Quality Cost Management

CHAPTER 14

AFTER STUDYING THIS CHAPTER, YOU SHOULD BE ABLE TO:

1. Define quality, describe the four types of quality costs, and discuss the approaches used for quality cost measurement.
2. Prepare a quality cost report, and explain its use.
3. Explain why quality cost information is needed and how it is used.
4. Describe and prepare three different types of quality performance reports.

There are numerous quality-related activities, all of which consume resources that determine the level of quality costs incurred by a firm. Inspecting or testing parts, for example, is an appraisal activity that has the objective of detecting bad products. Detecting bad products and correcting them before they are sent to customers is usually less expensive than letting them be acquired by customers. The objective of quality cost management is to find ways to minimize total quality costs.

Competitive forces are requiring firms to pay increasing attention to quality. Customers are demanding higher-quality products and services. Improving quality may actually be the key to survival for many firms. Improving process quality and the quality of products and services is a fundamental strategic objective that is part of any well-designed Balanced Scorecard. If quality is improved, then customer satisfaction increases; if customer satisfaction increases, then market share will increase; and if market share increases, then revenues will increase; moreover, if quality improves, then operating costs will also decrease. Thus, improving quality can increase market share and sales, while simultaneously decreasing costs. The overall effect enhances a firm's financial and competitive position.

One indication of the importance of quality in the United States is the creation of the Malcolm Baldrige National Quality Award (Public Law 100-107) in 1987. The Baldrige award was created to recognize U.S. companies that excel in quality management and achievement. The award categories are manufacturing, small business, service, educational, and health entities. Since no more than two awards are given per category, it is difficult to win and highly sought after. The first awards were given in 1988. Winners of the Baldrige award in 2003 included **Medrad, Inc.**, **Boeing Aerospace Support**, **Caterpillar Financial Services Corporation**, and **Baptist Hospital, Inc.** Winners in earlier years included **Dana Corporation's Spicer Driveshaft Division**, **Karlee Company**, **Operations Management International Inc.**, **Los Alamos National Bank**, **Texas Nameplate Company, Inc.**, and **Boeing Aircraft and Tanker Programs**.[1]

Improving quality can increase firm value because it increases a firm's profitability. Improving quality can increase profitability in at least two ways: (1) by increasing customer demand and (2) by decreasing the costs of providing goods and services.

Costs of Quality

OBJECTIVE 1

Define quality, describe the four types of quality costs, and discuss the approaches used for quality cost measurement.

Over the past 20 years, American industry has made significant strides in improving quality. Even so, much remains to be done. The costs of quality can be substantial and a source of significant savings. Wane Kost, president of **Philip Crosby Associates II**, maintains that the costs of quality (the "price of nonconformance") for manufacturing organizations fall between 20 to 25 percent of sales for manufacturing firms and 30 to 40 percent of sales for service organizations.[2] Yet, quality experts indicate that the optimal quality level should be about 2 to 4 percent of sales. This difference between actual and optimal figures represents a veritable gold mine of opportunity. Improving quality can produce significant improvements in profitability. Caterpillar Financial Services Corporation U.S. improved its quality and increased its contributions to Caterpillar Inc.'s total earnings from 5.6 percent to more than 25 percent.[3]

Quality has become an important competitive issue for both service and manufacturing organizations. The ability of foreign firms to sell higher-quality products at lower prices has cost many U.S. firms market share. In an effort to combat this stiff competition, U.S. firms have increasingly paid more attention to quality and productivity, especially given the potential to reduce costs and improve product quality simultaneously. In general, evidence exists that most American manufacturing industries have boosted quality. **General Motors**, for example, was ranked fourth in a vehicle dependability study on quality (behind **Toyota**, **American Honda Motor Co., Inc.**, and **Porsche Cars North America**).[4] Other American companies are following suit and are striving to meet consumer quality expectations.

As companies implement quality improvement programs, a need arises to monitor and report on the progress of these programs. Managers need to know what quality costs are and how they are changing over time. Reporting and measuring quality performance is absolutely essential to the success of an ongoing quality improvement program. A fundamental prerequisite for this reporting is measuring the costs of quality. But to measure those costs, an operational definition of quality is needed.

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1. As reported at http://www.nist.gov/ as of September 18, 2004.
2. Stephanie Fellenstein, "Taking Control of Quality Costs," an online article at http://www.eaglegroupusa.com/pubart/qim1298.htm, as of September 18, 2004.
3. "Quality Conversation with James S. Beard," *Quality Digest*, accessed at http://www.qualitydigest.com as of September 25, 2004.
4. Larry Adams, "Top 100 in Quality," *Quality Magazine*, accessed at http://www.qualitymag.com as of September 1, 2004.

The Meaning of Quality

Quality is often referred to as the "degree or grade of excellence"; thus, it is a relative measure of goodness. Defining quality as goodness is so general that it offers no operational content. Adopting a customer focus provides operational content. Operationally, a **quality product or service** is one that meets or exceeds customer expectations. Customer expectations relate to attributes such as product performance, reliability, durability, and fitness for use. A quality specification is the specific level of performance planned for a given quality attribute. Customers expect a quality product or service to perform according to specifications. **Quality of conformance** is a measure of how a product meets its specifications.

Conformance is strongly emphasized because it is the key to meeting customer expectations. In fact, most quality experts believe that "quality is conformance" is the best operational definition of quality. There is some logic to this position. Product specifications should explicitly consider such things as reliability, durability, fitness for use, and performance. Implicitly, a conforming product is reliable, durable, fit for use, and performs well. The product should be produced as specified by the design; specifications should be met. Conformance is the basis for defining what is meant by a nonconforming, or *defective*, product.

