

Chapter 11 : Cost Management Through Activity-Based Management

LEARNING OBJECTIVES

After Studying this chapter, you should be able to:

1. Define activity-based management (ABM).
2. Describe each phase of the four-phase ABM process.
3. Summarize vendor, time-based, productivity, and customer satisfaction performance measurements.
4. Explain why care should be taken in developing performance measurements that users can readily visualize, comprehend, and apply.

INTRODUCTION

Activity-based costing (ABC) is directly linked to and supportive of activity-based management (ABM), as Exhibit 11-1 shows. The main purposes of ABC are to:

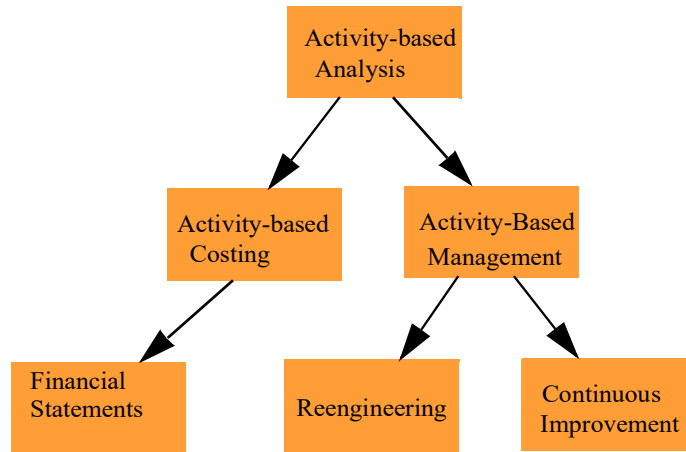
- Provide costing information on cost objects
- Provide information to enable management to re-engineer the business if necessary, and attain continuous improvement

Continuous improvement calls for systematic and small incremental actions. **Reengineering** requires large quantum changes in how the enterprise is currently operating. Companies that contain an inordinate amount of nonvalue-added activities and are no longer competitive are most likely to need reengineering.

As Chapter 10 illustrated, activities are the building blocks of organizations. Activities are what people do everyday. Therefore, if an organization is to change, the change must ultimately be made at the activity level.¹ **Activity-based management (ABM)** is the process of understanding, reengineering, measuring, and making decisions about activities to put the enterprise on the road to continuous improvement and excellence. It turns

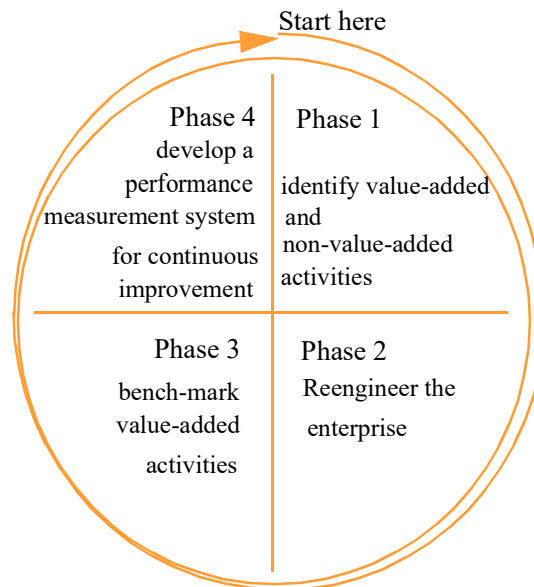
LEARNING OBJECTIVE 1

Define Activity Based Management (ABM)



out that the information collected when developing an ABC system also reveals an organization's activities and how they are performed. Workers and managers can use this knowledge to make their activities faster, higher quality, and more productive. As Exhibit 11-2 shows, ABM is an ongoing process involving four phases:

Exhibit 11-2 The Four Ongoing Phases of Activity-Based Management



- Identify value-added and nonvalue-added activities.
- Reengineer the enterprise.
- Benchmark value-added activities.
- Develop a performance measurement system for continuous improvement.

The ABM process is never completed. It is a constant process of evaluating performance, taking action, and tracking the results. Occasionally, recalibration is needed because of

1. James A. Brimson and Michael J. Burtha, "Activity Accounting," in *Handbook of Cost Management*, ed. Barry J. Brinker (Boston: Warren Gorham Lamont, 1992), p. C1-5. With permission.

changing business conditions. This recalibration calls for reanalyzing activities, possibly performing additional reengineering, doing new benchmarking, and revising performance measurements. As the management axiom says, “If you don't measure it, it won't improve, and if you don't take the necessary actions, it will get worse.” The ABM process helps prevent this from becoming reality. Problems that are ignored never go away by themselves. They grow until they get so big they cannot be ignored. If management wants to manage performance and eliminate cost-consuming activities, management accountants must provide a system to *measure* performance and continue to make sure that the right things are being measured in the right way. Indeed, management accountants must take the lead in measuring and reporting cost management information--both financial and nonfinancial. Helping implement the ABM process will achieve these goals.

The first sections of this chapter describe the four phases of the ABM process. Later sections explain how to prepare specific performance measurements and how to help management *visualize* performance measurements.

PHASE 1: IDENTIFYING VALUE-ADDED AND NON VALUE-ADDED ACTIVITIES

LEARNING OBJECTIVE 2

Describe each phase of the 4-phase ABM process

The Value-added/NonValue-added concept is, in hindsight, a significant error in ABM, in particular. Although there is a good way to use and understand it, almost all the uses you encounter will be deeply flawed. You can help people out, but they will be resistant. First, no one can know what adds economic value and what does not. If you ever figure this out, you will likely be the next Nobel Prize winner. By introducing the concept of economic value into decisions we have created an insoluble problem while at the same time looking like tough no-nonsense business people.

The good use of Value-added is the strict view that if the customer cannot tell directly, then it is non-value-added. This means that very little is value added, of course, which makes it seem to many people that this strict version is not useful. However it is the most useful version by far. This version tells you what is difficult and what is not; what can be done quickly and what will take a great deal of time to do well. Why? If the customer can tell something happened, they making any changes is a product design exercise, with the entire great mass of work and negotiation that entails. You will need to engage with several hundred people, at least, and then face engagement with the thousands of people in the market. This will take a long time, have an uncertain result. On the other hand, in this strict version, changes in anything that is non-value-added is not detectable by the customer, and thus can be changed in any way desired without any need for the level of engagement needed of VA things. In fact, we can completely outsource things like payroll because they are NVA.

Typical definitions are: “Value-added activities contribute something that is worthwhile to the enterprise and its customers. Such activities are critical factors that are essential to the enterprise's success”.

INSIGHTS & APPLICATIONS

The Management Accountant as a Business (Re)engineer

QuickPark, incorporated is a parking lot management company with contracts to oversee garages in several cities across the United States. QuickPark agreed to accept credit cards. Soon after customers complained about how long it took them to exit the garages during the 5-8pm. peak period. Barbara Turner asked her management accountant, Martina Daniels, to investigate the problem. In addition to recommending a number of logistical changes (e.g., removing concrete barriers to facilitate drivers to switch to faster-moving exit lanes),

Daniels designed and implemented a new credit card terminal system that reduced authorization and transaction time by an average of 10 seconds. The projected savings for QuickPark is \$500,000 annually. Several implications for management accountants underlie this case. First, management accountants must be more than merely data gatherers. They must be able to analyze existing activities, identify their weaknesses, and recommend practical improvements, or, in QuickPark's case, completely re-engineer the activity. Second, management accountants must take a proactive stance in evaluating emerging technologies for possible customer service and cost savings opportunities. Third, management accountants must be able to uncover causes of problems rather than symptoms.^a

a.Michael S. Luehlfigg, "Driving Out Inefficiency," *Management Accounting*, March 1993, pp. 33-36. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

TYPES OF VALUE-ADDED ACTIVITIES

Value-added activities are of two types. One type adds value to the customer; painting a car or delivering a shipment on time are examples. The second type is essential for the proper functioning of the enterprise. For example, paying employees is not of direct concern to customers, but it does satisfy an organizational need.

In this sentence we can see where the confusion begins. Confusing value and necessity is the problem. If we split this into two concepts, "value-added" and "needed", most of the problems with this concept will be eliminated.

	Value-added	NonValue-added
needed	reduce cost, but ?	reduce cost
not needed	try to identify, but ?	waste

NONVALUE-ADDED ACTIVITIES

Nonvalue-added and not needed activities represent waste; these activities can be reduced or eliminated without decreasing the enterprise's ability to compete and meet customer demands. Armed with a list of nonvalue-added not-needed activities, the organization can create teams to find innovative ways to eliminate, reduce, or re-engineer those activities. One of the costliest things a company can do is to invest in equipment and people to make nonvalue-added not-needed activities more efficient. The goal is to eliminate them altogether or subject them to a major overhaul, not to make them more efficient.

Inspection of incoming raw materials is a nonvalue-added not needed activity that can be eliminated without diminishing the value received by the enterprise or its customers. Customers do not value inspection; they value high quality. If a vendor of raw materials commits to supplying high-quality materials, then inspection is no longer required, and buying testing equipment and hiring more people to inspect the incoming raw materials would waste time and money.

UNDERSTANDING ACTIVITIES

Litigating oil spills and other violations is costly. Effort and money should be invested in training activities, which indirectly but effectively reduce litigating activities. Handling accidents and claims is another nonvalue-added activity that can be reduced by implementing strong and effective safety activities, with a target of an injury-free workplace. But simply implementing training and safety activities is not enough. Safety is also improved by *understanding the activities*. Just because an activity is value-added does not mean that it is being performed efficiently. Workers who take shortcuts, a major cause of accidents, may be pinpointing an inefficient activity, task, or tool.

INSIGHTS & APPLICATIONS

At 3M Cost Management Leadership Is Mandatory

Several years ago, a task force was formed to recommend changes to 3M's traditional accounting operations. The group's mission focused on understanding how management accounting could improve its effectiveness in the age of just-in-time, continuous improvement, activity-based costing, life cycle accounting, optimized operations, and total cost management. Routine analysis of product profitability and cost allocation

schemes based on activities continue. Changes in the management accounting system also now include nonfinancial performance measurements that assist management and workers in:- Improving quality throughout the enterprise- Reducing production lead time- Evaluating and streamlining logistics- Compressing research and development timetables Management accountants are located in operating units rather than in corporate headquarter offices. This way, operating personnel receive more relevant and timely information, and the accountants are active in day-to-day plant activities. The "cost accounting" specialization of the past has been replaced with a more diversified business exposure and cost management orientation. Activity-based costing and manager talent are used to help manage cost and weed out nonvalue-added activities.^a

a. Adapted from David A. Kunz, "3M Revisited: Evolving for the '90s." *Management Accounting*, October 1992, pp. 37-40. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

A pharmaceutical company, for example, makes random surveys of each work cell to ensure that safety activities are being performed precisely. After the survey, a colored sticker is attached to each work cell notice board. A red sticker indicates the work cell has seriously violated safety standards, orange signifies minor violations, and a green sticker indicates complete adherence to all safety activities. A green sticker is highly desired, and the work cells compete vigorously to obtain one.²

PHASE 2: REENGINEERING THE ENTERPRISE

From the viewpoint of activities, reengineering is the redesign of how work is done through activities. Because activities are what an organization does, to re-engineer the organization, the activities must be re-engineered.

Such a radical redesign effort normally takes a minimum of three to five years to complete successfully throughout the organization. That may seem a long time, but remember that existing systems and activities must be torn down and then rebuilt around more efficient and effective activities. A number of major companies including Eastman Kodak, AT&T, Burger King, American Express, Sears, ITT Sheraton Corporation,

2. Brian H. Maskell, *Performance Measurement for World Class Manufacturing* (Cambridge, Mass.: Productivity Press, 1991), p. 34. With permission.

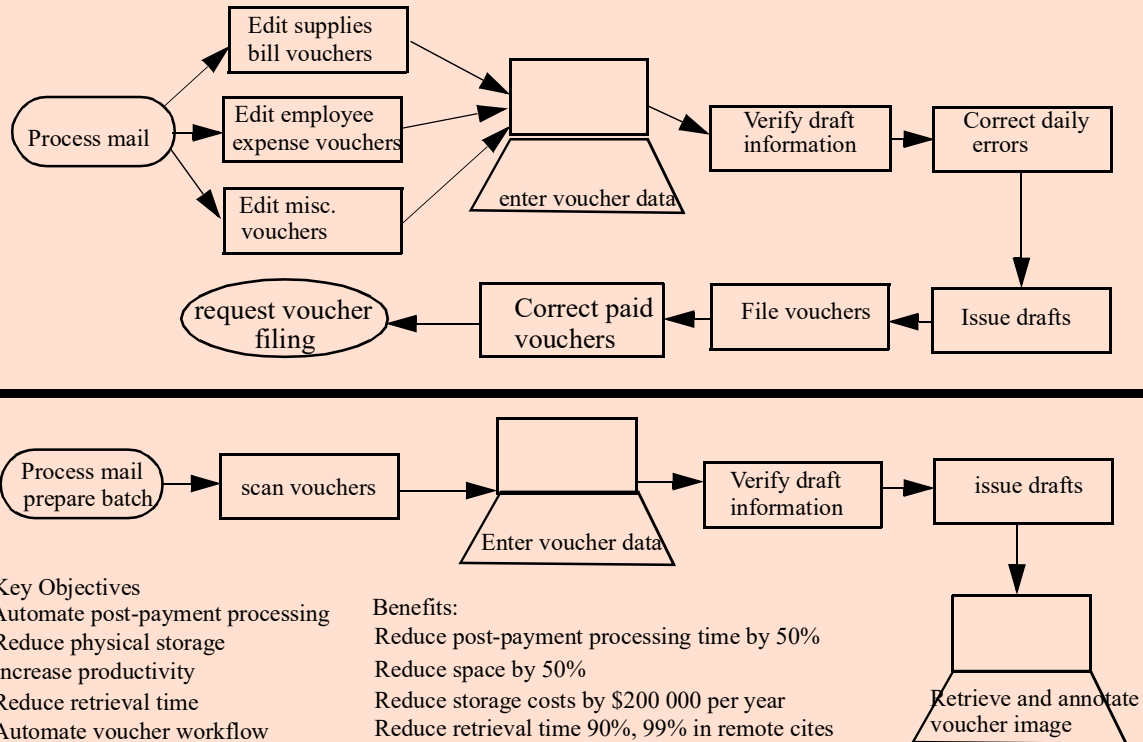
Chrysler, Xerox, and Caterpillar have gone through or are currently going through major reengineering.

REENGINEERING EXAMPLE

The development of an ABC system, described in Chapter 10, reveals the organization as *it is*. The reengineering of the enterprise involves changing the enterprise into *what it should be*.

INSIGHTS & APPLICATIONS

Reengineering: The Redesign of Business Activities

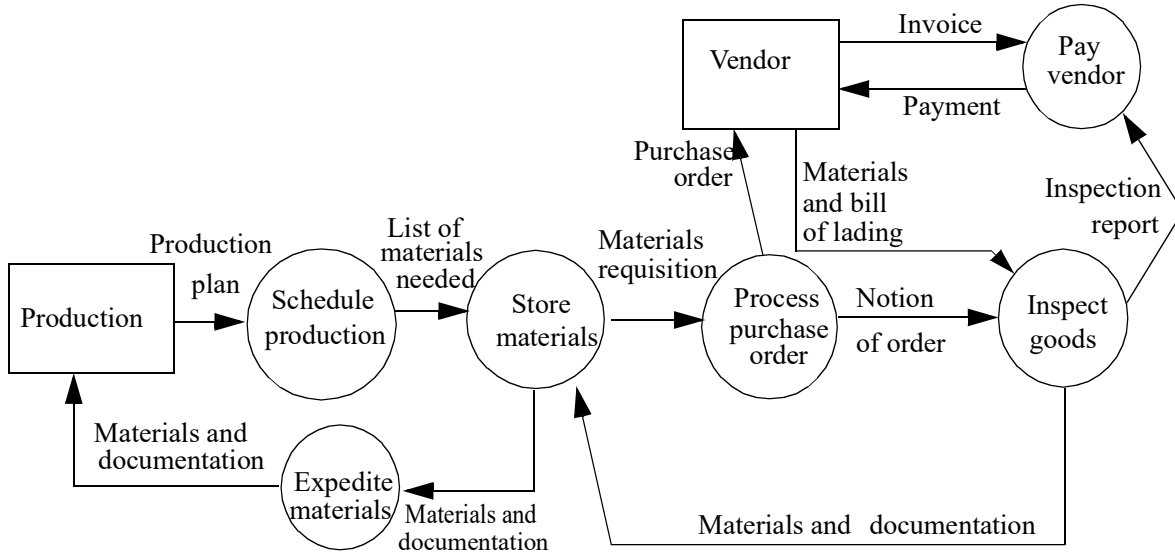
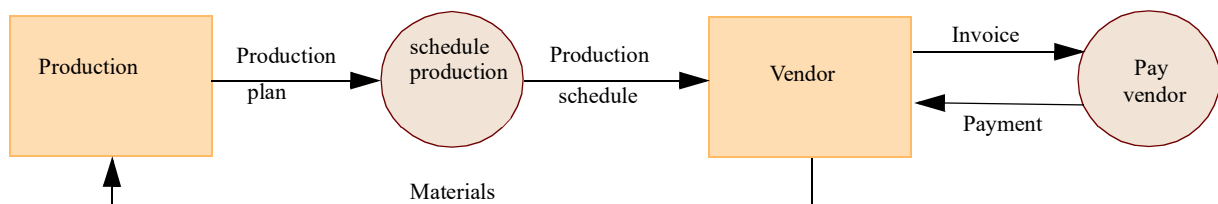


Consider the following procurement, storing, and materials handling activities:

- Schedule production
- Store materials
- Process purchase orders
- Inspect materials
- Pay vendor
- Expedite materials

The activity flow diagram in Exhibit 11-3 shows these activities. This exhibit represents the organization as it is.

