning the sales manager proudly announced that the sales force had enough orders at the end of the third quarter to meet this year's sales target. He expressed concern that sales personnel were really having to hand-hold nervous customers because production seemed to be unable to meet the normal delivery schedule. Our treasurer then reported that we had been forced to negotiate a large loan at a rather stiff interest rate."
c. Individual 3. "In the budget kickoff meeting last month, our president asked us all to do what we could to increase profits 20 percent this year. Today our accountant asked sales how they were going to grow sales 15 percent while cutting advertising by 10 percent."

Required:

Discuss what each of these situations may indicate is happening, correctly or incorrectly, in the budget process.

21. The Slumber Fall Company is a new client that has asked for your help in developing a budget process that works more effectively. You have spent some time at the company and gathered the following information:

a. The sales force is expected to meet or beat targets or face dire consequences.
b. The firm is chronically short of cash.
c. Production of the major product takes three weeks.
d. Workers are leaving the firm because of the amount of unscheduled overtime.
e. Deliveries to customers are regularly late, but the logistics manager refuses to use overnight package shipping.

Required:

Write a brief memo to the president indicating why some of these problems may arise. Suggest a solution to the problems. Focus explicitly on the technical, behavioral, and cultural attributes of a good budgeting process.

22. In a field study dealing with managerial propensity to create budgetary slack, Professor Ken Merchant reports that "propensities to create slack . . . appear to increase if a tight budget requires the managers to make frequent tactical responses so as not to incur budget overruns. On the other hand, allowing managers to participate actively in the budgeting processes seems to reduce their propensities to create slack."[22]

Required:

a. Discuss what organizational factors you believe would cause individual managers to prepare budgets that contain a considerable amount of slack.
b. Illustrate the types of problems that are likely to arise when a budget is unrealistic because of budgetary slack.
c. Discuss how having managers participate in the budget process can help reduce slack creation.

Mini Case

23. VisoSplash is a major circuit-board manufacturing facility. Its primary products are complex circuit boards that customers order in small quantities. Each order uses 1 of 15 basic product designs and a standard list of components for that design. However, small variations unique to each customer are incorporated into the final circuit board. Usually these are add-ons that can be attached near the end of the production process. Because the VisoSplash facility was designed to produce complex circuit boards it has very flexible equipment and some specialized engineering capabilities, which enable the plant to make almost any type of circuit board a customer may desire.

The VisoSplash management team has concluded that it is going to miss the plant's cash flow and sales targets for the second year in a row. The team is meeting to discuss possible actions that will allow the plant to meet profit targets in the future. Two alternatives have emerged as possible solutions to the problem.

Option 1 is to redesign the basic circuit board to reduce costs. The engineering group feels that with a concentrated effort over the next six months it may be possible to reduce the cost of the average board by up to 30 percent. This option will add significantly to the current year costs because of the people and equipment that will have to become part of the redesign effort. Even if the firm incurs these extra costs, the 30 percent cost reduction represents a stretch target.

Option 2 is to simplify the types of circuit boards that VisoSplash sells. The plant can produce the basic circuit board that is in wide use by the industry. By focusing on this basic circuit board and abandoning most of the complex custom boards now being produced, the

[22] Ken A. Merchant, "Budgeting and the Propensity to Create Budgetary Slack," *Accounting Organizations and Society*, 10, no. 2, (1985), p. 207.

facility could triple sales next year. Because this changeover can be made quickly, the plant may even be able to meet this year's sales targets.

Two young members of the executive team know that the popular plant manager is under intense pressure to meet the budget targets; they quickly suggest that the firm pursue option 2.

Required:

The plant manager has asked you to do the following:

a. Identify some of the basic activities with budget implications that occur when VisoSplash receives an order for a complex circuit board. Consider how these will change as one part of your answer to the remaining case requirements.
b. Develop a list of the reasons for accepting and for rejecting option 1.
c. Develop a list of the reasons for accepting and for rejecting option 2.
d. Make your own recommendation on the course VisoSplash should pursue.