A **defective product** is one that does not conform to specifications. **Zero defects** means that all products conform to specifications. But what is meant by "conforming to specifications"? Traditional conformance defines an acceptable range of values for each specification or quality characteristic. A target value is defined, and upper and lower limits are set that describe acceptable product variation for a given quality characteristic. Any unit that falls within the limits is deemed nondefective. For example, the targeted specification for a machined part may be a drilled hole that is two inches in diameter, and any part that is within 1/32 inch of the target is acceptable. On the other hand, the *robust quality view* of conformance emphasizes exactness of conformance. **Robustness** means exact conformance to the target value (no tolerance allowed). There is no range in which variation is acceptable. A nondefective machine part in the robust setting would be one that has a drilled hole that measures exactly two inches. Since evidence exists that product variation can be costly, the robust quality definition of conformance is superior to the traditional definition.

An example of the difference between the traditional approach and the robust quality approach can be found in two plants of the **Sony Corporation**. Both the Tokyo and the San Diego plants produce color television sets. One important feature of a color television set is color density. Sony sets a target value for color density as well as an upper specification limit and a lower specification limit. Any set with color density falling outside the specification limits is considered defective. Does that mean any set falling within the specification limits is acceptable? The viewpoint differs between the two plants. The San Diego plant emphasized zero defects in the traditional sense. In evaluating the quality of the color density of television sets, any television falling within the specification limits was deemed acceptable and shipped to customers. Sony of Tokyo, working with a robust quality viewpoint, strove to hit the target value for color density. Exhibit 14-1, on the following page, illustrates the distribution of color density of television sets shipped from the two plants.

When Sony evaluated customer satisfaction, it found that customers preferred the reduced variation of televisions produced at the Tokyo plant. These customers reported greater satisfaction and filed fewer warranty claims.[5]

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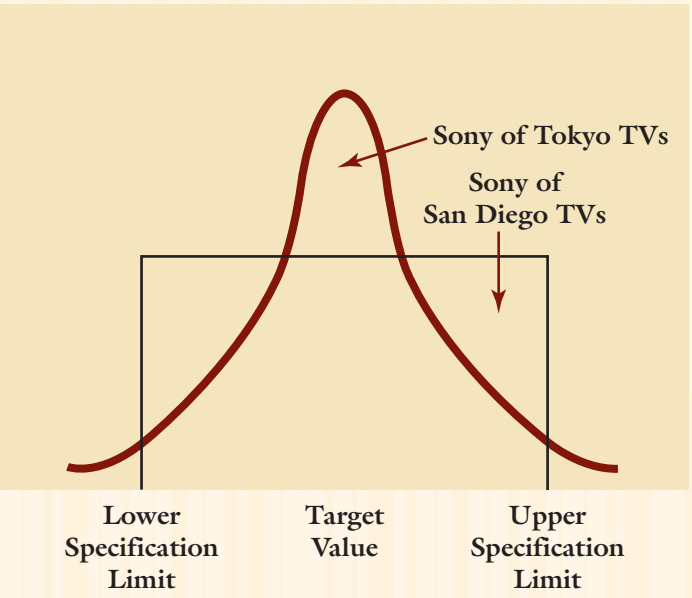
5. Harold P. Roth and Thomas L. Albright, "What Are the Costs of Variability?" *Management Accounting* (June 1994): 51–55; and Genichi Taguchi and Don Clausing, "Robust Quality," *Harvard Business Review* (January–February 1990): 65–75.

EXHIBIT 14-1 Distribution of Color Density of Sony Television Sets



Defining Quality Costs

Quality-linked activities are those activities performed because poor quality may or does exist. The costs of performing these activities are referred to as costs of quality. Thus, **costs of quality** are the costs that exist because poor quality may or does exist. This definition implies that quality costs are associated with two subcategories of quality-related activities: *control activities* and *failure activities*. **Control activities** are performed by an organization to prevent or detect poor quality (because poor quality may exist). Thus, control activities are made up of prevention and appraisal activities. **Control costs** are the costs of performing control activities. **Failure activities** are performed by an organization or its customers in response to poor quality (poor quality does exist). If the response to poor quality occurs before delivery of a bad (nonconforming, unreliable, not durable, and so on) product to a customer, the activities are classified as internal failure activities; otherwise, they are classified as external failure activities. **Failure costs** are the costs incurred by an organization because failure activities are performed. Notice that the definitions of failure activities and failure costs imply that customer response to poor quality can impose costs on an organization. The definitions of quality-related activities also imply four categories of quality costs: (1) prevention costs, (2) appraisal costs, (3) internal failure costs, and (4) external failure costs.

Prevention costs are incurred to prevent poor quality in the products or services being produced. As prevention costs increase, we would expect the costs of failure to decrease. Examples of prevention costs are quality engineering, quality training programs, quality planning, quality reporting, supplier evaluation and selection, quality audits, quality circles, field trials, and design reviews.

Appraisal costs are incurred to determine whether products and services are conforming to their requirements or customer needs. Examples include inspecting and testing materials, packaging inspection, supervising appraisal activities, product acceptance, process acceptance, measurement (inspection and test) equipment, and outside endorsements. Two of these terms require further explanation.

Product acceptance involves sampling from batches of finished goods to determine whether they meet an acceptable quality level; if so, the goods are accepted. *Process acceptance* involves sampling goods while in process to see if the process is in control and producing nondefective goods; if not, the process is shut down until corrective action can be taken. The main objective of the appraisal function is to prevent nonconforming goods from being shipped to customers.