How can this entire materials handling process be reengineered? (The results are presented in Exhibit 11-4.) The production schedule can be sent directly to the vendor who will deliver materials in accordance with the schedule. The vendor is paid weekly (possibly through EDI) on the basis of materials received. Therefore, the new process eliminates all the nonvalue-added activities except schedule production and pay vendor.

Exhibit 11-3 Activity-Flow Diagram Showing Materials Handling Activities Currently Being Performed**Exhibit 11-4 Activity Flow Diagram Showing Materials Handling Activities after Reengineering**

The parts can be delivered directly to the plant floor as needed as in a just-in-time system. Once the entire materials handling process has been re-engineered, it is no longer necessary to inspect and count parts when they are delivered or to place the parts on the shelf in the storeroom. Eliminating these activities reduces overall costs and the cost of products that no longer use these activities.³

The results of the reengineering are shown in Exhibit 11-4. This activity flow diagram models the materials handling process as *if should be*. Other methods may also be useful in re-engineering activities. For example, installing a kanban system, as described in Chapters 2 and 13, can help eliminate certain nonvalue-added activities as in the case on the next page.

3. Peter B. B. Turney, "Activity-Based Management," *Management Accounting*, January 1992, p. 24. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

GETTING AT THE ROOT CAUSE OF COSTS

In some instances, nonvalue-added activities, such as moving materials, cannot be totally eliminated. The enterprise may therefore be tempted to try to make this nonvalue-added activity more efficient. The focus, however, should be on root cause of moving materials activity costs and determining what can be changed to reduce these costs. For example, the costs of The moving materials activity are driven not only by the activity driver, such as number of pallets moved, but also by the physical layout of the plant, which is the underlying root cause of the moving materials costs. To reduce the materials moving activity costs, perhaps the physical layout of the plant should be re-engineered.

INSIGHTS & APPLICATIONS

Boeing's Ultimate Engineering Test

Activities are the focal point of *total* cost management. They must be engineered, benchmarked, and managed to achieve a competitive advantage. Rather than “slash-and-burn” downsizing, companies should concentrate on how efficiently resources are being deployed.

After examining themselves, often from a customer perspective, some companies realize that the original organizational structure has become dysfunctional, leading to certain corporate death. Reengineering

the organization activity-by-activity creates an enterprise fit to compete in the 90s and beyond. William Selby, head of parts production at Boeing says, “We saw right away that if we failed to cut costs, we risked a fall in profits, then a decline in our ability to develop new products. It would be the beginning of a death spiral.” CEO, Frank Shrontz says that Boeing is going to have to do things differently (re-engineer) to survive.

For much of its history, Boeing was insulated from the competitive fires that forged lean companies in steel, paper, autos, and computers. No wonder Boeing's warehouses bulge with inventories, while production often proceeds at the slow, zigzag pace of a cropduster. Today, Boeing is overcoming the drag of its hierarchy and reengineering the way it designs and builds its complex products.^a

a. Adapted from Shawn Tully, “Can Boeing Reinvent Itself?” *Fortune*, March 8, 1993, pp. 66-73.

For another example, insertion of components into electronic boards is a activity. To reduce insertion costs, management may be encouraged to replace Insertion Labour with an automated insertion machine. The acquisition of tire machine makes the insertion activity more efficient, but has it increased the company's profitability and competitiveness? Perhaps not, because the company has treated the symptom, which is high insertion cost, rather than the root cause of the cost. The root cause of the insertion activity is the state of technology and product design. The current state of technology allows surface mount technology to replace the insertion activity. Rather than increase the efficiency of the insertion activity, an alternative is to invest in surface mount technology. Similarly, the need for the insertion activity might be reduced or eliminated through the redesign of products. In both cases, the company should address the root cause of the need for insertions *before* attempting to improve efficiency. Again, the objective is to correct the source of the cost rather than treat its symptoms.⁴

KEEPING IT SIMPLE

Simplicity is the watchword of re-engineering. Generally, *complexity* is what drives costs; it represents the root cause of costs. Here are just a few complexities that drive costs: Excessive number of vendors

- Excessive number of purchase orders
- Excessive number of accounts payable
- Excessive number of parts
- Excessive number of product engineering changes
- Excessive number of schedule changes
- Excessive number of products

4. James A. Brimson, *Activity Accounting* (New York: John Wiley. 1991), p. 69.

- Excessive number of features, options, and accessories
- Complicated and outdated production activities

Analyzing these complexities enables management to treat the root cause of costs rather than the symptoms. For example, consider the case on the next page.

INSIGHTS & APPLICATIONS

Kanbans Help Reengineer Activities

The buyers at Stanfield Industries received weekly printouts of the production plan and material requirements.

The buyers visited the stockroom to compare the requirements with the quantity on hand. If there was a shortfall, the buyers called the appropriate vendors and placed orders. During activity analysis for the purpose of developing an activity-based costing system, it was suggested that this procurement activity be replaced. The activity was replaced with a kanban system that automatically triggers the replenishment of direct materials.

IBM simplified its ProPrinter as a result of activity analysis. IBM achieved significantly lower product costs by redesigning the ProPrinter with fewer parts, thus reducing the number of vendors and the costs of parts, manufacturing, storage, and handling. For another example of how reducing complexity can lower costs, read the case on page 504.

PHASE 3: BENCHMARKING VALUE-ADDED ACTIVITIES

The “should-be” model prepared during the re-engineering phase represents an organization that contains only value-added activities. Just because an activity is value-added, however, doesn't mean that it is performed efficiently and effectively. So, the next phase in the ABM process is **benchmarking**, which involves comparing activities to world-class best practices. Comparisons are made to a similar activity in another company or another part of the organization. The enterprise doing the benchmarking tries to set targets that equal or surpass the best-practices benchmark.

WHERE SHOULD BENCHMARKING BE DIRECTED?

Benchmarking should be directed to both world-class competitors and to organizations *outside* the industry. By seeking knowledge from outside the industry, an enterprise may encounter innovations that improve on the accepted industry best practices.⁵ For example, Xerox benchmarked L. L. Bean, a premier mail order company, to see how it handled customer orders.

Before performing benchmarking at another site, the company doing the benchmarking should thoroughly understand its own activities. The key activities that appear to be most problematical should define the *activities to* be benchmarked in the subject companies.

5. Gregory H. Watson, *The Benchmarking Workbook* (Cambridge, Mass.: Productivity Press, 1992), p. 5. With permission.

INSIGHTS & APPLICATIONS

How Activity-Based Costing Information Reduced Costs at B D Tool Company

B & D Tool Company makes a wide array of handtools for the retail trade. The activity-based costing system indicated that the number of parts was a significant cost driver. This driver was causing exceptionally high procurement, inspection, receiving, storage, and parts database maintenance costs.

The cost information motivated design engineers to redesign many of the products to use fewer unique parts. In three years, the part count for one division fell from about 5,000 to 800 while the number of vendors fell from over 1,200 to 100. The costs of the activities being consumed by parts count were reduced 70 percent. In addition, quality, functionality, and maintainability of the products improved substantially. Moreover, 15 different products that had been manufactured on separate sequential production lines were redesigned to be manufactured as a family of products on *one* U-shaped production cell.

The fundamental purpose of a site visit is to collect information about the activities the company has selected for benchmarking. Interviewing and observing are the key tools as the company seeks answers to the following questions:

INSIGHTS & APPLICATIONS

Trying to Eliminate Nonvalue-Added Cost at Nept Company

Nept Company was in the truck manufacturing business for nearly ten years, but lost its business to stronger, more efficient competitors. Now, Nept has downsized and is making lawn mowers, but the company is finding that it still can't compete. New management has been brought in to see if it can turn Nept around. Gilland Matthews, the new management accountant, makes a survey of operations.

He discusses his findings with Marla Gleason, the plant manager. "Why is the product just sitting there?" asks Gilland. "Why does it take three months to get the product through work-in-process when the engineers say it should only take two days to produce it?" "We're working on it," says Marla, "by eliminating excessive handling and rework." "And the way we make motor blocks is a mystery to me. We pour our castings and then turn around and machine off 70 percent of the material! Why do we do that sort of thing? Why do we have all that excess material in the first place?" asks Gilland. "Yes, I realize Nept's casting equipment and procedures are outdated. We are changing over to new casting and machine technology, which should eliminate most of the scrap."

"I realize that we're all new here and we've got a lot of work to do to eliminate all of Nept's nonvalue-added activities, but I have one more question," says Gilland. "And what's that?" Marla asks? "I just got through reviewing the bill of materials for our Model 12-C mower, and I discovered 60 different screws, bolts, and nuts. I'm not an engineer, but isn't that an example of another nonvalue-added situation?" asks Gilland. "How so?" asks Marlo. "Well, I went into assembly yesterday, and I saw a worker there and he was saying, 'Hey, Bill, toss the Phillips screwdriver.' And Bill tosses the Phillips screwdriver. Then, Bill asks somebody else if he has seen the half-inch box wrench, and on and on. I couldn't believe the inefficiencies caused by so many different screws, nuts, and bolts, and workers looking for different tools to assemble them.

Can't we make our mowers with a few standardized screws, nuts, and bolts? Or maybe use some plastic snaps instead?" asks Gilland. "Well, we're in the process of selecting and acquiring automatic wrenches and screwdrivers and devising a method for keeping them organized and handy for the workers," answers Marla, confidently."

"Apparently I'm not getting my point across," says Gilland, somewhat frustrated. "The point is that having so many different parts is nonvalue-added. Redesigning and standardizing a few parts will increase efficiency of assembly, and you won't need as many tools." "Well, you'll have to talk to engineering," says Marla. "The engineers design'em and we build'em." "Maybe what this company needs more than anything is a Department of Common Sense," says Gilland, not hiding his sarcasm.

- How do we do it?
- How do the best in the class do it?
- How can we do it as well or better?

Benchmarking is *not* industrial spying. A high code of ethics is necessary in conducting benchmarking studies. For example, when people at Xerox perform benchmarking, they ask that proprietary or confidential information not be divulged to them.

BENCHMARKING EXAMPLE

Benchmarking is the key tool for performing continuous improvement or additional reengineering. Once best-practices activities are identified, they become the targets to meet or exceed. Exhibit 11-5 illustrates a benchmark action plan to surpass a 97 percent on-time delivery benchmark.

Exhibit 11-5 Benchmark Action Plan

Activity benchmarked:	Shipping
Activity driver:	Number of shipments
Benchmark:	
Company:	Thoretic Industries
Dates observed;	03/22
	04/09
	04/17
	05/21
	06/18
Benchmark: 97% on-time delivery	
Performance measurement to be used to monitor continuous improvement:	Percent on-time delivery
Milestones	Targets
Short term:	90% on-time delivery
Intermediate term:	95% on-time delivery
Long term:	98% on-time delivery
Breakthrough:	100% on-time delivery

One of the most common pitfalls of benchmarking is to simply copy or cherry pick from successful companies. Merely copying activities from other organizations often ignores underlying factors that made the activity successful, such as empowering workers and effective training programs.

BENCHMARKS ARE NOT STATIC

A benchmark does not remain the same over time. Competitive market forces tend to drive benchmark performance trends to ever-higher levels of attainment. Indeed, a benchmark performance does not remain the best practice for long.⁶ Therefore, the original target set is actually *a moving target*. Thus, the ABM process is dynamic and must be repeated periodically for vigilant reassessment. Superior performance, or *dantotsu* in Japanese, means “striving to be the best of the best.”

INSIGHTS & APPLICATIONS

What is a Management Accountant Doing Here?

Nathan Weeks, management accountant at Automatic Feed Company, reengineered the production scheduling system, but it had never been benchmarked. Mr. Weeks, along with vice president Peter Beck, attended an Association for Manufacturing Technology scheduling conference to benchmark data and determine other scheduling improvements that may be applicable.

At the meeting, the moderator asked what type of managers were represented. There were presidents, vice presidents of manufacturing, production superintendents, and so on. The moderator asked if there were any other types. After a jab from Peter, Nathan said that he was a “treasurer.” The group erupted with laughter.

One person in the audience quipped, “Why would a bean counter be here?” Nathan replied, “If we could learn to schedule better and obtain one additional inventory turn per year, our company could reduce working capital requirements by \$1 million.” The laughter ceased and the person who had led the joking said, “Good answer, good answer.” After the conference, Nathan and Peter discussed some areas for improvement. But overall, they were satisfied with their scheduling system's competitiveness.^a

a. Adapted from Nathan W. Weeks, “The Accountant as Production Scheduler,” *Management Accounting*, March 1993, pp. 25-28. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

6. Ibid., p. 17.

PHASE 4: DEVELOPING A PERFORMANCE MEASUREMENT SYSTEM FOR CONTINUOUS IMPROVEMENT

Several studies have documented managers' frustration with existing performance measurement systems. Most notable was the survey jointly sponsored by the National Association of Accountants (now Institute of Management Accountants) and Computer Aided Manufacturing-International (CAM-I), in which 60 percent of the 260 financial officers and 64 operating executives surveyed stated that they were dissatisfied with their performance measurement system.⁷ Common complaints were that the performance measurements were:

- Too financial
- Irrelevant
- Difficult and complex to understand
- Unclear as to the linkage between activity measures and the enterprise's strategic objectives
- Not customer-driven

Management accountants have long found performance measurements to be valuable tools, but like all tools, they need periodic review to eliminate some, update others, and add new ones to meet changing needs. In the past, some management accounting performance measurements were used to punish. Today, the primary purpose of management accountants' performance measurements is to bring about improvement and make the enterprise successful. A well-designed performance measurement system can be used to encourage day-to-day actions that improve vendor performance, reduce lead times, increase productivity, satisfy customers, and improve quality (total quality management is the subject of Chapter 12).

INSIGHTS & APPLICATIONS

How Are We Doing?

On the sixth day of the month, Carl, the plant manager, walks apprehensively into the controller's office and asks, "Linda, how did the plant do last month?"

"Well, we had an unfavorable purchase price variance of \$70,000 and an unfavorable labor efficiency variance of \$50,000, but don't worry, the favorable overhead absorption variance of \$200,000 more than offset them."

"Wait! Stop! I asked how the plant did last month. I know for a fact that our quality teams improved setup times.

I also know that we missed three very important scheduled shipments! I don't want gobbledegook, I want to know how we did!" Carl is now pacing hurriedly around Linda's office, waiting for an explanation.

"Oh," replies Linda, "Sorry, I should have also pointed out that our revised LIFO reserve estimate and an increase in our tax provision due to a new Federal ruling adversely affected us last month. We should be able to counter that this month by adjusting our bad debt reserve."

To this response, Carl simply shrugs his shoulders, turns around to go back to his office, and mumbles something about "bean counters." If Carl has a difficult time understanding the plant's performance, imagine how well senior management understands the plant's performance. Current manufacturing performance measurement systems are inadequate, but what can be done? Activity-based management helps answer this question.^a

a. Adapted from Mark E. Ueishel and K. Richard Smith, "Linking the Shop Floor to the Top Floor," *Management Accounting*, October 1991, p. 25. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

The only way to improve continuously is to measure continuously the value-added activities and critical success factors of the enterprise. **Performance measurements** ascertain the work done and the results achieved in an activity. They are the devices that determine

7. Robert A. Howell, James D. Brown, Stephen R. Soucy, and Allen H. Seed III, *Management Accounting in the New Manufacturing Environment* (Montvale, N.J.: Institute of Management Accountants, formerly the National Association of Accountants, 1987). With permission.

or calculate the level of execution or accomplishment. The following performance measurements are stressed in this chapter:

- Vendor performance measurements
- Time-based performance measurements
- Productivity performance measurements
- Customer satisfaction performance measurements

Developing and using a performance measurement system is the key to continuous improvement and cost management.

Building and using a performance measurement system destroys clichés, such as the following:

- “That’s the way we’ve always done it.”
- “If it ain’t broke, don’t fix it.”
- “Don’t rock the boat. Leave well enough alone.”

Such attitudes will not allow companies to achieve success, or even survive, in an increasingly competitive marketplace. For companies that are operating at the margin, such attitudes will prove disastrous. But even efficient and economic enterprises have room for improvement. If these enterprises stand still while their competitors move forward, then they are really moving backward.

SETTING TARGETS

A **target** is a numerical value set by management or customers. Targets can also be derived from benchmarking. For example, assume that during benchmarking an enterprise discovers that the best-practice setup time is 5 minutes. Therefore, the enterprise may establish a target of 10 minutes to be achieved by the end of the quarter, 7 minutes by the following quarter, and 4 minutes by the end of the year. When short-term, intermediate-term, and long-term targets are set, people do not become discouraged trying to meet or exceed targets in the short run. Setting ongoing targets is essential to implementing continuous improvement. Appropriate performance measurements indicate how well the company is meeting or exceeding its targets.

Performance measurements put problems in a proper perspective. Almost daily, managers hear about many problems, receive voluminous computer printouts, and listen to a host of conflicting complaints. Often, this situation leads to confusion and the setting of wrong priorities. Relevant and consistent performance measurements that show trends help managers cut through the clutter and stay focused on the company’s targets instead of emotional issues. Moreover, performance measurements can alert managers to opportunities as well as problems,

RULES FOR DEVELOPING PERFORMANCE MEASUREMENTS

The following rules will help develop a viable system of performance measurements:

1. Performance measurements should be supportive of company goals and strategies. They should be traceable to the activities that they measure. They should also be linked to each other for consistency and goal congruency.