24. The Bassco Tennis and Health Club is a nonprofit club created by the city of Bassco for local residents. The city provided the land and building for the club and established a nonprofit foundation to provide the courts and equipment as well as to manage the club on a continuing basis. The actual results for the prior year and the budget prepared by the club manager are summarized here:

Category	***Last year***	***Budget***
Cash revenue		
Membership	$300,000	$320,000
Tennis lessons	42,000	45,000
Health club classes	90,000	100,000
Total cash in	*$432,000*	*$465,000*
Cash expenses		
Manager salary	65,000	70,000
Tennis pro	35,000	38,000
Health club employees	140,000	160,000
Supplies	50,000	55,000
Utilities	25,000	26,000
Equipment	24,000	85,000
Miscellaneous	5,000	5,000
Total cash out	*$344,000*	*$439,000*
Cash income	*$88,000*	*$26,000*

Additional information:

1. Membership has declined slightly in each of the last three years, and another small decline is anticipated for the budget year.
2. Membership fees are budgeted to increase 15 percent. Fees have risen an average of 10 percent in each of the past three years. Management believes the higher membership fees are justified because the number of health club class options continues to increase. The club has also held the cost of tennis lessons and health club classes constant for five consecutive years.
3. About 40 percent of the members take advantage of at least two classes or lessons a month.
4. Approximately 80 percent of the members use the facilities three or more times a month. More than 50 percent use the facilities at least twice a week.
5. The club prides itself on having first class equipment and facilities. It regularly spends large sums to make certain these remain state of the art.
6. The club also prides itself on having outstanding employees and regularly gives raises and bonuses to help retain employees.
7. Club employees have free use of the facilities and are heavy users of all the equipment.

Required:

Use the information provided to discuss the budget for Bassco Health and Tennis Club. What appear to be long-term strategic goals of the club? Are they appropriate? Why? What are the probable behavioral and cultural attributes of the existing environment and budget process? How would an activity-based budget help Bassco?

▲ TEAM OR INDIVIDUAL ASSIGNMENT

25. Prepare a personal (household) cash flow budget. *Include a column for each month of the semester and for the semester in total* (you should already have actual information available for the first month). You should select budget categories that fit your own situation (your instructor may provide basic categories). At least some of your budget amounts should change from month to month to reflect changes in your activities or seasonal changes. Discuss the choices you had to make in order to balance your budget. For example, do you have to drive home for break rather than fly in order to save money? Do you have to make a monthly insurance payment instead of a six-month payment on your car? If your budget indicates an excess of expenditures over income, discuss the alternatives you have for covering your excess expenditures or how you can increase your income.

26. Prepare a summary of actual inflows and outflows for one month, using the categories from the budget prepared in problem 25. Discuss the reasons for the differences between budget and actual.

27. Develop a list of the internal and external information that you would need to prepare a preliminary budget for a specific functional area where you (or one of your team) works. For example, what information would you need to prepare a budget for the wait staff of a restaurant?

True Sound Follow-up and "What Ifs."

The following problems are based on the True Sound example used in your module.

A. You are responsible for preparing the budget in your area at True Sound. Use the information in the module to prepare the requested budgets. (Your instructor may change the months requested.)

Required:

a. Estimate the gross sales of speakers for March and April.
b. Estimate the cash collections from speaker sales for March and April.
c. Estimate speaker production for March and April.
d. Compute the cost of components that True Sound must purchase for March and April.
e. Compute the direct labor costs associated with speaker production for March and April. Assume that over and above the minimum number or required workers, True Sound wants one additional worker available each month.
f. What resources are needed for quality inspections in March and April? True Sound will hire an inspector and buy needed equipment in April. The equipment cost is $30,000 and has a life of 5 years.
g. What is the estimated cost of the resources needed for the quality inspection activity for March and April?

B. You have been asked to verify the budget estimate for maintaining inventory, one of the overhead activities at True Sound. The budgeted cost of this activity for January is $104,971. You also have the following information:

- ▲ One employee is available at the beginning of January.
- ▲ Employees are paid $2,000 a month and are expected to work 160 hours. Approximately 28 percent of their time is nonproductive.
- ▲ There are 20 receipts of inventory each month, and it takes 30 minutes to process each receipt.
- ▲ Maintaining inventory takes 4 percent of a manager's time. The manager's salary is $6,500 a month (including benefits).
- ▲ Storage space costs $3 a square foot, and 15 percent of the space is devoted to aisles and hallways. True Sound now has 1,500 feet and will acquire 1,000 more in July. The initial space needs are 1,000 feet and will grow proportionally with sales volume.
- ▲ Insurance, taxes, and other holding costs on inventory are 12 percent a month. These holding costs are computed based on the inventory cost at the end of the month. For January the finished goods inventory cost is $454,643 and the component ending inventory cost is $355,451.
- ▲ Equipment depreciation is $1,000 a month, and no additional equipment is needed this year.

Required:

a. Prepare a detailed budget for January for the activity, maintaining inventory. Show all your computations.

b. What would be the effect on the January budget for the activity if True Sound used a JIT inventory system and reduced raw material inventory and finished goods inventory to 5 percent? For your calculations assume that a JIT system would require five times as many receipts each month. The inventory space needs would be only 500 square feet and would remain unchanged for the entire year. Each employee requires 100 feet of space.