Internal failure costs are incurred because products and services do not conform to specifications or customer needs. This nonconformance is detected prior to being shipped or delivered to outside parties. These are the failures detected by appraisal activities. Examples of internal failure costs are scrap, rework, downtime (due to defects), reinspection, retesting, and design changes. These costs disappear if no defects exist.

External failure costs are incurred because products and services fail to conform to requirements or satisfy customer needs after being delivered to customers. Of all the costs of quality, this category can be the most devastating. Costs of recalls, for example, can run into the hundreds of millions. Other examples include lost sales because of poor product performance, returns and allowances because of poor quality, warranties, repair, product liability, customer dissatisfaction, lost market share, and complaint adjustment. External failure costs, like internal failure costs, disappear if no defects exist.

Exhibit 14-2 summarizes the four quality cost categories and lists specific examples of costs. Each of the costs could have been expressed as the cost of quality-related activities such as the cost of certifying vendors, inspecting incoming materials, adjusting complaints, etc.

Quality Cost Measurement

Quality costs can also be classified as *observable* or *hidden*. **Observable quality costs** are those that are available from an organization's accounting records. **Hidden quality**

EXHIBIT 14-2 Examples of Quality Costs by Category

Prevention Costs	Appraisal (Detection) Costs
Quality engineering	Inspection of materials
Quality training	Packaging inspection
Recruiting	Product acceptance
Quality audits	Process acceptance
Design reviews	Field testing
Quality circles	Continuing supplier verification
Marketing research	
Prototype inspection	
Vendor certification	

Internal Failure Costs	External Failure Costs
Scrap	Lost sales (performance-related)
Rework	Returns/allowances
Downtime (defect-related)	Warranties
Reinspection	Discounts due to defects
Retesting	Product liability
Design changes	Complaint adjustment
Repairs	Recalls
	Ill will

costs are opportunity costs resulting from poor quality. (Opportunity costs are not usually recognized in accounting records.) Consider, for example, all the examples of quality costs listed in Exhibit 14-2. With the exception of lost sales, customer dissatisfaction, and lost market share, all the quality costs are observable and should be available from the accounting records. Note also that the hidden costs are all in the external failure category. These hidden quality costs can be significant and should be estimated. Although estimating hidden quality costs is not easy, three methods have been suggested: (1) the multiplier method, (2) the market research method, and (3) the Taguchi quality loss function.

The Multiplier Method

The multiplier method assumes that the total failure cost is simply some multiple of measured failure costs:

$$\text{Total external failure cost} = k(\text{Measured external failure costs})$$

where k is the multiplier effect. The value of k is based on experience. For example, **Westinghouse Electric** reports a value of k between 3 and 4.[6] Thus, if the measured external failure costs are $3 million, the actual external failure costs are between $9 million and $12 million. Including hidden costs in assessing the amount of external failure costs allows management to more accurately determine the level of resource spending for prevention and appraisal activities. Specifically, with an increase in failure costs, we would expect management to increase its investment in control costs.

The Market Research Method

Formal market research methods are used to assess the effect of poor quality on sales and market share. Customer surveys and interviews with members of a company's sales force can provide significant insights into the magnitude of a company's hidden costs. Market research results can be used to project future profit losses attributable to poor quality.

The Taguchi Quality Loss Function

The traditional zero defects definition assumes that hidden quality costs exist only for units that fall outside the upper and lower specification limits. The **Taguchi loss function** assumes that any variation from the target value of a quality characteristic causes hidden quality costs. Furthermore, the hidden quality costs increase quadratically as the actual value deviates from the target value. The Taguchi quality loss function, illustrated in Exhibit 14-3, can be described by the following equation:

$$L(y) = k(y - T)^2 \qquad (17.1)$$

where

k = A proportionality constant dependent upon the organization's external failure cost structure
y = Actual value of quality characteristic
T = Target value of quality characteristic
L = Quality loss

Exhibit 14-3 demonstrates that the quality cost is zero at the target value and increases symmetrically, at an increasing rate, as the actual value varies from the target value. Assume, for example, that a company produces watches and the quality characteristic is accuracy (as measured by how much time is gained or lost in three months). Assume k = $2 and T = 0 minutes. Exhibit 14-4 illustrates the computation of the

6. T. L. Albright and P. R. Roth, "The Measurement of Quality Costs: An Alternative Paradigm," *Accounting Horizons* (June 1992): 15–27.