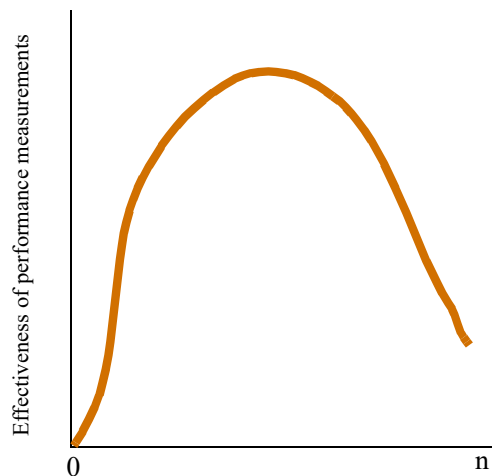
2. Performance measurements should be quantifiable. In many instances, ratios serve as appropriate measures. Performance measurements should be appropriate for graphical or other visual display. Many world-class manufacturers display the results of performance measurements throughout the day on boards, charts, or graphs located adjacent to production cells. For an example of how this is done, review the discussion of the visual factory in Chapter 2. Such direct reporting methods can be useful motivators because shop floor personnel are able to monitor their own performance on a continuous basis and the results are displayed for all to see.

3. Performance measurements should be simple, so the person performing or managing the activity can easily and quickly understand the measure. The relationship between performance and the measure of the performance should be readily apparent and easy to explain to other people.

4. Performance measurements should induce beneficial behavior. The people who are being measured must have confidence in the accuracy and relevancy of the measure. Performance measurements should not be influenced directly by factors that are not controllable by the person responsible for the activity being measured. People who are involved and readily accept the performance measurements are likely sources of suggestions for continuous improvement.⁸

If a firm measures and reports the results of someone's work, that person will be motivated to improve. People concentrate on whatever is measured. Appropriately selected performance measurements give a clear signal to all people in the company about the priorities of the enterprise. But performance measurements themselves must be checked occasionally to see if they are causing dysfunctional behavior. If so, they should be re-evaluated and changed.

Exhibit 11-6 The Law of Diminishing Marginal Utility as It Relates to the Number of Performance Measurements



5. Performance measurements should focus on the positive aspects as well as the problems. As a rule, all performance measures should point out what has been done right,

8. Jack Baffles, Ilene Kleinsorge, and Larry White, "How Support Services Can Use Process Control," *Management Accounting*, October 1992, 13.47. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

rather than emphasize the negative. For example, it is better to express production efficiency as a yield of good product rather than as a reject rate. It is better to show the orders shipped to customers on time than the number of late shipments. In other words, the shipping activity had a 98 percent on-time delivery performance this week rather than a 2 percent late delivery performance. This practice may be somewhat cosmetic, but it emphasizes that everyone in the organization is concentrating on getting better and better. As in sports, emphasis is on wins rather than losses, hits rather than strikeouts. Athletes, like workers, are motivated by seeing their improvement result in an increase in the performance measurements (e.g., a graph going upward) rather than in a decrease in errors. Sometimes however, a graph going downward indicates positive performance, as in time-based performance measures.

6. Performance measurements are intended to foster improvement rather than serve as monitors. Therefore, they should show clearly where improvement has been made and where more improvement is possible, rather than merely monitor people's work.⁹ Fast feedback also permits people to understand their work and to resolve problems quickly when they arise. Measurement that is too infrequent may not disclose undesirable variation in performance

There will always be areas for improvement, and new problems will occur as products and production change. Continuous improvement is a never ending journey. When certain targets are reached, it is time to look at changing activities that can take performance to a new plateau.

7. Too many performance measurements can confuse people and actually obscure rather than enlighten. The number of performance measurements that can be used effectively is governed by the law of diminishing marginal utility. Just as the *n*th glass of water will drown a thirsty person, the *n*th performance measurement will consume more time and incur more cost than it is worth. Exhibit 11-6 shows this relationship¹⁰. After the optimum point is reached, adding more performance measurements will result in dramatic decline in their effectiveness.

LINKING PERFORMANCE MEASUREMENTS THROUGHOUT THE ENTERPRISE

At the activity level, nonfinancial performance measurements are normally more important than financial performance measurements, because activity operating performance translates into financial performance¹¹. Management's goals are both financial and nonfinancial, however, so performance measurements that reflect both of these goals need to be developed. Traditional financial performance measurements concentrate on the following: Sales and market share

- Return on investment (ROI) or return on assets (ROA)
- Net income

9. Maskell, op. cit., p. 37.

10. Richard S. Sloma, *How to Measure Managerial Performance* (New York: Macmillan, 1980), p. 11.

11. Allen H. Seed III, *Adapting Management Accounting Practice to an Advanced Manufacturing Environment* (Montvale, NJ: Institute of Management Accountants, formerly the National Association of Accountants 1988), p. 72. With permission.

INSIGHTS & APPLICATIONS

Toyota's idea of Continuous Improvement

Doing everything the same old way is sure to produce the same old results, and nothing is more wasteful than doing with great efficiency that which is totally unnecessary. To remain competitive, managers and workers must continually improve the performance of value-added activities from the executive suite to the shop floor. No enterprise can rest on its past success or performance. Improvement is not a one-shot task that can be completed in a few months. Improvement to activities, products, and services must be continuous and ongoing. Objective performance measurements help managers and workers understand how well they are improving. Indeed, if performance is to be improved, it must be measured. A sound performance measurement system makes performance *visible* and provides *feedback* that helps everyone do a better job.

Toyota's managers and workers are committed to the concept of continuous improvement or *kaizen*. One consultant calls Toyota's continuous improvement strategy "rapid inch-up." It's another way of saying, "Take enough tiny, fast steps and pretty soon you outdistance the competition."

Toyota considers continuous improvement as a dynamic process where workers and managers constantly seek perfection by removing constraints and nonvalue-added activities. Toyota has long recognized that continuous improvement, in concert with total quality management, IT systems, target costing, and life cycle costing, has contributed substantially to the production of high-quality, low-cost products. Clearly, such a strategy works for Toyota because it is a top company in quality, productivity, and efficiency.

Nevertheless, it keeps getting better. Toyota's viewpoint is "Our current success is the best reason to *change* things." This proactive stance replaces the cliché, "If it ain't broke, don't fix it" with, "If it ain't broke, you haven't looked hard enough." At Toyota, cost information is used to *manage* activities. Linking cost management with continuous improvement enables managers and workers to focus on activities.

Performance measurements assist Toyota in decreasing leadtimes and increasing quality, productivity, and customer satisfaction. This focusing on activities represents a major paradigm shift from the cost-cutting mindset of many other organizations.

- Earnings per share

Many people, especially investors, boards of directors, and executives appear to be hypnotized by these short-term financial measures. Most executives are rewarded largely according to how well they improve these measures, even though most agree that this practice does not contribute to the company's long-term health.

Return on investment (ROI), specifically return on net assets or equity, is affected because increases in automation increase costs in the short term and increase the proportion of investment in machinery and equipment to total investment.¹² Consequently, investments in automation tend to reduce returns in the short term. Old plants with fully depreciated assets show a higher accounting return than new plants with state-of-the-art technology. Thus, the more automated a plant becomes, the less relevant financial accounting performance measurements become.

INSIGHTS & APPLICATIONS

Linking Performance Measurements

Measuring individual activities with overall gross measures is similar to measuring a baseball player on his team's overall performance. It isn't fair to say that a player is no good because his team has a losing record. It is fair, however, to measure that player on RBIs, batting average, or on-base percentage because he can influence those measures directly.

In the manufacturing process, it is unfair to measure a foreman on cost of production as a percentage of sales because he cannot control sales price, sales volume, or many elements of cost. It is fair, however, to measure that foreman on machine uptime and setup time, which he can control and influence directly and which eventually will contribute to cost as a percentage of sales. As a baseball player's RBIs will contribute to a team's wins, the foreman's reduced setup times will contribute to improved plant performance *and* financial measures, such as return on assets and earnings per share.^a

a. Adapted from Beishel and Smith, op. cit., p. 26.

Using financial performance measurements to improve performance is like concentrating on the scoreboard in a football game. Although the scoreboard tells the coaches whether they are winning or losing, it doesn't provide them with much guidance as to which plays

12. Ibid., p. 86.

should be called. What the coaches need is information that ultimately affects the score, such as which running plays are most successful, how well the quarterback is passing, how well the defense is stopping the opponent's attack, and so on. In business terms, managers need performance measurements of the activities and prior outcomes that *lead* to superior financial *results*¹³.

Financial performance measurements often lead management to employ cost-cutting throughout the organization. Cost-cutting across the board is the conventional way to “manage costs,” but it results in reducing or eliminating both nonvalue-added *and* value-added activities. Such efforts work in the short run but usually fail in the long run, because they strip both “fat and muscle” from the organization.

Effective use of nonfinancial performance measurements leads to a reduced dependence on conventional financial reports as the only performance criteria that matter. Most people in an organization do not manage nor are they directly responsible for “dollars.” They manage activities and cost drivers that consume dollars. Therefore, focusing on activities that advance the competitiveness of the organization will lead to improved financial performance and ultimately improve profitability and enhance the value of the firm to shareholders.

A variety of performance measurements should be used. Whether nonfinancial or financial, they should be linked together to obtain a complete picture. No single performance measurement is perfect or all-encompassing, but a combination can be used to indicate trends and relationships.

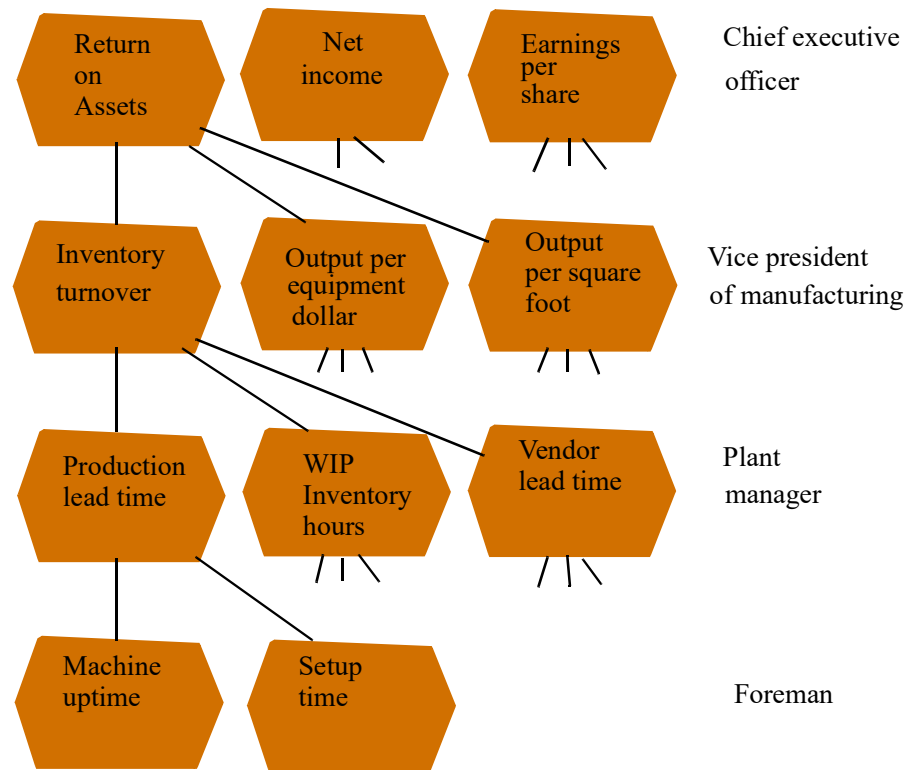
Decision making at *all* levels in the organization should be synchronized with the company's goals and strategy. Decision making without regard to goals and strategy can be very costly and counterproductive. Therefore, the company should develop a performance measurement system that communicates goals and strategy throughout the organization. For example, achieving shorter production lead times without improving customer satisfaction will not lead to organizational congruency.

Exhibit 11-7 presents an example of performance measurements linked at each organizational level. The chief executive officer's measure of return on assets is supported by or linked to the three performance measurements associated with the vice president of manufacturing: inventory turnover, output per equipment dollar, and output per square foot of plant. The performance measurements associated with the plant manager are production lead time, work-in-process inventory hours, and vendor lead time. These performance measurements are supportive of the vice president's inventory turnover performance measurement. At the foreman level, the performance measurements linked to production lead time are machine uptime and setup time.

Linking performance measurements at each level of the organization ensures congruency and constancy of purpose throughout. Workers and managers at each level can control their measures, and they understand clearly how they support the performance

13. Robert C. Eccles and Philip J. Perón, “Creating a Comprehensive System to Measure Performance,” *Management Accounting*, October 1992, p. 41. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

Exhibit 11-7 Example of Linking Financial and Nonfinancial Performance Measurements at All Levels in the Organization



measurements above them. They also know where to look to correct problems that are causing poor performance.¹⁴

Notice that the performance measurements at the chief executive officer's level are financial. At the vice president's level, they are financial *and* nonfinancial. At both the plant manager's and the foreman's level, they are nonfinancial (or physical).

Activities performed in any enterprise ultimately affect the company's financial health. Shareholders, investment analysts, competitors, and customers measure companies primarily in financial terms. Although overemphasized in the past, financial measures are very much a reality and provide good aggregate measures of an enterprise's overall financial health. By linking nonfinancial physical measures to financial measures, management accountants are not subordinating physical measures to short-term profits, they are supporting the financial health of the enterprise with sound decisions regarding the company's activities. The point is that decisions made about activities *do* impact financial results and therefore the two should be linked.¹⁵

The performance measurements for managers and workers in the plant should reveal whether the activities are leading to simpler, faster, and better production. The financial performance measurements at the top are checks on the success of re-engineering and continuous improvement of activities. For example, reduced production lead time and

14. Ibid.

15. Ibid., pp. 27-28.

increased productivity will eventually show up in improved profitability and return on assets.

VENDOR PERFORMANCE MEASUREMENTS

Poor-quality inputs will limit the quality of outputs and the effectiveness and efficiency of production activities. Because manufacturers commonly spend 50 percent or more of their sales dollars on raw materials, it is assumed that a corresponding amount of quality problems come from vendors. Vendors must meet standards of:

- Quality
- Price
- Delivery time

A **vendor certification program** selects vendors that can meet these standards. Generally, certified vendors are given five-year contracts and have access to production schedules. Non-certified vendors are classified as:

- Acceptable
- Probationary
- Unacceptable

With a certification program, manufacturers are often able to reduce the number of vendors to only 10 to 20 percent of the original number and reduce, if not eliminate, non-value-added activities, such as ordering, inspecting, and counting.

Certified vendors become extensions of the enterprise. For example, Xerox reduced its vendors from 5,000 to 400, trained them, included them in the design of products, provided specifications, and informed them of Xerox's production schedules. As a result, product costs decreased 10 percent per year and rejects decreased by 93 percent. Indeed, it is a lot easier and less costly to deal with 400 vendors than with 5,000.

A **vendor financial performance measurement**, presented in Exhibit 11-8, discloses unnecessary costs caused by a vendor's nonconformance with specifications for quality and delivery schedules. Vendor nonconformance means that the buying company has to perform nonvalue-added activities that would otherwise be unnecessary, such as those listed on page 513 and in the exhibit.

Exhibit 11-8 Vendor Financial Performance Measurement

Nonvalue-Added Activity	Labor Hours per Occurrence	Cost at \$60 per Labor Hour
- Inspection rejection	0.4	\$ 24
- Paperwork rejection	0.2	12

- Rework at company	5.0	300
- Materials received too early	4.0	240
- Materials received too late	8.0	480
- Excess materials	1.0	60
- Short materials	4.0	240
Totals	22.6	\$ 1,356
Total cost of purchased raw materials:		\$33,900
Vendor performance index (VPI)	= (\$33,900 + \$1,356) / \$33,900	
	= 1.04	

- Inspection rejection
- Paperwork rejection
- Rework at company
- Material received too early
- Material received too late
- Excess material
- Short material

The management accountant assigns labor hours per nonvalue-added activity. For example, inspection rejection may take 0.4 labor hours while rework, if done at the company, may require 5.0 labor hours. Then, it's just a matter of multiplying the labor hours by the total cost per labor hour, which is \$60. The results of each delivery are entered in the vendor's record stored in the database. A vendor financial performance measurement record can be set up in the database for each vendor and data compiled over a 6- or 12-month period to derive a valid performance profile. Such profiles enable management to make vendor decisions, that is, eventually to select certified vendors.

The **vendor performance index (VPI)** is calculated by:

$$\text{VPI} = (\text{Cost of purchased raw materials} + \text{Cost of nonvalue-added activities}) / \text{Cost of purchased raw materials}$$

if the vendor does not cause nonvalue-added activities, then the VPI will equal one. Anything above one is an indication of some form of vendor nonconformance. A VPI of 1.02 to 1.04 may place a vendor on acceptable or probationary status. A VPI greater than 1.04 may be sufficient to eliminate a vendor from doing business with the company. A VPI close to one over a period of time is sufficient for a vendor to achieve certification status.

The VPI can also be used as a bid multiplier for determining the “true” cost of purchasing from a particular vendor. To illustrate, consider the following bid for a part Y:

	Vendor A	Vendor B
Bid price for part Y:	\$100	\$110
x VPI	1.4	1.0
Total cost per part Y:	\$140	\$110

Based solely on the bid price, Vendor A is the low-cost vendor. After considering past quality and performance as measured by the VPI, Vendor B provides the better overall value.

In high-velocity manufacturing environments, the VPI may be computed daily or weekly. The VPI is also used to compare vendors with similar complexities of supply

and material. In time, the absolute best vendors in each area will emerge as potential certified vendors. Other vendors will fall into one of three categories:

- Acceptable (these vendors are working toward certified status)
- Probationary (these vendors are on the boundary of what is acceptable)
- Unacceptable (the company will not do business with these vendors)

VENDOR NONFINANCIAL PERFORMANCE MEASUREMENT

A vendor nonfinancial performance measurement is presented in Exhibit 11-9. It rates the following performance measures on the basis of points:

- Quality
- Price
- On-time delivery
- Bonus.