C. Your boss wants you to verify the budget estimate for receiving and storing components, one of the overhead activities at True Sound. The budgeted cost of this activity for January is $5,530. You also have the following information:

- ▲ One employee is available at the beginning of January.
- ▲ Employees are paid $1,250 a month and are expected to work 160 hours. Approximately 28 percent of their time is nonproductive.
- ▲ There are 20 receipts of inventory each month, and it takes 85 minutes to process each receipt.
- ▲ Maintaining inventory takes 2 percent of a manager's time. The manager's salary is $6,500 a month.
- ▲ Storage space costs $3 a square foot and 15 percent of the space is devoted to aisles and hallways. True Sound now has 300 feet. The initial space needs are 100 feet and they will grow with sales volume.
- ▲ Supplies are 20 percent of worker salaries.
- ▲ Equipment depreciation is $3,000 a month, and no additional equipment is needed this year.

Required:

a. Prepare a detailed budget for January and February for the activity, receiving and storing components. Show all your computations.

b. What would be the effect on the January and February budgets if True Sound uses a JIT inventory system and the number of receipts increases 500 percent?

D. You have been asked to verify the budget estimate for moving components, one of the overhead activities at True Sound. The budgeted cost of this activity for January is $5,145. You also have the following information:

- ▲ One employee is available at the beginning of January.
- ▲ Employees are paid $2,000 a month and are expected to work 160 hours. Approximately 28 percent of their time is nonproductive.
- ▲ Components are moved in batches of 2,000. Each batch move takes 150 minutes. Production in January is estimated at 41,047 speakers and in February at 43,510 speakers.
- ▲ Moving components takes 3 percent of a manager's time. The manager's salary is $6,500 a month.
- ▲ Storage space costs $3 a square foot, and 15 percent of the space is devoted to aisles and hallways. True Sound now has 350 feet. The initial space needs are 150 feet and will grow with sales volume.
- ▲ Supplies are 20 percent of worker salaries.

▲ Equipment depreciation is $1,500 a month, and no additional equipment is needed this year.

Required:

a. Prepare a detailed budget for January and February for the activity, moving components. Show all your computations.
b. The activities of maintaining inventory, receiving and storing components, and moving components are related. (See information in problems B and C.) If True Sound cross-trained workers for these three activities how would it affect the January budget?
c. Make some additional suggestions for modifying these three activities so they become more efficient.

For the remaining problems:

Use the electronic spreadsheet True Sound provided with your module to answer the following questions. Your instructor may provide you with additional scenarios.

E. The module suggested that True Sound might come closer to meeting its budget targets if it changes to a JIT inventory for components, speed up collections, and adds a second shift.

Required:

Carefully review the information about True Sound's activities found in your True Sound spreadsheet. List other items that might logically change if True Sound were to take the suggested actions.

F. The True Sound spreadsheet provides the details of the major activities and resources for the True Sound marketing and administrative activities.

Required:

a. Use the True Sound spreadsheet to prepare a detailed budget for the marketing and administrative activities specified by your instructor.
b. For the activities specified, critically analyze the activities and resources used. Suggest changes that may make True Sound more cost-effective without sacrificing quality of time to market.

G. Assume that each of the following situations is an independent change. Explain how the change would affect True Sound. Your discussion should document the key effects of the change. A second part of your discussion should comment on how this change might affect other activities.

a. True Sound determines it will be able to keep prices at $48 a speaker for the first six months and then lower the price by $5 a speaker.
b. True Sound will double the sales commission percentage and make salespersons responsible for all sales support costs currently paid by the firm. Base salary remains $1,000 for each salesperson.
c. True Sound has identified a new production technique that eliminates the need for speaker quality inspection. It requires an additional supervisor at a cost of $2,000 a month and increases the total production time to eight minutes. This change would occur at the start of year 3.

d. True Sound decides to estimate sales growth rate at 8 percent a month.
e. True Sound will ask local distributors to charge their purchases and will receive 95 percent of the sales amount from a local bank the month following the sale.

H. Make four additional assumption changes an executive of True Sound might consider. These should be fundamentally different from the changes mentioned in the prior problems. At least two of the changes should involve the modification of two variables.

a. Before testing the effect of the changes, document your reasons for making the proposals (for example to modify how activities are used, to improve profits, or increase cash inflows).
b. Use the spreadsheet template to determine whether the changes yield the anticipated results. Report on the results of your changes. Include an analysis of how the changes modified activity and resource use.
c. Discuss a technical, behavioral, and cultural issue that might be associated with the results of each proposed change.

NOTES