EXHIBIT 14-3 The Taguchi Quality Loss Function

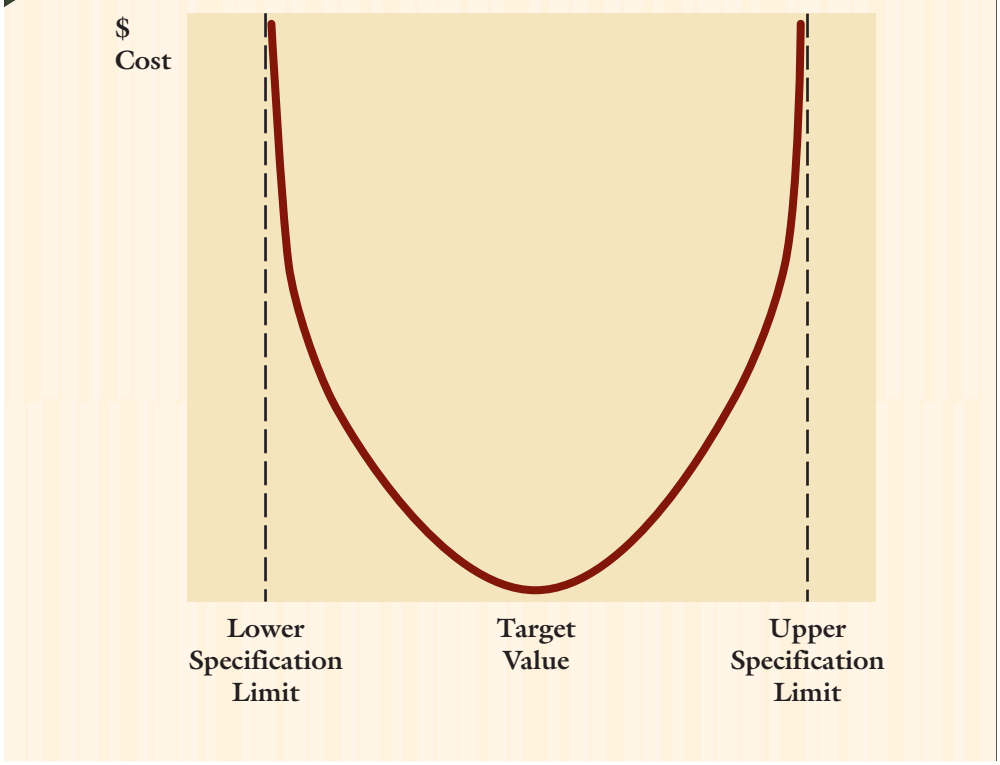


EXHIBIT 14-4 Quality Loss Computation Illustrated

Unit No.	Time Gained (Lost) (y)	y − T	$(y - T)^2$	$k(y - T)^2$
1	−1	−1	1	$ 2.00
2	2	2	4	8.00
3	4	4	16	32.00
4	−3	−3	9	18.00
			30	$60.00
Units			÷ 4	÷ 4
Average			7.5	$15.00

quality loss for four units. Notice that the cost quadruples when the deviation from target doubles (Units 2 and 3). Notice also that the average deviation squared and the average loss per unit can be computed. These averages can be used to compute the total expected hidden quality costs for a product. If, for example, the total units produced are 5,000 and the average squared deviation is 7.5, then the expected cost per unit is \$15 (7.5 × \$2) and the total expected loss for the 5,000 units would be \$75,000 (\$15 × 5,000).

To apply the Taguchi loss function, k must be estimated. The value for k is computed by dividing the estimated cost at one of the specification limits by the squared deviation of the limit from the target value:

$$k = c/d^2$$

where

c = Loss at the lower or upper specification limit
d = Distance of limit from target value

This means that we still must estimate the loss for a given deviation from the target value. The first two methods, the multiplier method or the market research method, may be used to help in this estimation (a 1-time assessment need). Once k is known, the hidden quality costs can be estimated for any level of variation from the target value.

Reporting Quality Costs

OBJECTIVE 2

Prepare a quality cost report, and explain its use.

A quality cost reporting system is essential if an organization is serious about improving and controlling quality costs. The first and simplest step in creating such a system is assessing current actual quality costs. A detailed listing of actual quality costs by category can provide two important insights. First, it reveals the magnitude of the quality costs in each category, allowing managers to assess their financial impact. Second, it shows the distribution of quality costs by category, allowing managers to assess the relative importance of each category.

Quality Cost Reports

The financial significance of quality costs can be assessed more easily by expressing these costs as a percentage of actual sales. Exhibit 14-5, for example, reports the quality costs of Goates Company for fiscal 2007. According to the report, quality costs represent 20 percent of sales. Given the rule of thumb that quality costs should be no more than 2 to 4 percent, Goates has ample opportunity to improve profits by decreasing quality costs. Understand, however, that reduction in costs should come through improvement of quality. Reduction of quality costs without any effort to improve quality could prove to be a disastrous strategy.

Additional insight concerning the relative distribution of quality costs can be realized by constructing charts that show the relative amount of costs in each category. Exhibit 14-6 provides a bar graph and pie chart that show each category's percentage contribution to total quality costs. The graphs reveal that failure costs are approximately 82 percent of the total quality costs, suggesting that Goates has ample opportunity to improve quality and lower total quality costs. But by how much? What is the optimal relative distribution of quality costs?

Distribution of Quality Costs: The Acceptable Quality View

One view of optimal quality cost distribution is the *acceptable quality view*. Although this view is no longer widely accepted, it serves as a useful point of reference for understanding the current views on how quality costs should be distributed. According to the acceptable quality view, there is an optimal tradeoff between failure and control costs. As control costs increase, failure costs should decrease. As long as the decrease in failure costs is greater than the corresponding increase in control costs, a company should continue increasing its efforts to prevent or detect nonconforming units. Eventually, a point is reached at which any additional increase in this effort costs more than the corresponding reduction in failure costs. This point represents the minimum level of total quality costs. It is the optimal balance between control costs and failure costs