Exhibit 11-9 Vendor Nonfinancial Performance Measurement

Goal:	100+ points for certification
Acceptable:	95-99 points
Probationary:	90-94 points
Unacceptable:	<90 points
Performance measurements:	
Quality:	40 points
	Zero rejections = 40 points
	One rejection = 30 points
	Two rejections = 20 points
	Three rejections = 0 points
More than three rejections = -40 points	
Price:	
	20 points
	Better price than similar vendors = 20 points
	Competitive price with similar vendors = 10 points
	Higher price than similar vendors = 0 points
On-time delivery:	
	40 points
	100% on time = 40 points
	Each percentage point <100% = -2 points
Bonus rating:	
	20 points
	Superior performance = 20 points
	Exceeds goals = 10 points
	Acceptable = 0 points
	Needs Improvement = -10 points
	Unacceptable = -20 points

To meet the criteria for selection as a certified vendor, a vendor must provide zero- or near zero-defect material at a competitive price at the right time and be willing to improve continually. Although price is a financial measurement, it is not emphasized in the nonfinancial performance measurement in a dollars and cents fashion. In fact, “shop-

ping for the best price” is de-emphasized. For example, it is possible for a vendor to have a *higher* price than competing vendors and still reach certified vendor status, because the vendor excels in other performance measures. In a large number of situations, using price as the main selection criterion can be the costliest way to select vendors. What world-class managers want are a few vendors whom they can rely on for quality, on-time delivery, and general performance (e.g., co-operative attitude and willingness to try new technology such as EDI). As long as their prices are “in the ballpark,” they will remain certified vendors, and their relationship with the buying company will be a long and profitable one.

Vendors are audited weekly or monthly during the selection process. The goal is for each vendor to receive 100 or 100-plus points. A score between 95 and 99 points is acceptable but indicates a need for improvement. A score between 90 and 94 points puts a vendor on probation and indicates corrective action is needed before the vendor will be taken off probation. A score of less than 90 points means that the vendor's performance is unacceptable, and the vendor is eliminated as a vendor for the company. Usually, it takes anywhere from 6 to 12 months to build a reliable vendor performance score that can be used to certify a vendor. For many companies, having certified vendors is imperative because they are trying to become certified vendors of other enterprises. A vendor cannot become a certified vendor unless it also has certified vendors. Moreover, the vendor has to show continuous improvement if it is to continue to get the enterprise's business. For example, Intel, a vendor to PC manufacturers, has honed its vendor base down to an average of 1.6 vendors per part purchased. Intel's goal is one certified vendor per part.

PERFORMANCE MEASUREMENT THAT FOCUSES ON QUALITY

The **vendor quality performance measurement** focuses on the vendor's ability to deliver raw materials of consistently high quality. This performance is calculated as follows:

Acceptance percentage = (Number of parts accepted) / (Number of parts delivered)

A vendor who supplies 1,000 parts with 100 rejects would have a 90 percent acceptance percentage, calculated as follows:

Acceptance percentage = (900 parts accepted) / (1,000 parts delivered)
= 90% parts accepted

The buying company may set a target of 99.9 percent acceptance percentage, which is one rejected part per 1,000 parts ordered. In this case, an acceptance percentage of 90 percent is far from the company's quality target.

PERFORMANCE MEASUREMENT THAT FOCUSES ON ON-TIME DELIVERIES

The **vendor on-time delivery performance measurement** discloses the vendor's ability to deliver raw materials just-in-time, not too early and not too late. On-time deliveries are important, because early deliveries build up raw materials inventory and late deliveries disrupt production and cause wasteful expediting activities. Exhibit 11-10 gives an example of a bar graph used to track vendor delivery performance. As shown in the exhibit, Eksi is the only vendor that has a chance of becoming a certified vendor. In some companies that want just-in-time delivery, even Eksi would not qualify as a certified vendor, because the “delivery window” is usually measured in hours or minutes.

Exhibit 11 -10 A Bar Graph Used to Track Vendor Delivery Performance

Vendors	Number of Deliveries	Delivery performance for the week ending May 7											
Adams	20												
Brown	24												
Chen	17												
Eksi	32												
Zerga	18												
			-10	-8	-6	-4	-2	2	4	6	8	10	
		Days early						Days late					

PERFORMANCE MEASUREMENTS THAT FOCUS ON VENDOR SIMPLICITY

The **vendor simplicity performance measurement** calculates two values:

- The number of vendors per product
- The number of purchase orders per product

By reducing the complexity of activities and implementing a certified vendor program, a company can reduce the number of vendors and purchase orders, thereby streamlining vendor relations and reducing costs of vendor-driven activities.

As stated before, complexity is the main culprit that drives costs. Complex products require more vendors, and more vendors drive purchasing and materials handling activities, and so on. Therefore, to see how well the company is doing in simplifying vendor-driven activities, the following performance measurement is recommended:

$$\begin{aligned}
 \text{Number of vendors per product} &= (\text{Number of vendors}) / (\text{Number of products}) \\
 &= 1,000 / 10 \\
 &= 100 \text{ vendors per product}
 \end{aligned}$$

To measure how the number of vendors is driving the purchasing activity, the following performance measurement is recommended:

$$\begin{aligned}
 \text{Number of purchase orders per product} &= (\# \text{ of purchase orders}) / (\# \text{ of products}) \\
 &= 6,000 / 10 \\
 &= 600 \text{ purchase orders per product}
 \end{aligned}$$

Elimination of unprofitable products and the simplification of the remaining products will substantially reduce the number of parts required. A vendor certification program will reduce the number of vendors. And, the need for fewer parts and fewer vendors will, in turn, reduce, if not eliminate, the purchasing activity.

TIME-BASED PERFORMANCE MEASUREMENTS

The use of **time-based performance measurements** means that time is recognized as the equivalent of money, productivity, quality, and resources. Time is manageable and a source of competitive advantage throughout every activity in the organization. The longer an activity takes to perform, the greater the resources it requires. Also, the longer the activity takes, the more likely that work will have to be redone to correct mistakes or defects. Conversely, the shorter the elapsed time, the quicker the activity's response to changes in customer demand.

LEAD TIME

Lead time is the time between the beginning of a process or activity and the appearance of its results. Reducing lead times increases speed, and speed is the watchword of world-class manufacturers. Speed in world-class manufacturing falls into the following categories:

- Speed of design engineering in getting new products from the design stage to the production stage
- Speed of vendors in getting raw materials to the production process
- Speed of converting raw materials to finished products
- Speed of delivering finished products to customers

Notice the dominant role played by speed in the following definition of a world-class manufacturer of printed circuit boards:

- A facility with a capacity to assemble more than 300 printed circuit boards per eight-hour shift
- A lead time of less than 30 minutes per board from raw materials to ship time
- A setup time of less than 30 minutes for changing the type of board being assembled

The overall performance of an enterprise can be judged by its lead times.

LEAD TIME EFFICIENCY RATIO

The **lead time efficiency (LTE) ratio performance measurement**, introduced in Chapter 2, indicates the level of value-added and nonvalue-added activities in a process. A lead time is associated with every activity in an organization. The activity lead time efficiency ratio can be a:

- Design engineering lead time efficiency ratio
- Vendor delivery lead time efficiency ratio
- Production lead time efficiency ratio
- Customer delivery lead time efficiency ratio

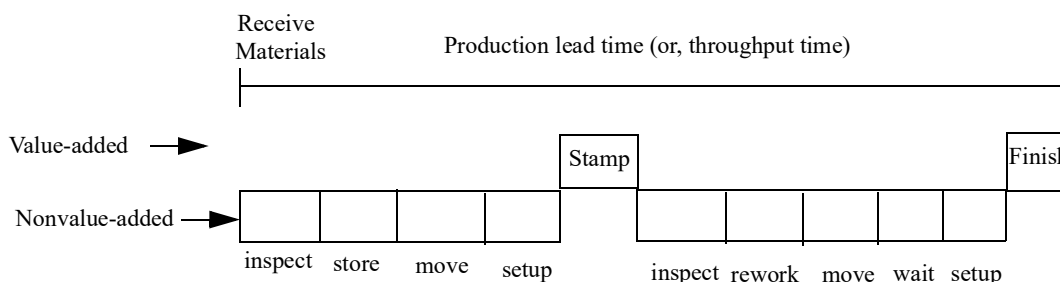
LTE ratios should be applied throughout the organization on the plant floor as well as in administrative offices.

Management's concern is that a large portion of costs are driven by a large number of nonvalue-added activities, as shown in the production LTE ratio presented in Exhibit 11-11. The **production lead time** is the interval between the acquisition of raw materials and first stage of production and the time that the finished products come off the production line.

Traditional batch manufacturers have an LTE ratio of 10 percent or less. If the production LTE ratio is 10 percent, that means that 90 percent of the production activities are creating no value. The challenge for cost management is to reduce the 90 percent. In some administrative functions, it is not unusual to see an LTE ratio of 1 percent or less¹⁶.

Exhibit 11-11 Production Lead Time Efficiency (LTE) Ratio Containing Value-Added and Nonvalue-Added Activities

$$\begin{array}{lcl}
 \text{Production Lead Time} = & \text{Process +} & \text{Inspect + Store + Setup + Move + Rework + Wait} \\
 & \text{Value-added activity} & \text{Nonvalue-added activity} \\
 \\
 \text{Production lead time efficiency} & = & \frac{\text{Value added activities}}{\text{Value-added activities + Nonvalue-added activities}} \\
 \text{ratio (LTE)} & &
 \end{array}$$



Note: From the time raw materials are received until the product is completed, nine nonvalue-added activities are performed compared to two value-added activities. The cost management opportunity is to eliminate as many nonvalue-added activities as possible and Reengineer the rest, such as redesigning setup procedures and installing production cells to reduce excessive material movement.

World-class manufacturers enjoy production LTE ratios of 40 percent or more, some as high as 70 to 80 percent. An LTE ratio of 80 percent means that only 20 percent of the production process includes nonvalue-added activities.

A perfect plant operation achieves a production LTE ratio of one, or 100 percent, as shown in Exhibit 11-12. Such a ratio will probably never be achieved, but by implementing the concepts of reengineering and continuous improvement, an enterprise can strive to bring nonvalue-added activities down to as low a level as possible, as indicated by the graph in Exhibit 11-12. To achieve production LTE ratios of one, the following conditions must exist:

- On-time delivery of high-quality raw materials
- Lot sizes equal to one
- Zero setup time
- Zero time between operations
- Zero defects
- Zero machine downtime

These conditions assume perfectly synchronized operations throughout the production process.

16. Robert D. McIlhatten, "The Impact of JIT on the Financial Executive: How Cost Management Can Support the A T Philosophy," in *Cost Accounting for the 90s: Responding to Technological Change* (Montvale, N.J.: Institute of Management Accountants, formerly the National Association of Accountants, 1988), p. 248. With permission.

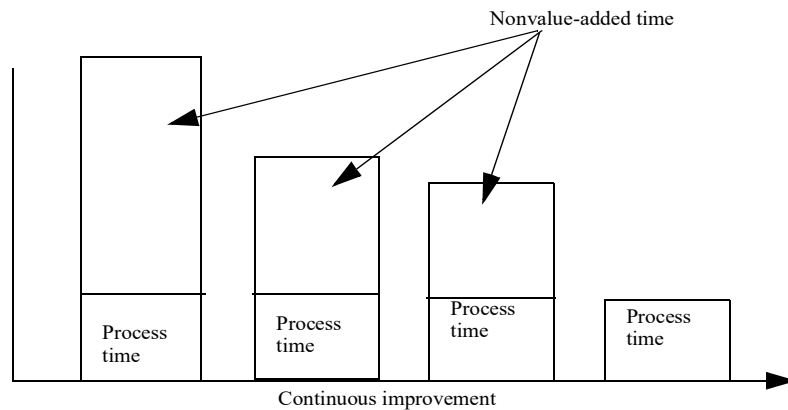
Exhibit 11-12 Production Lead Time Efficiency (LTE) Ratio of a Perfect Operation

Production lead time efficiency (LTE) ratio = process time / (process time + 0) = 1

Conditions for achieving an LTE ratio of 1:

lot size = 1
setup time = 0
time between operations = 0
defects = 0
machine downtime = 0

Note: Process time, a value-added activity, is the only time expended. All nonvalue-added activities have been eliminated. When this occurs, the ratio = 1.



WHAT ARE THE RESULTS OF IMPROVING THE LTE RATIO?

Reducing lead times and eliminating nonvalue-added activities improve everything. In Chapter 2, production activities were portrayed as pipelines. At one end, the company pays its vendors for raw materials entering the pipeline. At the other end, the company's customers pay for products delivered. The goal of the company is to reduce the time between payment on one end and receipt on the other. To accomplish this, the company needs to reduce, if not eliminate, nonvalue-added activities. Nonvalue-added activities in the production pipeline (or the administrative, marketing, and distribution pipelines) are like cholesterol in the arteries of a person. They cause problems and increase costs.

Improving the production LTE ratio produces the following positive results:

- Increased cash flow
- Increased profit
- Improved customer service
- Better quality
- Lower inventories
- Less spoilage, scrap, and rework
- Smaller lot sizes
- Faster responsiveness to changes in the marketplace

CONTRIBUTION MARGIN VELOCITY RATIO

The **contribution margin velocity ratio performance measurement** is based on the observation that profitability is a function of both the absolute profitability of a product and the production lead time; it is formulated as follows:

Contribution margin velocity ratio = Product CM / Production lead time

To illustrate the contribution margin velocity ratio, consider two products:

PRODUCT	Contribution Margin	Production Lead Time (Days)
A	\$55	5
B	42	3

Conventional cost accounting determines that product A is more profitable than product B, which is correct in absolute terms. But when the contribution margin velocity ratio is computed for each product, the following results occur:

Product A's contribution margin velocity ratio =

= Product A's contribution margin / Product A's production lead time

= \$55 / 5 days

= \$11 contribution margin per production day

Product B's contribution margin velocity ratio =

= Product B's contribution margin / Product B's production lead time

= \$42 / 3 days

= \$14 contribution margin per production day

The contribution margin velocity for product A is \$11 per production day while it is \$14 per production day for product B. Assuming sufficient demand for product B and holding other factors constant, the company would be more profitable selling product B than product A.

THE DELIVERY PRODUCTION RATIO

The **delivery production (D : P) ratio performance measurement** compares delivery lead time to production lead time. The **delivery lead time (D)** is the lead time required by customers to receive the product or service. The **production lead time (P)** is the lead time necessary to acquire raw materials and convert them into finished goods ready for shipment to customers.

Assume that the value of D is greater than P, such as:

Delivery: Production ratio =

= Production lead time (P) / Delivery lead time (D)

= 5 days / 10 days

= 0.50 times as long to produce as to deliver

In this case, the product can be made to order. The manufacturer, therefore, has a great deal of flexibility to change product mix and customize products.

The following D: P ratio shows that this product takes considerably longer to produce than to deliver:

Delivery: Production ratio =

= Production lead time (P) / Delivery lead time (D)

= 40 days / 10 days

= 4.00 times as long to produce as to deliver

In this case, the value of D is less than P, which means the product must be made to stock to anticipate and meet customer demand. If a product is made to stock, a substantial amount of finished goods inventory must be stocked to meet the required customer service level. In this example, it takes four times as long to make the product as it does to deliver the finished product to customers. The manufacturer not only has to spend money on holding and storing finished goods inventory, but must also prepare accurate sales forecasts. Also, the manufacturer cannot offer customized products because there is not enough time to make them. The company has restricted its ability to be flexible and responsive to customers' needs.

Generally, world-class manufacturers' objective is to reduce the D: P ratio continuously until it is less than one. However, producing products much faster than they are delivered will also build up inventory even though this situation gives the manufacturer a great deal of production flexibility. If a manufacturer wants to achieve a continuous flow and synchronized operation, as described in Chapter 2, then a D: P ratio of one is ideal:

Delivery: Production ratio =

= Production lead time (P) / Delivery lead time (D)

= 5 days / 5 days

= 1.00 times as long to produce as to deliver

In this way, production is synchronized with delivery, and vice versa. Such a situation means zero inventories and the elimination of all costs related to holding inventory.

INSIGHTS & APPLICATIONS

Reducing Inventories through Shorter Lead-Times

"We're beginning to see the critical nature of shorter lead times in the marketplace," stated Keith Buchell, newly hired management accountant. "How's that?" asked Marshall Evans, inventory manager.

"Lead time is a very powerful weapon. Some of our competitors are gaining additional market share simply because they deliver faster. I don't mean 10 percent faster. I mean 50 to 70 percent faster. And they're getting top prices for their ability to perform this way." "What does all this have to do with inventories?" asked Marshall.

"Well, work-in-process inventory is the same thing as lead time," Keith responded. "You've lost me," said Marshall, puzzled. "Look, if we have three months of work-in-process, it's going to take us an average of three months to get everything through the plant. And finished goods inventories should be proportional to production lead times," said Keith. "I still don't understand," Marshall responded. "We ship from stock. OK, if it takes us an average of three months to get something through the plant, we're going to need about three and a half or four months of finished goods inventory.

But if we can cut our lead time to one week, then we only need one and a half or two weeks of finished goods inventory. Plus, we can probably serve our customers better, and cash flow will increase." "I see," said Marshall. "If we reduce lead times, we can reduce inventories. If we can reduce inventories, we can drive costs down. We can probably also increase quality. All of this will make us more competitive." "Right," Keith responded, "and don't forget, improved productivity and increased customer service and satisfaction."