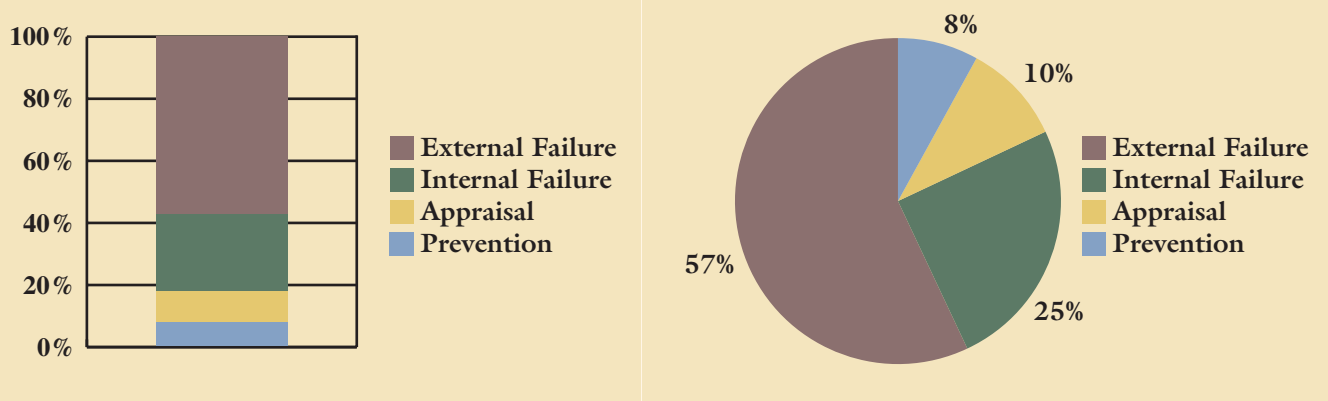
EXHIBIT 14-5 Quality Cost Report

Goates Company
Quality Cost Report
For the Year Ended June 30, 2007

	Quality Costs		Percentage of Sales[a]
Prevention costs:			
Quality training	$ 10,000		
Reliability engineering	65,000	$ 75,000	1.50%
Appraisal costs:			
Materials inspection	$ 5,000		
Product acceptance	20,000		
Process acceptance	75,000	100,000	2.00
Internal failure costs:			
Scrap	$150,000		
Rework	100,000	250,000	5.00
External failure costs:			
Customer complaints	$150,000		
Warranty	250,000		
Returns and allowances	175,000	575,000	11.50
Total quality costs		$1,000,000	20.00%[b]

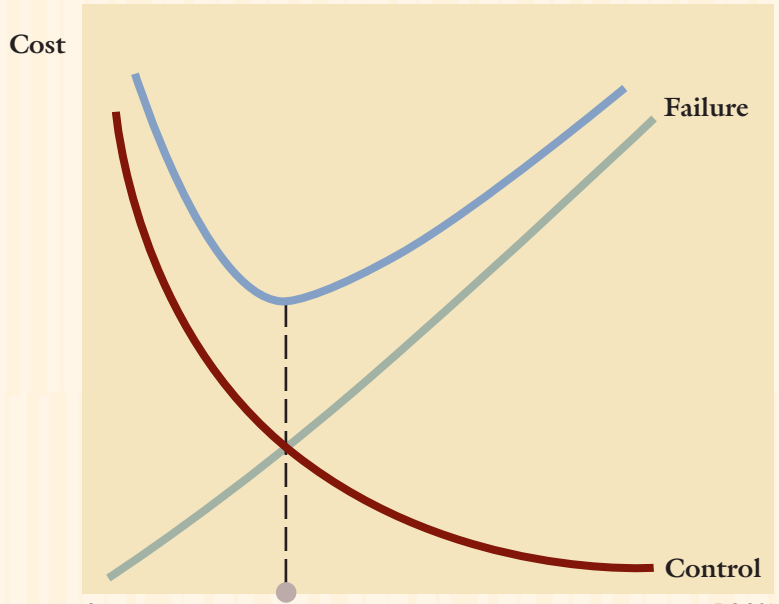
[a]Actual sales of $5,000,000.
[b]$1,000,000/$5,000,000 = 20 percent.

EXHIBIT 14-6 Quality Cost Categories: Relative Contribution Graphs



and defines what is known as the **acceptable quality level (AQL)**. This theoretical relationship is illustrated in Exhibit 14-7 on the following page. The graph reveals that total quality costs decrease as quality improves up to a point. After that, no further improvement is possible. Thus, AQL identifies an optimal level of defective units. Note that this level does not correspond to that of zero defects.

EXHIBIT 14-7 AQL Quality Cost Graph



Distribution of Quality Costs: Zero-Defects View

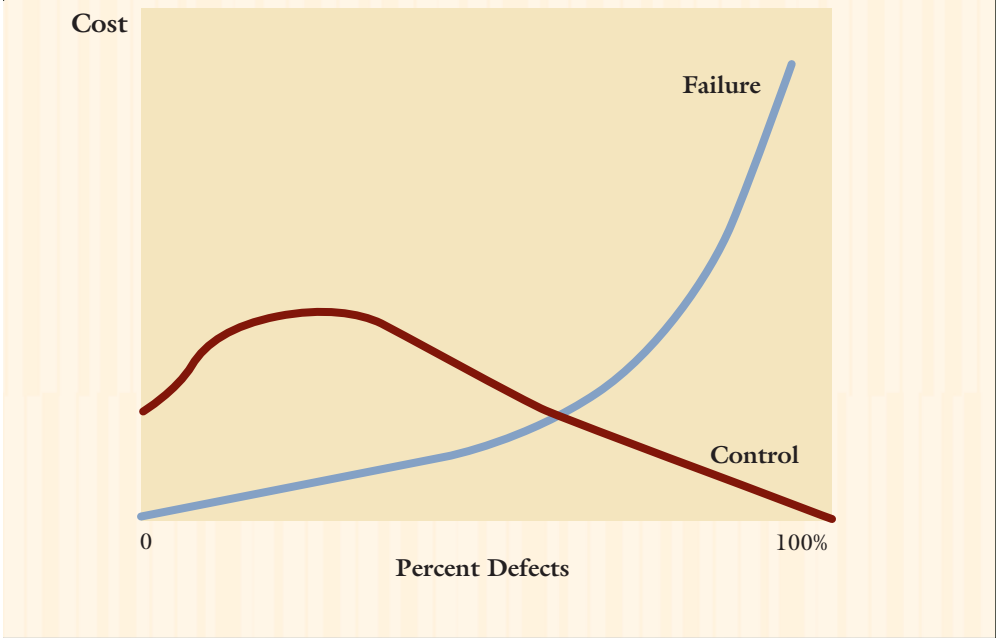
The AQL view permitted and, in fact, encouraged the production of a given number of defective units. This model prevailed in the quality control world until the late 1970s, when the AQL model was challenged by the zero-defects model. Essentially, the zero-defects model made the claim that it was cost-beneficial to reduce nonconforming units to zero. Firms producing increasingly fewer nonconforming units became more competitive relative to firms that continued with the traditional AQL model. In the mid-1980s, the zero-defects model was taken one step further by the robust quality model, which challenged the definition of a defective unit. According to the robust view, a loss is experienced from producing products that vary from a target value; the greater the distance from the target value, the greater the loss. In other words, variation from the ideal is costly, and specification limits serve no useful purpose and, in fact, may be deceptive. The zero-defects model understates the quality costs and, thus, the potential for savings from even greater efforts to improve quality (remember the multiplication factor of **Westinghouse Electric**). Therefore, the robust quality model tightened the definition of a defective unit, refined our view of quality costs, and intensified the quality race.

For firms operating in an intensely competitive environment, improving quality is a competitive necessity. If the robust quality view is correct, then firms can capitalize on it, decreasing the number of defective units (robustly defined as zero tolerance) while simultaneously decreasing their total quality costs. The quest to find ways to achieve the target value creates a dynamic quality world as opposed to the static quality world of AQL.

Robust Quality View and Quality Cost Distribution

Exhibit 14-8 shows a quality cost function consistent with the robust quality view. Essentially, what happens is that as firms increase their prevention and appraisal costs and reduce their failure costs, they discover that they can then cut back on their prevention

EXHIBIT 14-8 Zero-Defects Quality Cost Graph



and appraisal costs. What initially appears to be a trade-off turns out to be a permanent reduction in costs for all quality cost categories. There are some key differences. First, control costs do not increase without limit as a robust zero-defect state is approached. Second, control costs may increase and then decrease as the robust state is approached. Third, failure costs can be driven to zero.

Suppose, for example, that a firm has decided to improve the quality of its products by reengineering its manufacturing processes. The objective is to identify ways of producing products that have less chance of being defective. As the firm works to implement this program, additional costs may be incurred (for example, special studies, consulting fees, and hiring of additional process design engineers, etc.). Initially, other prevention and appraisal costs may continue at their current levels. However, once the program is fully implemented and evidence is surfacing that the failure costs are being reduced (for example, less rework, fewer customer complaints, and fewer repairs), then the company may decide to cut back on inspections of product, customer complaint departments, and so on. The net effect is a reduction in all quality cost categories. And quality has increased!

This example is consistent with the strategy to reduce quality costs recommended by the American Society for Quality Control:[7]

> *The strategy for reducing quality costs is quite simple: (1) take direct attack on failure costs in an attempt to drive them to zero; (2) invest in the "right" prevention activities to bring about improvement; (3) reduce appraisal costs according to results achieved; and, (4) continuously evaluate and redirect prevention efforts to gain further improvement. This strategy is based on the premise that:*
>
> - *For each failure there is a* root cause.
> - *Causes are* preventable.
> - *Prevention is always* cheaper.

7. Jack Campanella, ed., *Principles of Quality Costs* (Milwaukee: ASQC Quality Press, 1990): 12.

This ability to reduce total quality costs dramatically in all categories is borne out by real-world experiences. **Tennant**, for example, over an 8-year period, reduced its costs of quality from 17 percent of sales, with failure costs accounting for 50 percent of the total costs of quality (8.5 percent of sales), to 2.5 percent of sales, with failure costs accounting for only 15 percent of the total costs of quality (0.375 percent of sales). Further support for the total quality control model is provided by **Westinghouse Electric**. Similar to Tennant's experience, Westinghouse Electric found that its profits continued to improve until its control costs accounted for about 70 to 80 percent of total quality costs.[8] Based on these two companies' experiences, we know that it is possible to reduce total quality costs significantly—in all categories—and that the process radically alters the relative distribution of the quality cost categories.

The Role of Activity-Based Cost Management

Activity-based costing can be used to calculate the quality costs per unit of a firm's products. Once an ABC system is in place, the only requirement is to identify those activities that are quality related, such as inspection, rework, and warranty work. Assume, for example, that the cost of the rework activity is $250,000. Now, assume that a company produces 10,000 units each of two products: a regular model and a deluxe model. The number of units reworked is 1,000 for the regular model and 4,000 for the deluxe model (units reworked is the activity driver). The activity rate is $50 per reworked unit ($250,000/5,000), and the rework costs (an internal failure cost) assigned to each product are $50,000 and $200,000 for the regular model and the deluxe model, respectively. This provides a signal that the deluxe model is of lower quality than the regular model. Thus, ABC can be used as a means to identify cost objects with quality problems, such as low-quality products, low-quality processes, and low-quality suppliers. This can then allow more focused management of quality costs.