SETUP TIME

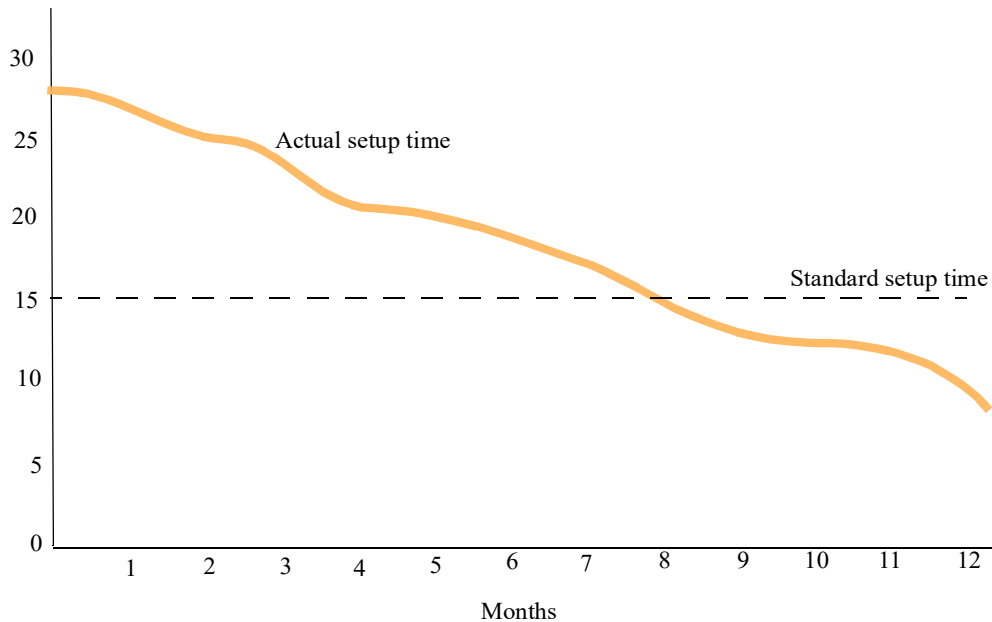
Setup time is the amount of time needed to change production facilities for a different product or service. Setup time is closely linked to a number of other activities, and the faster the setup time, the better these activities will be performed.

The reduction of setup time permits lot sizes to be decreased, thus shrinking work-in-process inventories. Reduced lot sizes, in turn, will enable production lead times to be reduced. Reduced production lead times will give the enterprise more flexibility and allow it to be more responsive to its customers. Reduced production lead times and deliv-

ery lead times (i.e., the D: P ratio) will reduce or eliminate the need for finished goods inventories.¹⁷

Indeed, decreasing setup time is a key element of continuous improvement, as Exhibit 11-13 illustrates. For example, a plant scheduled 40 machine setups for one week at 15

Exhibit 11-13 Graph Showing Improvement in Setup Time



minutes standard time per setup. The actual time for the first setup was 27 minutes, 12 minutes over the standard. By recognizing the unfavorable time variance when it first occurred, corrective action could be taken immediately to eliminate the 12-minute variance. At this point, a supervisor recommended engineering and procedural changes, which, over a 12-month period, reduced the actual setup time to less than 10 minutes, 5 minutes below the original standard setup time of 15 minutes.

The **setup time performance measurement** indicates how efficiently the production facilities are made ready to make another product or provide a service. Clearly, the goal of production management is to reduce the amount of setup time. One way to compute a setup time ratio follows:

Setup time =

= (Total setup time during the week) / (Number of setups)

= 600 minutes / 60 setups

= 10 minutes per setup

17. Maskell, op. cit., pp. 145-147.

MACHINE UPTIME

World-class manufacturing assumes a very high degree of reliability in production and does not tolerate machine failures or downtime. When the production process is ready, it is assumed that the machines will be ready to produce and be in good working order. Therefore, the **machine uptime performance measurement** determines the percentage of time the machine is ready for production when needed. Encapsulated in this one performance measurement are several factors such as the following:

Reliability

- Mean time to repair (Ideally, repairs shouldn't be needed, but if they are, the mean time to repair should be measured in seconds or minutes.)
- Effectiveness of preventive maintenance programs
- Effectiveness of training programs (Better training should produce machine operators who know how to operate machines properly and care for them.)

Just-in-time manufacturing does not necessarily use machines 100 percent of the time, because the philosophy is that an idle machine is preferable to a machine making product that is not needed immediately. But when a machine or cell is required to manufacture product, it must be able to go into action immediately. The following performance measurement indicates the percentage of time the machine is up and ready to process:

Machine uptime =

$$= 1 - (\# \text{ of hrs machine not ready for prod'n}) / (\# \text{ of hrs machine needed for prod'n})$$

$$= 1 - (2 \text{ hours}) / (100 \text{ hours})$$

$$= 1 - .02$$

$$= 98\% \text{ of the time the machine is up and ready to process when needed}$$

This performance measurement indicates that the machine is ready to process when needed 98 percent of the time. To some, this figure may represent a high degree of machine uptime, but to world-class manufacturers, 98 percent machine uptime may be intolerable, because they expect 100 percent machine uptime. This stringent target is the reason world-class manufacturers install comprehensive preventive maintenance programs. Production personnel are trained to perform basic daily and weekly preventive maintenance tasks, and emphasis is placed on the quality of product made by each machine. Care is taken to make sure that all machines are in peak condition *all* the time.

PRODUCTIVITY PERFORMANCE MEASUREMENTS

Although time-based performance measurements provide indirect measures of productivity, the following performance measurements can be used to measure productivity directly:

- Work force productivity performance measurement
- Direct materials yield performance measurement
- Activity productivity performance measurement

Productivity performance measurements ascertain the amount of outputs produced by inputs. Therefore, productivity is normally measured using ratios, such as the following.

$$\text{Productivity} = (\text{Outputs produced}) / (\text{Inputs consumed})$$

A successful enterprise must continue to improve its output of products and services in relation to the inputs of direct labor, direct materials, and activities.

WORK FORCE PRODUCTIVITY

The **work force productivity performance measurement** indicates the number of units produced per direct labor hour. It is calculated as follows:

Work force productivity =

= (Units produced during the day) / (Direct labor hours consumed during the day)

= 150,000 units produced / 3,000 direct labor hours consumed

= 50 units produced per direct labor hour

A decrease in the denominator with a corresponding increase in the numerator would mean that the work force is becoming more productive.

DIRECT MATERIALS YIELD

The **direct materials yield performance measurement** indicates how efficiently raw materials are being converted into finished products. Its ratio is computed as follows:

Direct materials yield =

= (# of finished units produced each day) / (# of direct materials input each day)

= (50,000 finished unit) / (200,000 direct materials parts)

= 25% direct materials yield

An increase in the denominator without a corresponding increase in the numerator would indicate waste, excessive scrap, or defects.

ACTIVITY PRODUCTIVITY

The **activity productivity performance measurement** indicates how efficiently an activity is being performed. The productivity of any activity can be measured by dividing the activity's output volume by the input required by that activity during the same period. For example, assume that the machining activity required 5,000 machine hours to produce 150,000 units during the day. The machining activity's productivity is measured as follows:

Machining activity =

= (Units produced during the day) / (Machine hours consumed during the day)

= 150,000 units produced / 5,000 machine hours consumed

= 30 units produced per machine hour

CUSTOMER SATISFACTION PERFORMANCE MEASUREMENTS

Customer satisfaction performance measurements determine how well the company is meeting the needs, wants, and expectations of customers. Such performance measurements are subject to change, because the marketplace is dynamic. To a great extent, customers define many of the enterprise's activities. Indeed, without customers there would

be no business. Successful businesses know what the customer demands and figure out the best ways to meet those demands.

World-class enterprises view customer satisfaction as the primary reason for being in business. The aim is to be close to the customer and understand fully, on a continuing basis, what it takes to keep the customer satisfied. Most of the performance measurements covered to this point support customer satisfaction either directly or indirectly. For example, high-quality raw materials delivered by the vendor to the manufacturer on time will help to ensure that high-quality finished goods will be produced in a timely manner. Shorter setup times and production lead times reduce customer delivery lead times and enable the manufacturer to be more flexible and responsive to customer needs.

Before customer satisfaction performance measurements are developed, what the customer needs and wants should be established. This information is usually generated from a **customer survey**, such as the one presented in Exhibit 11-14. This initial customer sur-

Exhibit 11-14 Customer Survey to Determine Needs and Wants of Customers

Customer: Metatrax Corporation											
Date:											10/18/94
1. You rate the ability of your vendor to make on-time deliveries as:											
Not	1	2	3	4	5	6	7	8	9	10	Very
Important											Important
2. You rate the ability of your vendor to handle emergency orders as:											
Not	1	2	3	4	5	6	7	8	9	10	Very
Important											Important
3. You rate the ability of your vendor to fill each order completely without any backorders as:											
Not	1	2	3	4	5	6	7	8	9	10	Very
Important											Important
4. Please list additional needs and wants:											

vey will point out areas of strength and weakness and will enable the enterprise to change or better manage its activities to achieve customer satisfaction.

Assuming that items 1 and 3 in the customer survey are rated as very important (e.g., 9 or 10) by the company's customers, then the following performance measurements should be established:

- On-time delivery performance measurement
- Percentage of complete order filling

ON-TIME DELIVERY

The **on-time delivery performance measurement** determines if the finished product or service is being delivered at the time specified by the customer. One way to calculate on-time delivery performance is:

On-time delivery =

= (# of units delivered to customers during period) / (# of units committed to customers for period)

= 9,800 units delivered / 10,000 units committed
 = 98% on-time delivery

Clearly, the objective is to deliver to customers what was promised when it was promised.

Performance measurements, especially those measuring customer satisfaction, are not just for manufacturers. Service companies can also monitor their performance and achieve their goals and strategies with a performance measurement system. For example, airlines regularly compute on-time arrival performance and customer complaint ratios. In fact, delivering the product or service to the customer on time is the culmination of a series of activities being done effectively and efficiently throughout the organization whether it's a manufacturer or a service enterprise.

On-time delivery performance measurements can also be established to measure internal activities. For example, an activity, such as finishing, is a down-stream activity of machining. The finishing activity is viewed as a “customer” of the machining activity, and the machining activity is a “vendor” of the finishing activity. In many world-class companies, having “vendors” and “customers” *internal* to the company means that, to the ABM system, customer satisfaction is essential throughout the enterprise. The ABM idea is “We've got to satisfy each other before we can satisfy our ultimate customer.”

COMPLETE ORDER FILLING

The **complete order filling performance measurement** determines how many orders are completely filled over some time period. If all items are available in the quantities ordered by customers all the time, then the percent of complete order filling is 100 percent. Normally, this is not the case and some items will have to be backordered (i.e., an order to be filled when stock is renewed). The percentage of complete order filling is calculated as follows

Complete order filling percentage =

= 1 - (# of backorders) / (# of orders)
 = 1 - (50 backorders / 1,000 orders)
 = 1 - .05
 = 95% orders completely filled

CUSTOMER SATISFACTION IS AN ONGOING PROCESS

It should be stressed that the initial customer survey is not enough. Both customer surveys *and* performance measurements must be an ongoing process. Customers' wants and needs may change, which, in turn, may change the performance measurements. Ongoing customer surveys often use a **snake chart**, which captures the dynamics of the marketplace by showing what customers think is important and how they rate the company in those areas. The snake chart, as shown in Exhibit 11-15, lists six attributes for customers to weigh. The “importance” curve indicates the level of importance the customers give to the listed attributes. The “rating” curve shows how well the customers rate the company on those attributes. In the exhibit, the company excels only in the attributes

Exhibit 11-15 Snake Chart Showing Attribute Weighting by Customers

Attributes	Weights									
	1	2	3	4	5	6	7	8	9	10
On-time delivery						O			X	
Complete order file						X		O		
Emergency orders			X		O					
“Hot-line” support	O									X
Packing		O		X						
Online product information			O						X	
	Key:	Ratings by customers					O			
		Importance of attribute to customer					X			

“complete order fills” and “emergency orders.” To achieve total customer satisfaction, the company needs to improve its performance in the other four attributes.

The information supplied by the snake chart is powerful and readily comprehensible. Its results may often prove surprising. Most marketing managers often *assume* that they have a clear understanding of what customers consider important, but the information disclosed by a snake chart can prove their assumptions are wrong. In any event, an ongoing customer survey process and continuing adjustments to activities and their measurements will eventually result in the two “snakes” being very close to each other, if not completely overlaid¹⁸.

SALES ACTIVITY

The final measure of how well the company is achieving total customer satisfaction is the sales activity. Two excellent performance measurements can be used to measure this activity:

- Sales growth performance measurement
- Budgeted sales variance performance measurement

SALES GROWTH. The **sales growth performance measurement** calculates the percentage rate of growth from the last period to the current period. It is computed as follows:

Sales growth =

$$= ((\text{Sales this period} - \text{Sales last period}) / \text{Sales last period}) \times 100\%$$

$$= ((\$11,000,000 - \$10,000,000) / \$10,000,000) \times 100\%$$

$$= 10\% \text{ sales growth}$$

In this case, the performance measurement shows a 10 percent sales growth.

BUDGETED SALES VARIANCE. The **budgeted sales variance performance measurement** compares budgeted sales with actual sales and indicates a variance in percentage terms. If the variance is negative, actual sales are less than budgeted sales. If the

18. Ibid., p. 229.

variance is positive, actual sales are greater than budgeted sales. The budgeted sales variance performance measurement is calculated as follows:

Budgeted sales variance =

$$= ((\text{Actual sales} - \text{Budgeted sales}) / \text{Budgeted sales}) \times 100\%$$

$$= ((\$9,500,000 - \$10,000,000) / \$10,000,000) \times 100\%$$

$$= -5\% \text{ budgeted sales variance}$$

HELPING MANAGEMENT AND WORKERS VISUALIZE PERFORMANCE INFORMATION

LEARNING OBJECTIVE 4

Explain why care should be taken in developing performance measurements that users can readily visualize, comprehend, and apply.

Graphs are devices that present information in image form so it can be visualized and quickly comprehended. Graphs make relationships between numbers visible by turning numerical quantities into various shapes. Graphs pack a large amount of information into a small area. They tend to show the “big picture” or gestalt. Presenting output in image form reinforces the clichés that “a picture is worth a thousand computer print-outs” and “seeing the problem is solving the problem.” With graphs the viewer can often *see the unseen*. Four of the best tools for generating graphs are spreadsheets and graphics software, computer-aided systems and software engineering (CASE) tools, database management systems (DBMS), and fourth-generation languages (4GLs).

The goal of a graph is to convey a clear vision and understanding of the underlying data. To achieve this, the data region of the graph should be emphasized and not be filled with extraneous items. The following guidelines will help achieve this:

- Don't clutter the data region.
- Don't overdo the number of tick marks or grid lines.
- Don't let reference lines interfere with the data.
- Avoid notes, keys, markers, and labels in the data region.
- Use scale breaks only when necessary.
- Don't always insist on including zero magnitudes.¹⁹

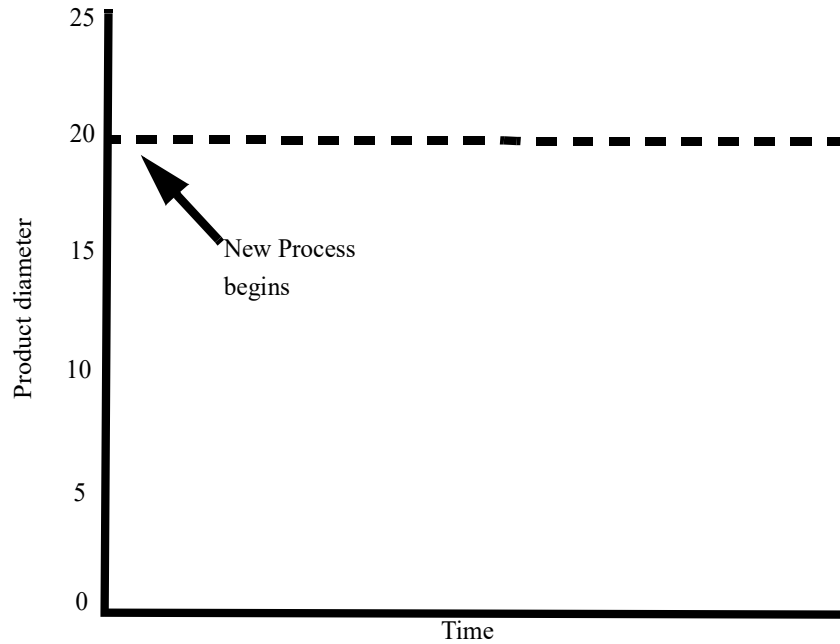
Exhibit 11-16a is an example of an unclear and misleading graph that does not follow these guidelines. The information the graph is trying to convey is lost. Exhibit 11-16b shows the same data with a graphical presentation that does follow the guidelines. Here, the information is clear and readily comprehensible.

Graphs can be divided into categories based on the kind of information they convey²⁰. The following categories are particularly well suited for displaying output from a performance measurement system:

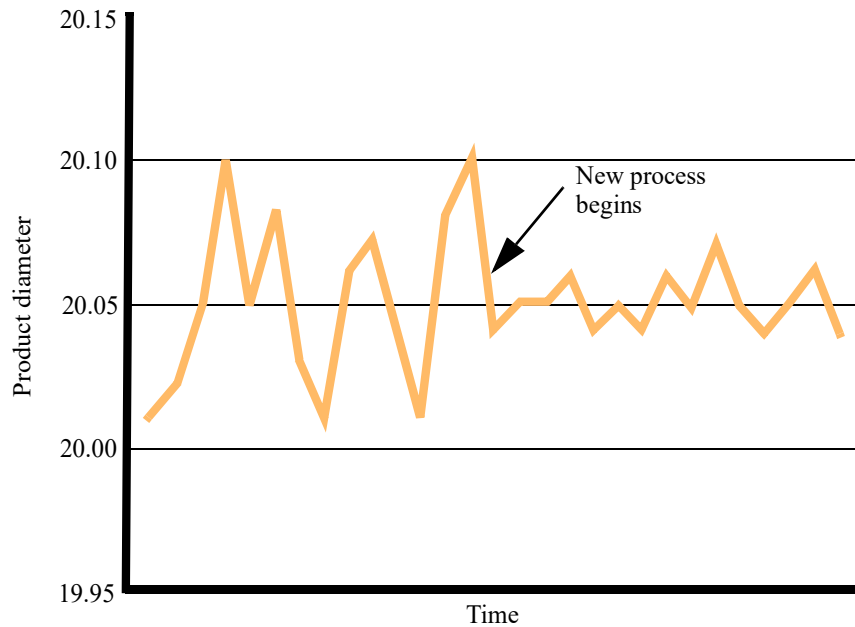
- Scattergraphs
- Line graphs

19. From *The Elements of Graphing Data* by W.S. Cleveland. Copyright © 1985 by Bell Telephone Laboratories, Inc. Reprinted by permission of Brooks/Cole Publishing Company, Pacific Grove, CA 93950; pp. 100-101.

20. Hilary Goodall and Susan Smith Reilly, *Writing for the Computer Screen* (New York: Praeger Publishers, 1988), p. 103.



A. A poorly constructed graphical display



B. A better graphical display

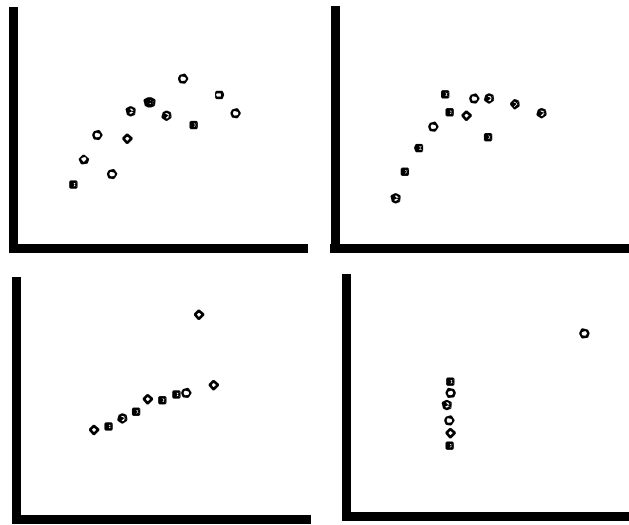
-
- Control charts
 - Bar graphs
 - Sectographs
 - Picturegraphs

SCATTERGRAPHS

Scattergraphs (also called **scatterplots** or **scatter diagrams**) clearly reveal trends of the underlying data. Compare the four x, y columns of data in Exhibit 11-17

Exhibit 11-17 Data Trends and Behavior Revealed in scattergraphs

1		2		3		4	
X	Y	X	Y	X	Y	X	Y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
	8.81	9.0	8.77	9.0	7.11	8.0	6.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89



to the Scattergraphs. Notice how difficult it is to gain insight or detect a trend from the columns of data, whereas the scattergraphs clearly indicate the behavior and trends²¹.

LINE GRAPHS

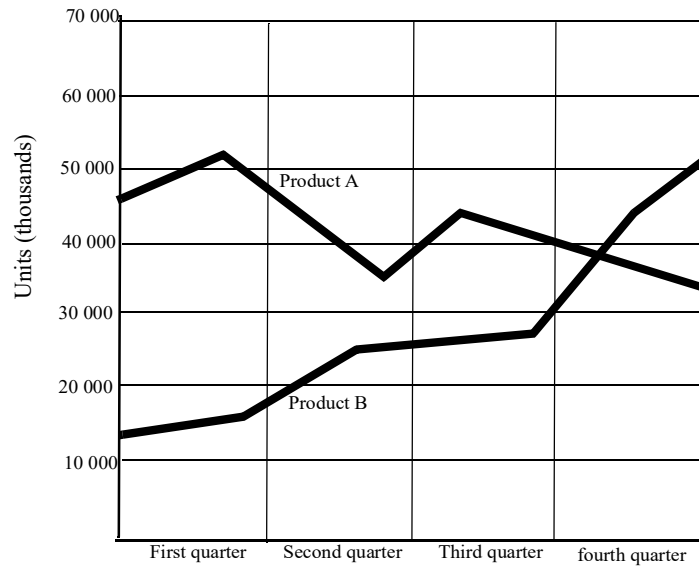
Line graphs show fluctuations over time by means of a rising and falling line that indicates highs, lows, rapid movement, or stability. Relatively thin lines should be used so that points of reference are not obscured. Using contrasting color for emphasis is more effective than bold lines. Care must be taken to adjust the size of the grid in a line graph after the points of reference are plotted to ensure maximum visibility of the information. Too many grid lines, however, obstruct the view. Too few lines make information difficult to read²². In addition, the grid lines should be much lighter than the data lines so that the user's attention is focused on the data lines.

21. F. J. Enscombe, "Graphs in Statistical Analysis," *American Statistician*, February 1973, pp. 17-21.

22. *Ibid.*, p. 104.

Exhibit 11-18 shows unit sales of products A and B at Starling Company for the fiscal

Exhibit 11-18 Line Graph



Note: The lines represent a pattern of weekly sales.

year 1993. Notice how the grid makes it easier to read the lines at various points on the graph.

CONTROL CHARTS

Every activity has variation. The more fine-tuned the activity, the less variation there is from the average. The less activity variation, the less waste. A **control chart** is simply a picture of the activity and its variation. It includes upper and lower control limits drawn on either side of the activity average. Roughly half the points will be above average and half below²³.

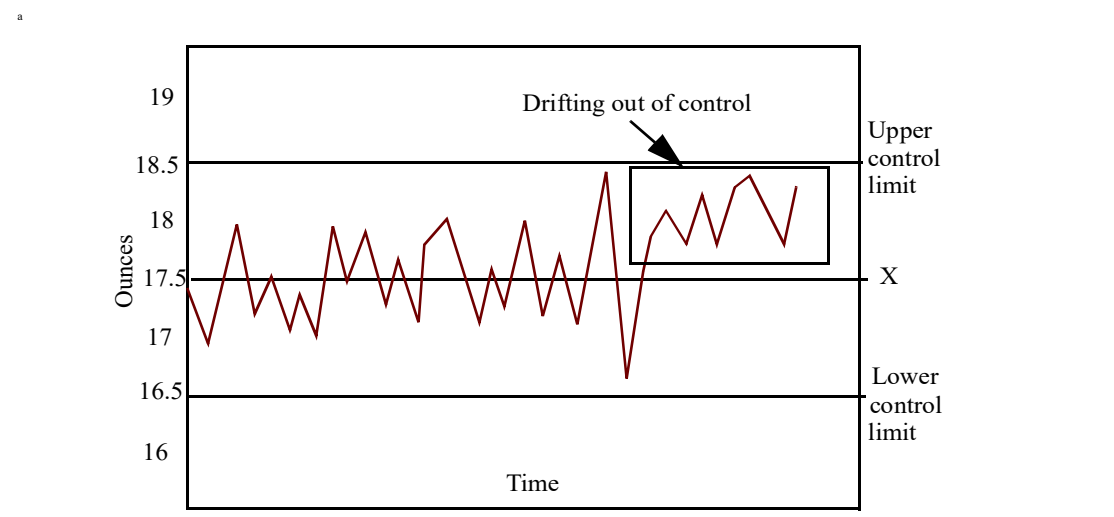
Control charts help improve performance by displaying problems within activities. Performance data are plotted and compared with control limit lines to determine the true state of an activity. If the points plotted on the chart begin to cross or actually cross the control limit lines, it is vital to find out what the problem is, determine its cause, and fix it as rapidly as possible. Corrective action should solve the problem *and* offer ways to prevent it from recurring in the future.

Exhibit 11-19 presents an example of a control chart. It shows the pack and fill line activity of Morning Flakes for a cereal company. The activity fills material into a package that is labelled to hold 16 ounces of product. The control chart shows results of weight measurements of packages sampled from the line.

Two important pieces of information are readily apparent. First, the average amount of weight in each package is 17.5 ounces. Second, the filling and packing activity is drifting out of control. The weight (X) is averaging the amount due to the variation in packing material from the pack heads. The variation forces the average pack well above the lower

23. Mary Walton, *The Deming Management Method* (New York: Perigee Books published by The Putnam Publishing Group, 1986), p. 114.

Exhibit 11-19 Control Chart of Pack Fill Weight



a. James M. Reeve, "The impact of Variation on Operating System Performance," in *Performance Measurement in Manufacturing and Service Organizations*, ed by Peter B. B. Turney (San Diego, Calif.: Proceedings of the Third Annual Management Accounting Symposium, 1989), pp. 83-84.

specification limit. The lower specification limit must be protected, because labelling requires that each package contain at least 16 ounces of product. The regulatory cost of underpacking is high. Therefore, variation translates directly into higher average material weight. The higher the variation, the greater the waste. Thus, the decision, based on the information displayed in the control chart, should be to change or clean the pack heads on the machines more often to improve pack head performance and decrease variation.

Lower variation translates directly into a decrease in average packing amount and direct cost savings²⁴. Controlling variation also helps prevent the activity from drifting out of control. If the control chart does indicate that the activity is drifting out of control, then the pack heads may have to be replaced. A point need not be outside the limits to indicate action. Abrupt shifts or distinct trends within limits are signals for investigation.

Control charts should not be used in isolation but should be integrated with total quality management (TQM), the subject of the next chapter. By using control charts, an enterprise can identify activities that can be improved and thereby stop defects *before* they occur. For example, preventive actions involve machine maintenance and operator training. The more management understands the activity, the more proactive measures can be applied to prevent problems from occurring.

BAR GRAPHS

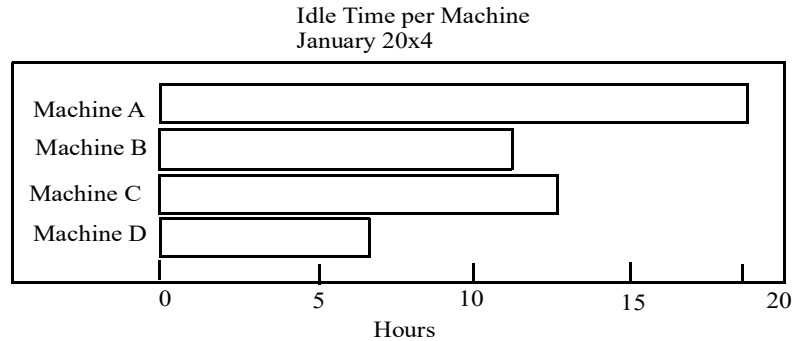
Bar graphs show how proportions or quantities are related to each other. There are two types of bar graphs:

24. James M. Reeve, "The impact of Variation on Operating System Performance," in *Performance Measurement in Manufacturing and Service Organizations*, ed by Peter B. B. Turney (San Diego, Calif.: Proceedings of the Third Annual Management Accounting Symposium, 1989), pp. 83-84.

- Horizontal bar graphs
- Vertical bar graphs

Each type indicates amounts by placing bars on a grid. The length or height of the bars represents an amount determined by the grid's scale.

Exhibit 11-20 Horizontal bar Graph

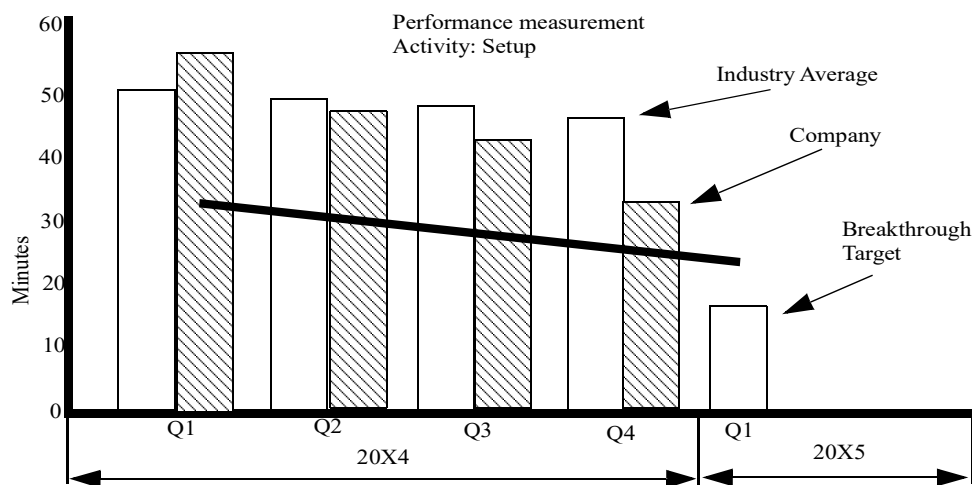


Unlike line graphs, bar graphs emphasize totals at specific points rather than fluctuations of data over time. Bar graphs should be used only when the number of amounts to be compared is relatively small. If too many comparisons are made, the bars will be too thin to have much visual impact²⁵. In some designs, bars can be differentiated by filling them with contrasting textures and colors.

HORIZONTAL BAR GRAPHS. A **horizontal bar graph** compares different items during the same time frame. For example, the horizontal bar graph in Exhibit 11-20 discloses the amount of idle time for four machines during January 20x4.

VERTICAL BAR GRAPHS. A **vertical bar graph** measures the same item at different periods of time. For example, the graph in Exhibit 11-21 shows changes in minutes

Exhibit 11-21 Vertical Bar Graph



25. Goodall and Reilly, op. cit., p. 105.

required per setup over five consecutive quarters. The company is clearly achieving continuous improvement over time. Furthermore, in the first quarter of 20x5, the company reached its breakthrough target of 15 minutes per setup, which is much better than both the industry average and the benchmark.

INSIGHTS & APPLICATIONS

Tailoring Reports to User Needs

The two owners of a small company were presented with a forecast of working capital every week. One of the owners was very enthusiastic about the information and felt that it was invaluable for short-term planning.

The other owner kept complaining that the working capital forecast was useless because “it had too much detail, and the individual numbers in the forecast did not seem to tie into each other.” It appeared that the second owner had a difficult time absorbing written material.

In order to give him a better understanding of the information in the forecast, a bar graph was inserted. The graph gave a quick overview of the details in the report. It allowed the second owner to grasp the numbers in the report, and it helped everyone to identify important trends.

The moral of this story is that people absorb and understand information in different ways. As managers, we all have been involved with training subordinates, but how much thought goes into training the boss? Whether you know it or not, you actually are teaching things to your boss all the time. Whenever you present information—for example, explaining relationships among data that you compiled and analyzed in an effort to show how the company is performing—you and your boss are in the roles of teacher and learner, respectively.^a

a. William Blais, “Training Your Boss,” *Management Accounting*, September 1991, p. 47. Reprinted from *Management Accounting*. Copyright by Institute of Management Accountants, Montvale, N.J.

SECTOGRAPHS

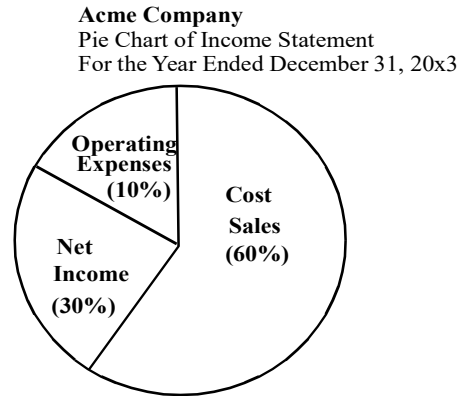
Sectographs show how total amounts are divided up. Two popular sectographs are the:

- Pie chart
- Layer graph

PIE CHARTS. In its simplest form, a **pie** chart is a circle that has been segmented into two or more pieces, like slices of a pie—hence the name. Each “slice of the pie” or triangular wedge represents a certain percentage of the whole, and the size of each wedge is proportional to its contribution to the whole. Since the proportional amount is immedi-

ately apparent, the visual impact is strong and memorable. The pie chart in Exhibit 11-22

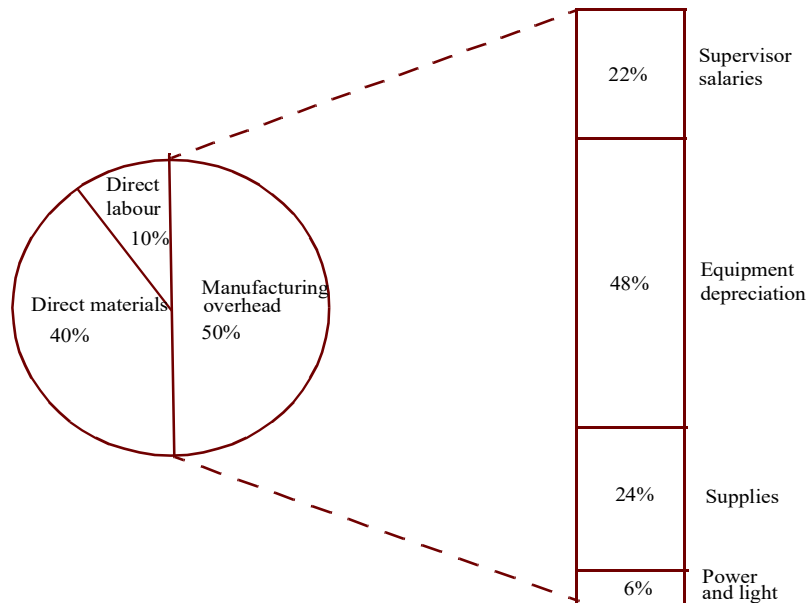
Exhibit 11-22 Pie Chart



shows the income statement items for Acme Company.