Activity-based management is also useful. ABM classifies activities as value-added and non-value-added and keeps only those that add value. This principle can be applied to quality-related activities. Appraisal and failure activities and their associated costs are non-value-added and should be eliminated (eventually). Prevention activities—performed efficiently—can be classified as value-added and should be retained. **Grede Foundries, Inc.**, of Milwaukee, the world's largest foundry company, has been tracking all four categories of quality costs for more than 15 years. However, it does not report prevention costs as part of its final cost-of-quality figures because it does not want its managers to reduce quality costs by cutting prevention activities. It feels strongly that spending money on prevention activities pays off. For example, it has found that a 1 percent reduction in scrap reduces external defects by about 5 percent.[9]

Root causes (cost drivers) can also be identified, especially for failure activities, and used to help managers understand what is causing the costs of the activities. This information can then be used to select ways of reducing quality costs to the level demonstrated in Exhibit 14-8. In effect, activity-based management supports the robust zero-defect view of quality costs. There is no optimal trade-off between control and failure costs; the latter are non-value-added costs and should be reduced to zero. Some control activities are non-value-added and should be eliminated. Other control activities are value-added but may be performed inefficiently, and the costs caused by the inefficiency are non-value-added. Thus, costs for these categories may also be reduced to lower levels.

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8. These factual observations are based on those reported by Carr and Tyson, "Planning Quality Cost Expenditures," *Management Accounting* (August 1995).
9. Nancy Chase, "Accounting for Quality: Counting Costs, Reaping Returns," *Quality*. Vol. 37, Issue 10 (October 1998): 38–42.

COST MANAGEMENT **Technology in Action**

Robert Bosch Corporation manufactures automotive parts. The company discovered that automation facilitated its objectives of producing high-quality automotive parts and increasing profits. In its South Carolina facility, control units for anti-lock brakes are manufactured. The control units are subjected to 450 quality control tests, generating about 1.5 million data values per day. To manage and use these data, Bosch put together a Data Collection, Analysis, and Reporting (DCAR) system, using an **Oracle** database and **SAS** statistical software. DCAR tracks control parameters in the manufacturing process, highlights potential cost savings, and allows production personnel to quickly retrieve and view test results in graphical form. Scrap reduction is one example of how DCAR has improved quality and reduced costs. Before DCAR, a problem with a pallet of products would typically result in scrapping the entire pallet. Now, with DCAR, the particular parts affected can be identified, and Bosch can save about 80 percent of a pallet, producing significant savings (by identifying the true internal failure units). The next step is to use the data in a more proactive approach (preventive mode), producing even higher-quality performance while simultaneously lowering costs even more.

Source: Taken from the Web site, http://www.sas.com/success/robertbosch.html, as of Oct. 15, 2004.

OBJECTIVE 3

Explain why quality cost information is needed and how it is used.

Quality Cost Information and Decision Making

Reporting quality costs can improve managerial planning, control, and decision making. For example, if a company wants to implement a process reengineering program to improve the quality of its products, it will need to assess the following: current quality costs by item and by category, the additional costs associated with the program, and the projected savings by item and by category. *When* the costs and savings will occur must also be projected. Then, a capital budgeting analysis can be done to determine the merits of the proposed program. If the outcome is favorable and the program is initiated, then it becomes important to monitor the program through performance reporting.

Using quality cost information to implement and monitor the effectiveness of quality programs is only one use of a quality cost system. Other important uses can also be identified. Quality cost information is an important input to management decision making. It is also important to outside parties as they assess the quality of the company, through programs such as ISO 9000.

Decision Making Contexts

Managers need quality cost information in a number of decision-making contexts. Two of these contexts are strategic pricing and cost-volume-profit analysis.

Strategic Pricing

Consider AMD, Inc., which produces electronic measurement devices. Market share for the company's low-level electronic measurement instruments had been steadily dropping. Linda Werther, marketing manager, identified price as the major problem. She knew that Japanese firms produced and sold the low-level instruments for less than AMD could. If AMD reduced its price to that of the competition, the new price would be below cost. Yet, if something were not done, the Japanese firms would continue to expand their market share. One possibility was simply to drop the low-level line and concentrate on instruments in the medium- and high-level categories. Linda knew, however, that this was a short-term solution, since soon the same Japanese firms would be competing at the higher levels. A brief income statement for the low-level instruments is as follows:

Revenues (1,000,000 @ $20)	$20,000,000
Cost of goods sold	(15,000,000)
Operating expenses	(3,000,000)
Product-line income	$ 2,000,000

Linda strongly believed that a 15 percent price decrease would restore the instrument line's market share and profitability to its former levels. One possibility was the implementation of total quality management. Her first action was to request information on the quality costs for the lower-level instruments. AMD's controller, Eugene Sadler, admitted that the costs were not tracked separately. For example, the cost of scrap was buried in the work-in-process inventory account. He did promise, however, to estimate some of the costs. Data from his report for the low-level instruments are as follows:

Quality costs (estimated):	
Inspection of materials	$ 200,000
Scrap	800,000
Rejects	500,000
Rework	400,000
Product inspection	300,000
Warranty work	1,000,000
Total estimate	$3,200,000

Upon receiving the report, Linda, Eugene, and Art Smith, manager of the quality control department, met to determine possible ways of reducing quality costs for the low-level line. Art was confident that the quality costs could be reduced by 50 percent within 18 months. He had already begun planning the implementation of a new quality program. Linda calculated that a 50 percent reduction in the quality costs associated with the low-level instruments would reduce costs by about $1.60 per unit ($1,600,000/1,000,000)—which would make up slightly more than half of the $3 reduction in selling price that would be needed (the reduction is 15 percent of $20). Based on this outcome, Linda decided to implement the price reduction in three phases: a $1 reduction immediately, a $1 reduction in six months, and the final reduction of $1 in 12 months. This phased reduction would likely prevent any further erosion of market share and would start increasing market share sometime in the second phase. By phasing in the price reductions, the quality control department would have time to reduce costs so that any big losses could be avoided.