Pie charts can be combined with bar graphs to display additional information. For example, in Exhibit 11-23, the pie chart shows percentages of production costs, and the bar

Exhibit 11-23 Pie Chart Combined with Bar Graph



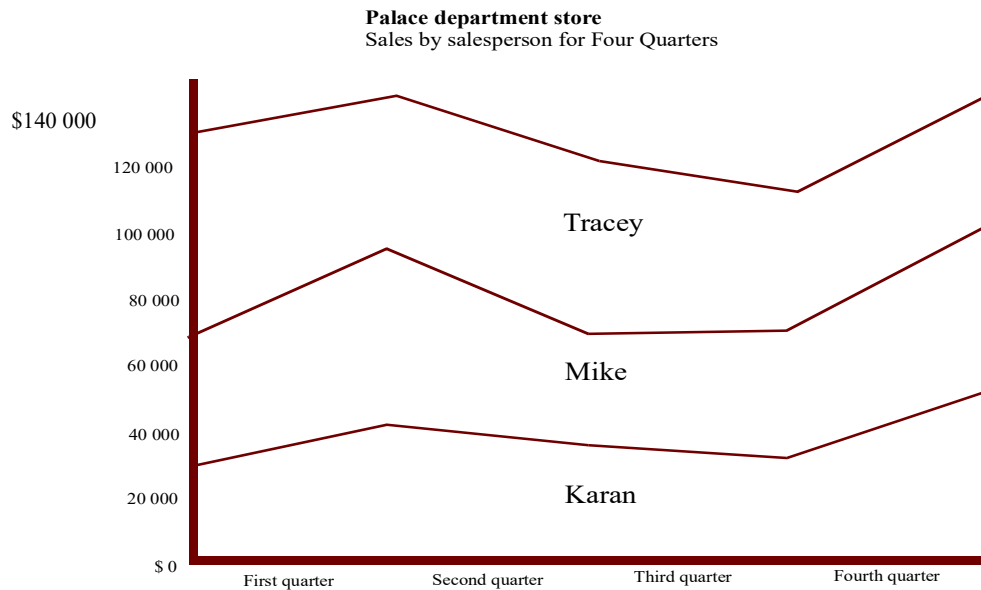
graph discloses the breakdown of manufacturing overhead costs.

When pie charts are used to display output from performance measurements, these guidelines should be followed:

- Use fewer than ten wedges to provide adequate differentiation and to avoid “confusion.”
- Identify each wedge with labels and numbers.
- Use contrasting colors or textures to intensify comparisons.
- Explode wedges slightly from the remainder of the pie for emphasis and clarity.

LAYER GRAPHS. A **layer graph** is created like a line graph, but the areas between the lines represent quantities and add up to a total amount. Each layer is differentiated by using a different color or texture. The layer graph in Exhibit 11-24 shows sales by sales-

Exhibit 11-24 Layer Graph



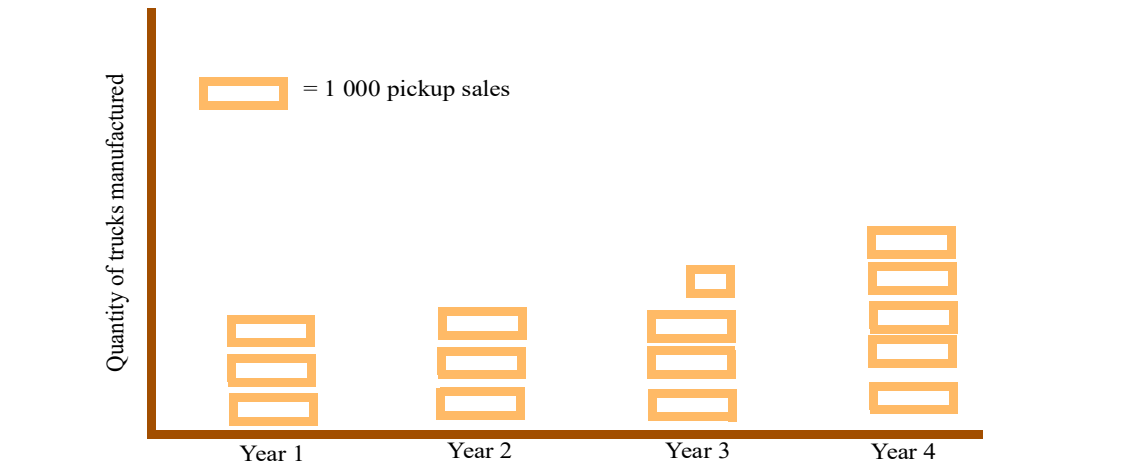
person over four quarters at Palace Department Store.

PICTUREGRAPHS

Picturegraphs are similar to bar charts except that columns of little signs or icons are used in place of bars. Each picture represents a certain quantity of the item illustrated. The picture graph in Exhibit 11-25 shows the number of pickup trucks sold over a four-year period in Suffolk County.

Picturegraphs do indeed catch the user's eye, but they are best used to convey a general impression of quantities rather than precise information. In preparing picturegraphs, the following design guidelines should be used:

- Use familiar pictures or symbols. Unfamiliar pictures or symbols must be learned.
- Design pictures and symbols that convey their intended meaning precisely.
- Design for efficiency. In some instances, a picturegraph may consume more display space than text or numbers.
- Choose symbols that are visually distinguishable from other symbols. Users' ability to discriminate alphabetic or alphanumeric information is much more powerful than their ability to discriminate among a large number of symbols.



SUMMARY OF LEARNING OBJECTIVES

The major goals of this chapter were to enable you to achieve four learning objectives:

Learning objective 1. Define activity-based management (ABM).

Whereas the activity-based costing (ABC) system is developed to cost objects, activity-based management (ABM) uses information from the ABC system, benchmarking, and performance measurements to reengineer and improve the organization to achieve excellence.

ABM is an ongoing process involving four phases:

Phase 1. Identify value-added and nonvalue-added activities.

Phase 2. Reengineer the enterprise.

Phase 3. Benchmark value-added activities.

Phase 4. Develop a performance measurement system for continuous improvement.

Learning objective 2. Describe each phase of the four-phase ABM process.

The first phase of the ABM process is directed toward identifying and thoroughly understanding both value-added and nonvalue-added activities. The information for this phase comes from work performed during the development of the ABC system and additional activity analysis.

The second phase entails determining the root causes of costs and reengineering activities. Reengineering can involve any aspect of the enterprise, such as redesigning products or services, restructuring the plant layout, and overhauling or eliminating activities. The reengineering effort moves the enterprise from *what it is* to *what it should be in* order to compete effectively.

Once nonvalue-added activities are eliminated or reengineered, the third phase is implemented, which involves benchmarking the best practices of world-class companies. Benchmarking results will give the enterprise worthwhile targets to meet or exceed.

Targets without measures, however, are destinations without road maps. Therefore, to make sure that the enterprise stays on the continuous improvement track and meets or exceeds its targets, the fourth phase is devoted to building a performance measurement system. Performance measurements indicate to managers and workers how well they are doing compared to targets or other criteria established during benchmarking.

The following rules will help in developing performance measurements:

1. Link them for coordination and consistency throughout the organization.
2. Quantify them and display them so they are easily comprehended by users.
3. Make them simple and easy to understand.
4. Select performance measurements that induce beneficial behavior.
5. Make the performance measurements show positives rather than negatives.
6. Use performance measurements that show improvement, trends, and relationships.
7. Use an optimum number of key performance measurements that signify the enterprise's critical success factors.

Learning objective 3. Summarize vendor, time-based, productivity, and customer satisfaction performance measurements.

Management accountants are not expected to use *all* of the performance measurements summarized in Exhibit 11-26, nor would it necessarily be appropriate for them to do so. However, out of all the performance measurements that could be derived, the ones in this chapter measure most of the critical success factors of most enterprises. (Quality is also a critical success factor, but it is covered in Chapter 12.)

None of these performance measurements measure profitability, return on investment or assets, or earnings per share, but they will help improve these critical financial factors. These performance measurements are simple and easy to understand. They show change and degree of change over time, and that is what is important in performing activity-based management.

Learning objective 4. Explain why care should be taken in developing performance measurements that users can readily visualize, comprehend, and apply.

Exhibit 11-26 Summary of Performance Measurements

Performance Area	Specific Performance Measurements	Target
Vendor performance	Vendor financial performance measurement	Elimination of nonvalue-added costs
	Vendor performance index (VPI)	An index of one
	Vendor nonfinancial performance measurement	100-plus points for vendor certification
	Vendor quality performance measurement	100 percent parts accepted
	Vendor on-time delivery performance measurement	Zero late and early deliveries
	Vendor simplicity performance measurement	Minimum number of vendors and purchase orders
	Lead time efficiency (LTE) ratio performance measurement	A ratio that equals one
Time-based performance	Contribution margin velocity ratio performance	Maximize contribution margin of products in terms of production lead time
	Delivery production (D: P) ratio performance measurement	A ratio of one or less

	Setup time performance measurement	Reduction in setup time (zero setup time is ideal)
	Machine uptime performance measurement	100 percent machine uptime
Productivity performance	Work force productivity performance measurement	Increase number of units produced and decrease number of direct labor hours consumed
	Direct materials yield performance measurement	Increase number of units produced and decrease number of direct materials consumed
	Activity productivity performance measurement	Increase number of outputs produced and decrease number of inputs consumed
Note: An initial customer survey should be conducted to determine customer needs, wants, and expectations. Ongoing customer surveys should be conducted and snake charts should be prepared to determine the enterprise's alignment with changing customer needs, wants, and expectations.		
Customer satisfaction performance	On-time delivery performance measurement	100 percent on-time delivery if important to customers
	Complete order filling performance measurement	100 percent of orders completely filled if important to customers
	Sales growth performance measurement	Continuing sales growth
	Budgeted sales variance performance measurement	Positive budgeted sales variance

Not only is the *substance of* performance measurements important to users, but the *form* in which they are presented is also critical. To assist users in tapping the full potential of performance measurements, the output should be easily accessible, visual, and simple.

Producing reams of computer printouts containing columns of numbers is a good example of a nonvalue-added activity, because such printouts usually wind up in the incinerator without ever being read by anyone. This problem of too much data and not enough information can be solved with graphs, such as the following:

- Scattergraphs
- Line graphs
- control charts
- Bar graphs
- Sectographs
- Picturegraphs

The following summary guidelines will help in selecting the proper graph for the data:

- if comparing correlative data, select a scattergraph.
- If a long series or several series of data are to be displayed over time, use a line graph.
- If variations in a process are to be presented, choose a control chart.
- If different items are to be compared during the same time frame, use a horizontal bar graph.
- If the same item is to be compared at different time periods, use a vertical bar graph.
- If parts of a whole are to be compared, prepare a pie chart.
- If the sizes of total amounts are to be compared over time, use a layer graph.
- If data are to be captured in the form of pictures or symbols, select a picturegraph.
- If using both numbers and graphs will help the user understand the performance measurement better, design the output to combine them in one presentation.

IMPORTANT TERMS

Activity-based management (ABM) An ongoing process of understanding, reengineering, measuring, and making decisions about activities to put the enterprise on the road to continuous improvement and excellence.

Activity productivity performance measurement Indicates how efficiently an activity is being performed.

Bar graphs Block like graphs used to compare quantities.

Benchmarking The process of comparing activities to world-class best practices.

Budgeted sales variance performance measurement Compares budgeted sales with actual sales and indicates a variance in percentage terms.

Complete order filling performance measurement Determines the percentage of the orders completely filled over some period of time.

Continuous improvement The systematic and small incremental actions that enable an enterprise to achieve excellence.

Contribution margin velocity ratio performance measurement Determines the amount of contribution margin a product generates per unit of production lead time.

Control chart A graph that shows variation in an activity over time.

Customer satisfaction performance measurements Determine how well the company is meeting needs, wants, and expectations of customers.

Customer survey A questionnaire that helps determine the needs, wants, and expectations of customers.

Delivery lead time Represents the time required by customers to receive the product or service.

Delivery production (D: P) ratio performance measurement Compares delivery lead time to production lead time.

Direct materials yield performance measurement Indicates how efficiently raw materials are being converted into finished products.

Graphs Devices that present information in image form so it can be quickly comprehended. A diagram or chart displayed as a series of one or more points, lines, line segments, curves, or areas that represent one variable in comparison with one or more other variables.

Horizontal bar graph A bar graph that compares different items during the same time frame.

Layer graph A line graph in which the areas between the lines represent quantities, which add up to a total amount.

Lead time The time between the beginning of a processor activity and the appearance of its results.

Lead time efficiency (LTE) ratio performance measurement A key lead time performance measurement that indicates the level of value-added and nonvalue-added activities in a particular process or operation.

Line graphs Graphs used to compare fluctuations in several items over time.

Machine uptime performance measurement Determines the percentage of time the machine is ready for production when needed.

Nonvalue-added activities Activities that represent waste. They can be reduced or eliminated without decreasing the enterprise's ability to compete and meet customer demands.

On-time delivery performance measurement Determines if the finished product or service is being delivered at the time specified by the customer.

Performance measurements Devices used to ascertain the effort expended or work done to execute or accomplish output of an activity.

Picturegraph A graph made up of columns of pictures or symbols, each of which represents a certain quantity of the item illustrated.

Pie chart A circle that has been segmented into portions, each of which represents a certain percentage of the whole.

Production lead time The interval between the acquisition of raw materials and the first stage of production and the time that the finished products come off the production line.

Productivity performance measurements Ascertain the amount of outputs produced by the inputs consumed.

Reengineering The process of making substantial changes in how an enterprise currently operates. It involves the redesign of how work is done through activities.

Sales growth performance measurement Calculates the percentage rate of growth from the last period to the current period.

Scattergraphs (scatterplots or scatter diagrams) Plots of observations relative to the x- and y-axes.

Sectographs Graphs that show how total amounts are divided. Two popular sectographs are pie charts and layer graphs.

Setup time The amount of time needed to change production facilities for a different product or service.

Setup time performance measurement Indicates how efficiently the production facilities are made ready to make another product or provide a service.

Snake chart Shows variances between what customers (or others) deem important and what is currently being done.

Target A numerical value set by management or customers. It is a goal or objective to meet or exceed that is often established during benchmarking.

Time-based performance measurements Recognize time as the equivalent of money, productivity, quality, and resources.

Value-added activities Actions or functions that contribute something worthwhile to the enterprise and its customers. They are essential to the enterprise's success.

Vendor certification program A process that selects vendors on their ability to meet certain performance measurements. Certified vendors are the buying company's preferred vendors; they establish a long-term, trusting relationship with the buying company.

Vendor financial performance measurement Discloses unnecessary costs caused by the vendor's nonconformance with specifications for quality and delivery schedules.

Vendor nonfinancial performance measurement Weights the vendor on quality, price, on-time delivery, and general performance.

Vendor on-time delivery performance measurement Discloses the vendor's ability to deliver raw materials just-in-time, not too early and not too late.

Vendor performance index (VPI) Calculated by adding the cost of purchased raw materials to the cost of nonvalue-added activities and dividing the total by the cost of purchased raw materials. An index of one means the vendor has eliminated all nonvalue-added activities.

Vendor quality performance measurement A measure that focuses on the vendor's ability to deliver raw materials of consistently high quality.

Vendor simplicity performance measurement Calculates the number of vendors and number of purchase orders per product.

Vertical bar graph A bar graph that measures the same item at different periods of time.

Work force productivity performance measurement Indicates the cost per **unit** of product produced by the work force.

DEMONSTRATION PROBLEMS

DEMONSTRATION PROBLEM 1 *Linking performance measurements for over-all organizational performance.*

For constancy of purpose and strategic and goal congruency, performance measurements must be linked in a balanced and coordinated effort. Following are typical statements of goals that are congruent from the senior level to the plant floor:

- Chief executive officer: “We must provide value to our shareholders.”
- Vice president of manufacturing: “To achieve success, we must satisfy our customers.”
- Plant manager: “To be responsive to customers and flexible in meeting their needs, we must excel in certain activities.”
- Plant supervisors and workers: “To be faster, stronger, and better, we must excel in certain activities.”

Required:

Make a table with these statements of goals as the left-hand column. In the right-hand column, insert the performance measurements you believe will provide the appropriate feedback to enable the managers and workers at each level to achieve the goals. Also comment on how frequently each level should receive performance feedback.

SOLUTION TO DEMONSTRATION PROBLEM 1

GOALS	PERFORMANCE MEASUREMENTS
Chief executive officer: “We must provide value to our shareholders.”	Net income Sales and market share Return on investment (ROI) Return on assets (ROA) Earnings per share
Vice president of manufacturing: “To achieve success, we must satisfy our customers.”	On-time delivery Sales growth Budgeted sales variance
Plant manager: “To be responsive to customers and flexible in meeting their needs, we must excel in certain activities.”	Lead time efficiency (LTE) ratio Contribution margin velocity ratio Complete order filling Delivery production (D: P) ratio
Plant supervisors and workers: “To be faster, stronger, and better, we must excel in certain activities.”	Work force productivity Setup time Direct materials yield Activity productivity Machine uptime

Although the performance measurements listed here are directed to organizational levels, in most companies, all levels have access to the performance measurement system. For example, the supervisors and workers on the plant floor can receive feedback on net income, on-time delivery, or lead time efficiency. Also, different managers, supervisors, or workers across levels are given equal access. For example, the vice president of marketing is given performance feedback on return on assets, on-time delivery, delivery production (D: P), and so forth.

Because the decisions made at the senior level are more strategic and long range, performance measurements are usually reported on a monthly or quarterly basis. At the tactical level (e.g., the plant manager), feedback may occur daily or weekly. At the plant-floor level where the activities are actually performed, the feedback is, in many instances, in real-time. Supervisors and workers use the performance measurement output to control or adjust tasks and activities as they are being carried out.

DEMONSTRATION PROBLEM 2 *The real costs of purchasing.*

“To achieve world-class status, we must build and maintain long-term partnerships with a small group of vendors that offer the best *overall* value,” says Malcolm Ridgeway, management accountant at Evian Company.

“Nortec supplies us with circuit boards at \$20 per board,” says Melisa Alexander, purchasing agent. “That's cheaper than we can get them from other vendors.”

“That's true,” says Malcolm, “but I've been doing some analysis and I'm surprised to find that the price of raw materials represents only a fraction of the cost of doing business with vendors.”

“How's that?” asks Melisa.

Required:

Despite the attraction of a low price, Nortec causes Evian to perform a number of non-value-added activities due to poor quality and vendor performance. Show how much it's really costing Evian to continue doing business with Nortec, assuming the total non-value-added costs are \$96. Use any cost figure that you consider appropriate for each nonvalue-added activity caused by Nortec. Assume that Evian can purchase circuit boards from Bates Corporation for \$80 per board. Bates's vendor performance index (VPI) is 1.1. Calculate Bates's total cost per board.

SOLUTION TO DEMONSTRATION PROBLEM 2

Purchase price per board		<u>\$20.00</u>
Average nonvalue-added costs per board:		
Inspecting and testing	\$14.00	
Paperwork	6.00	
Reworking	16.00	
Materials received too early	14.00	
Materials received too late	14.00	
Excess materials	12.00	
Short materials	12.00	
Warehousing and handling	8.00	
Total average nonvalue-added costs per board		<u>\$96.00</u>

$$\begin{aligned}\text{Nortec's vendor performance index (VPI)} &= (\$20 + \$96) / \$20 \\ &= 5.8\end{aligned}$$

	Nortec	Bates
Purchase price per board	\$ 20	\$80
x VPI	5.8	1.1
Total cost per board	\$116	\$88

DEMONSTRATION PROBLEM 3 *Using nonfinancial and financial performance measurements.*

Financial performance measurements used at the plant level may create barriers to achieving profitability and return on investment. For example, to achieve improved production efficiency, an organization might be tempted to manufacture excess inventories to avoid potential unfavorable production volume variances reported by traditional standard costing systems. To obtain lower raw materials cost and eliminate unfavorable purchase price variances, an organization may select vendors based only on price.

Required:

Name a nonfinancial performance measurement that would encourage management to produce only the amount of product that is needed and a financial performance measurement that would encourage management to select vendors based on overall performance.

SOLUTION TO DEMONSTRATION PROBLEM 3

The delivery production (D: P) ratio performance measurement encourages management to achieve a ratio of one or less. A ratio of one means that production is in balance with delivery, which means there is no buildup of excess inventories. The vendor performance index (VPI) evaluates vendors according to price plus costs of nonvalue-added activities that they cause. A ratio of one means that the vendor is in total conformance with the buying company's needs and therefore does not require any nonvalue-added activities to be performed.

REVIEW QUESTIONS

- 11.1 What are the two main purposes of activity-based costing?
- 11.2 Name the four phases involved in activity-based management and briefly describe how they work.
- 11.3 Why is the activity-based management process never considered complete?
- 11.4 Value-added activities are of two types. Describe these activities.
- 11.5 Explain the difference between value-added and nonvalue-added activities.
- 11.6 Describe five complexities that drive costs.
- 11.7 Describe what is meant by reengineering the enterprise. Give some examples.
- 11.8 Explain what benchmarking is and how it is accomplished. Name and discuss a common pitfall of benchmarking.
- 11.9 During benchmarking, what is the fundamental purpose of a site visit?
- 11.10 Explain why the original benchmark performance target is actually a moving target.
- 11.11 Name the four types of performance measurements. Discuss four of the seven rules you should follow when developing performance measurements. What benefits are gained through developing and using a performance measurement system?
- 11.12 Describe two typical traditional financial performance measurements. What are the primary drawbacks of using financial performance measurements?
- 11.13 Discuss how focusing on and improving nonfinancial performance measurements ultimately leads to improved financial performance.
- 11.14 How should performance measures change as you move down the organization chart? How are they linked? What *checks* do they provide?

- 11.15** Describe how a vendor certification program works and what costs a company can reduce by implementing such a program.
- 11.16** Name the four vendor nonfinancial performance measurements used in selecting certified vendors. What score must be achieved to become a certified vendor?
- 11.17** Time is manageable and a source of competitive advantage. Describe the negative impacts of taking longer to perform an activity. Describe the advantages to the firm of performing the same activity in a shorter time frame.
- 11.18** Reducing lead times increases speed. Name the four categories that speed falls into in world-class manufacturing.
- 11.19** Name four conditions that must exist to achieve production LTE ratios of one. Identify four positive results achieved by improving the production LTE ratio.
- 11.20** If a manufacturer wants to achieve a continuous flow and synchronized operation, what D: P ratio would be ideal and why?
- 11.21** What machine uptime percentage do world-class manufacturers demand and how do they achieve this percentage?
- 11.22** Name the three types of productivity performance measurements and briefly indicate what they measure.
- 11.23** Name two types of customer satisfaction performance measurements and briefly indicate what they measure.
- 11.24** Explain what is meant by the ABM idea that “We’ve got to satisfy each other before we can satisfy our ultimate customer.”
- 11.25** When a snake chart is used to measure customer satisfaction, what will the two curves on the chart represent? What ultimate goal should be achieved?
- 11.26** Describe the benefits of using graphs to present performance data.
- 11.27** Name the various graph styles and state the purpose of each.

CHAPTER-SPECIFIC PROBLEMS

These problems require responses based directly on concepts and techniques presented in the text.

11.28 Identifying value-added and nonvalue-added activities. The following are some typical activities for a small tool manufacturer:

- Inspecting raw materials,
- Storing raw materials,
- Casting tool
- Stacking casting
- Grinding and polishing tool
- Inspecting finished tool
- Storing finished tool
- Shipping tool

Required:

Identify each activity as value-added or nonvalue-added.

11.29 Calculating vendor financial performance measurements. Richie Company produces toy train sets for major department stores. Richie uses two vendors to supply the sectional track pieces for its packaged sets. Following are the historical nonvalue-added activities required by Richie for each vendor:

	Labor Hours	
	Per Standard Shipment Size	
	Vendor A	Vendor B
Inspection rejection	1.5	0.1
Paperwork rejection	5.0	0.5
Rework at company	15.5	1.0
Materials received early	3.0	1.0
Materials received late	20.0	8.0
Excess materials	8.5	1.0
Short materials	13.5	2.5

Required:

If the Richie labor hour cost is \$45 for each of these activities, calculate the total non-value-added activity cost for each vendor. Then calculate the vendor performance index for each vendor, assuming the cost of purchased raw materials is \$60,000 for each standard shipment size.

11.30 Distinguishing between value-added and nonvalue-added activities. Identify which of the following are value-added and nonvalue-added activities by placing an X under the appropriate column:

Activity	Value-added	Nonvalue-added
Review of invoices		
Engineering parts		
Cleanup of excess materials		
Dealing with customer complaints		
Product delivery		
Materials movement		
Materials assembly		
Inspection of incoming product deliveries		
Quality control by all employees		
Quality control department		
Purchase order preparation		
Tracking machine setup time		
Storage of raw materials		
Using graphs to illustrate performance		
Product rework		

11.31 Graphing sales information to show quarterly sales contribution by product. Ted Andrews, purchasing director, has just handed you the following information and requested that you provide him with a graph of it for his presentation to the board of directors.

	1994 Sales			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
CDs	\$ 87,971	\$ 98,589	\$108,769	\$ 73,175
Tapes (audio)	109,870	117,413	127,791	132,418
Tapes (video)	41,147	52,149	57,129	50,111

Required: Graph the sales information and explain why you selected that particular graph.

11.32 Graphing information using a control chart. Bill, the bottling supervisor, tells you that he believes the new bottling line is underfilling the bottles and that he is concerned about the possibility of fines. You ask Bill what makes him believe that the bottles are being underfilled. He replies, “It’s just a gut feeling.” You tell him to go with his gut feeling; however, you also ask him to provide you with sample data before and after the increase, to confirm that the increase was necessary. The company is producing 12-ounce bottles of liquid soap and has set the minimum and maximum acceptable fill levels at 12.5 and 13.0 ounces, respectively.

Time	Sample Number	Net Weight (Ounces)	
1:01	1	12.50	
1:03	2	11.95	
1:05	3	12.15	
1:07	4	12.27	
1:09	5	11.90	Before
1:11	6	12.50	After
1:13	7	12.70	
1:15	8	12.95	
1:17	9	12.50	
1:19	10	13.05	
1:21	11	12.75	
1:23	12	12.80	
1:25	13	12.50	
1:27	14	12.45	
1:29	15	13.00	

Required: Make a control chart and establish whether increasing the fill was indeed necessary.

11.33 Preparing a performance measurement graph. The following performance information was obtained during a six-month period for a critical machine in a factory:

Month	Hours Of Machine Downtime	Hours Machine Needed
April	15.5	105.0
May	12.0	120.0
June	8.0	110.5
July	6.5	105.0
August	9.5	110.0
September	5.0	120.0

Required: Calculate and graph the machine uptime performance measurement. Discuss what the graph shows. Make any assumptions necessary.

11.34 Graphing cost of energy use information using various types of graphs. You are trying to impress upon management the importance of purchasing more energy-efficient vehicles as older models are retired. Senior management does not believe that gasoline fuel costs are that significant. They plan to spend the “fuel efficiency” budget on new heating equipment. Jane Kirkland, CEO, however, requests that you present your findings to her by September 20. You receive the following summary of fuel expenditures:

Required: Graph the above information using the following formats:

- Pie chart.
- Dual (pie and bar) chart.
- Bar chart.

20x5 Energy Costs

Electricity	\$1,579,732
Natural gas	2,510,818
Gasoline	4,372,951
Propane	500,141
Coal	1,150,021

d. Line chart.

11.35 Calculating the vendor performance index. The delivery performances of companies A, B, and C are as follows:

Non Value-added activity	Labor Hours Per Occurrence		
	Company A	Company B	Company C
Inspection rejection	1.3	0.5	0.9
Paperwork rejection	0.2	0.1	0.3
Rework at company	02	1.4	1.1
Materials received early	7.0	2.0	3.0
Materials received late	2.8	5.6	1.4
Excess materials	4.0	0.2	0.6
Short materials	0.5	3.7	0.6
Total	16.0	13.5	7.9
Cost of raw materials delivered	\$14,000	\$12,000	\$16,400

Required:

- Calculate the VPI for each company using a cost of \$50 per labor hour.
- Determine which of the companies should be eliminated as vendors based on the calculated VPI.

11.36 Calculating the vendor qualify performance measurement. Infinity Company has gathered the following delivery data for one of its vendors. Infinity wishes to determine if its vendor was able to consistently remain within its target vendor quality performance acceptance percentage of 97%.

Shipment	Number Of Parts	
	Ordered/delivered	Rejected
1	1,200	23
2	800	12
3	1,500	30
4	1,301)	34
5	900	32

Required:

- Calculate the acceptance percentage for each shipment.
- What trend is indicated?

11.37 Calculating the complete order filling performance measurement. The Triad Company is evaluating how effective its vendors are at completely filling orders when they are placed. The company currently has three vendors that supply part #621357928. Their order filling performances, for the past year follow:

	Vendor 1	Vendor 2	Vendor 3
Number of orders	34	51	86
Number of orders filled completely	29	43	75
Number of backorders	5	8	11

Required:

- Calculate the complete order filling percentage for each vendor.
- Determine which vendor has the highest percentage of orders filled completely.

11.38 Determine what performance measurements to use. Management just assigned you to report on customer satisfaction and provided the following data:

Total number of deliveries	582
Number of on-time deliveries	513
Number of vendor complaints	5
Number of complete deliveries	504
Number of customer complaints	17

Required: Select and apply two performance measurements that are applicable to this problem.

11.39 Calculating the production lead time efficiency (LTE) ratio. The Rithe Company has compiled the following data on the total time required to produce and store its product:

Production line 1	30 minutes
Production line 2	50 minutes
Quality control inspection	25 minutes;
Product movement to storage location	60 minutes
Storing the product in inventory	45 minutes

Required:

- Determine which of the company's activities are value-added and which are nonvalue-added.
- Calculate the company's production lead time efficiency ratio.
- Would the calculated ratio be acceptable in a world-class manufacturing environment? Explain your answer.

11.40 Calculating the contribution margin velocity ratio. The Jester Company is analyzing its product mix to determine which of its three products is the most profitable. It has compiled the following data on each of its products:

Product	Annual sales	Variable costs	Fixed Costs	Production Lead Time (Days)
A	\$ 63,856	\$12,776	\$31,117	7
B	81,937	28,665	40,923	4
C	120,542	50,125	65,718	6

Required: Calculate the contribution margin velocity ratio to determine which product produces the highest profits.

11.41 Calculating the most profitable product. Karob Kandies produces two kinds of candies: Critter Crunchers and Darb's Drops. Karob Kandies collected the following data on both products:

Required: Identify which product is more profitable to produce.

	Contribution Margin	Production Lead Time
Critter Crunchers	\$1.50	5.0 minutes
Darb's Drops	1.00	2.5 minutes

11.42 Calculating the setup time performance measurement. Prior to beginning production on each of its seven products, the Robotron Company experiences some downtime in setting up its production line. Over a week's period, the following data were collected:

Product	Number Of Setups	Setup time (Minutes)	Production Time (Minutes)
1	5	50	100
2	7	105	210
3	9	108	225
4	12	120	360
5	8	144	320
6	4	80	180
7	6	78	150

Required:

- Calculate the setup time ratio for each of the products.
- Identify which product(s) provide(s) the shorter setup time.
- In general, what benefits are provided by shorter setup times?

11.43 Graphing a snake chart. The Eatery Stop has just finished compiling the results of its two-week-long customer satisfaction survey for its new upscale dinner menu items. its customers provided the following ratings on a scale of 1 to 10, 10 being the best:

	Importance To Customer	Category Rating
Quick service	8	6
Accurate service	10	4
Friendly service	8	9
Server knowledge	5	7
Dinners were served hot	7	7
Dinners were tasty	9	6
Dinners were attractive	3	7
Dinners were priced right	8	6

Required:

- Graph the survey results using a snake chart.
- Given the differences between the expected service and the delivered service, what are the key areas that the company should focus on to achieve total customer satisfaction?

THINK-TANK PROBLEMS

Although these problems are based on chapter material, reading extra material, reviewing previous chapters, and using creativity may be required to develop workable solutions.

11.44 Determining value-added and nonvalue-added activities. In your present or past position, list ten value-added and ten nonvalue-added activities that were a part of your job responsibilities.

11.45 Reengineering activities. Cook & Cook Books has a primary operation of receiving and warehousing books from publishers and packing and shipping book requests from bookstores, schools, and libraries. For library requests, a security strip has to be glued into the binding, a due-date card sleeve attached inside, and a clear plastic cover applied to each book prior to shipping. Based on the advice of various business consultants over the years, Cook & Cook has dedicated full-time workers to this process and maintains a storehouse stock of books ready

for library shipments. A certain percentage of each new book from each vendor is sent through this library process. Although the per book costs of the library process have decreased significantly, management is increasingly concerned over rising storage costs and the unresponsiveness of the process to library customer demands, among other things.

Required: As a world-class manufacturing consultant, you are called in to evaluate the library book process. Make any assumptions you deem necessary.

- Draw an activity flow diagram for the library book process as it is described above.
- Reengineer the process to world-class standards.
- Discuss the performance measurements you might use for your reengineered process.
- What concerns could management have with the existing process? How does your reengineered process address these concerns?

11.46 Determining manufacturing complexities. ElectroKing, a large manufacturer of home electric appliances, has been in business for more than 50 years. Although it started by making only electric toasters, ElectroKing now produces over 30 different product classes from microwave ovens to blenders and can openers. Out of respect for its loyal repeat customers, ElectroKing corporate philosophy has been to never discontinue any product. As each new product was introduced over the years, it was considered a new and separate entity; thus, an entire new suite of vendors, parts, and assembly lines were used. To combat the increasing competition from overseas manufacturers, ElectroKing has increased the customization (i.e., options) available for each product, while trying to maintain a constant price.

Required: List the complexities of this operation that are driving costs. Describe an action management might take to reduce each. Make any assumptions necessary.

11.47 Calculating the machine uptime percentage. The foreman over the production line at the Production Time Company has noticed that a certain machine has been experiencing an inordinate amount of downtime. Upon further observation, the foreman noted the machine is not always in working condition when needed and also usually breaks down at least once during production. The foreman has gathered the following data on the machine's performance over a one-week period:

Day	Number Of Hours Scheduled For Production	Number Of Hours machine needed for Production	Number Of Hours machine Not Ready For Production
Sun.	16	9.50	0.25
Mon.	24	16.25	2.75
Tue.	24	12.50	1.50
Wed.	24	14.00	2.00
Thu.	24	13.75	3.75
Fri.	24	19.25	2.50
Sat.	16	10.75	0.75

Required:

- Calculate the machine uptime percentage.
- Would this percentage be acceptable to a world-class manufacturer?
- According to a benchmarking study of comparable machines, the industry's best uptime for this type of machine ranges from 95 to 98 percent when needed in production. Describe what alternative courses of action the foreman should consider to bring the machine's performance more in line with the industry's best?

11.48 Determining causes of customer service performance measurements. Warren Wendellson, sales director of Ardco Inc. is to present this quarter's sales results to senior management in one hour. He has just received this quarter's customer service performance measurement results from the accounting office, which are as follows:

- Sales growth performance measurement = 8% growth over the previous quarter.
- Budgeted sales variance performance measurement = -3% budgeted sales variance.

Wendellson will be in big trouble if he cannot explain the causes for the variations.

Required:

- List ten possible causes of the sales increase and the variance between actual and budgeted sales.
- List ten additional pieces of information that could be of value to Wendellson.

11.49 Customer satisfaction performance measurement. As a recently hired management accountant for SlimCo, a large manufacturer of random access memory (RAM) boards supplied to PC clone manufacturers, you have been given the task of evaluating customer satisfaction with SlimCo's performance in relation to how the company can achieve world-class manufacturing (WCM) status. Your search of previous work turned up just informal feelings from the sales staff about how well SlimCo does.

Required: Design a customer performance measurement program that can assist SlimCo's progress toward achieving WCM status. As part of the program, determine which performance measurements would be useful, explain how *they* would relate to WCM customer service factors, and design the customer survey form.