The AMD, Inc., example illustrates that both quality cost information and the implementation of a total quality control program contributed to a significant strategic decision. It also illustrates that improving quality was not a panacea. The reductions were not as large as needed to bear the full price reduction. Other productivity gains will be needed to ensure the long-range viability of the product line. Implementing JIT manufacturing, for example, might reduce inventories and decrease costs of materials handling and maintenance.

Cost-Volume-Profit Analysis and Strategic Design Decisions

Traditionally, cost-volume-profit analysis relies on the analysis of fixed and variable costs in conjunction with cost. Terry Foster, the marketing manager, and Sharon Fox, the design engineer, discovered shortcomings in the traditional analysis when they proposed a new product. They had been certain that a proposal for the new product was going to be approved. Instead, they received the following report from the controller's office.

Report: New Product Analysis, Project 675

Projected sales potential: 44,000 units
Production capacity: 45,000 units
Unit selling price: $60
Unit variable costs: $40
Fixed costs:

Product development	$ 500,000
Manufacturing	200,000
Selling	300,000
Total	$1,000,000

Projected break-even: 50,000 units
Decision: Reject
Reason(s): The break-even point is greater than the production capacity as well as the projected sales volume.

In an effort to discover just why the cost figures came out so poorly for a project that both individuals felt strongly would be profitable, the two met with Bob Brown, the assistant controller. The following conversation took place.

SHARON: Bob, I would like to know why there is a $3-per-unit scrap cost. Can you explain it?

BOB: Sure. It's based on the scrap cost that we track for existing, similar products.

SHARON: Well, I think you have overlooked the new design features of this new product. Its design virtually eliminates any waste—especially when you consider that the product will be made on a numerically controlled machine.

TERRY: Also, this $2-per-unit charge for repair work should be eliminated. The new design that Sharon is proposing solves the failure problems we have had with related products. It also means that the $100,000 of fixed costs associated with the Repair Center can be eliminated.

BOB: Sharon, how certain are you that this new design will eliminate some of these quality problems?

SHARON: I'm absolutely positive. The early prototypes did exactly as we expected. The results of those tests are included in the proposal.

BOB: Right. Reducing the variable cost by $5 per unit and the fixed costs by $100,000 produces a break-even point of 36,000 units. These changes alone make the project viable. I'll change the report to reflect a positive recommendation.

The above scenario illustrates the importance of further classifying quality costs by behavior. Although only unit-based behavior is assumed, activity-based classification is also possible and could enhance the decision usefulness of quality costs. The scenario also reinforces the importance of identifying and reporting quality costs separately. The new product was designed to reduce its quality costs, and only by knowing the quality costs assigned could Sharon and Terry have discovered the error in the break-even analysis. Finally, notice the effect total quality management has on design decisions. By being aware of the quality costs and their causes, the new product's design was structured to avoid many of the existing quality problems.

Certifying Quality through ISO 9000

Just as a company assesses the quality of its suppliers, that same company may supply other companies that require vendor certification of quality. A relatively new program

called ISO 9000 has evolved in response to the need for a standardized set of procedures for supplier quality verification.

ISO (pronounced ICE-OH) 9000 is a standard of quality measurement. Developed by the International Organization for Standardization in Geneva, Switzerland, it is a series of five international quality standards. These standards center on the concept of documentation and control of nonconformance and change. ISO 9000 has been a success in Europe, and U.S. companies doing business in Europe were the first to board the ISO 9000 bandwagon, simply because it is a requirement of doing business. Companies that attain ISO 9000 certification have been audited by an independent test company, which certifies that the company meets certain quality standards. These standards do not apply to the production of a particular product or service. Instead, they apply to the way in which a company ensures quality, for example, by testing products, training employees, keeping records, and fixing defects.

It is important to note that ISO 9000 does not certify either the quality of the product itself or the commitment of the company to continuous improvement. In fact, ISO 9000 is a vocabulary and a set of five standards. These are given in Exhibit 14-9.[10] As a result, companies that require ISO 9000 certification (like **Motorola** or **GE**) do not stop auditing their suppliers. Requiring ISO 9000 certification is just a first step.

EXHIBIT 14-9 ISO 9000 Standards

ISO 8402: Quality—Vocabulary
ISO 9000: Quality management and quality assurance standards—Guidelines for selection and use
ISO 9001: Quality systems—Model for quality assurance in design/development, production, installation, and servicing
ISO 9002: Quality systems—Model for quality assurance in production and installation
ISO 9003: Quality systems—Model for quality assurance in final inspection and test
ISO 9004: Quality management and quality system elements—Guidelines

On the plus side, many companies have found that the process of applying for ISO 9000 certification, while lengthy and expensive (it can take many months and cost $1,000,000 or more for larger companies), yields important benefits in terms of self-knowledge and improved financial performance. For example, **Haworth Furniture**, a maker of office furniture, posts placards with words and pictures at work stations throughout its five factories to show employees exactly what should be done. These placards help to ensure that all workers are following company policies consistently, a hallmark of conformance quality. Similarly, **Allen-Bradley**'s Twinsburg plant has improved quality and productivity significantly by replacing a system of paper manuals with an electronic mail system. Now, when engineering changes are made, the system purges the old instructions and inserts the new ones. Workers no longer tape personal directions to their work stations—directions which were quickly out of date.

ISO 9000 is not a quality system. It is a first step in supplier certification. However, companies are finding it hard to resist paying for an independent audit of their quality processes. By 1998, 21,482 ISO 9000 certifications had been awarded in the United

10. These steps are listed in A. Faye Borthick and Harold P. Roth, "Will Europeans Buy Your Company's Products?" *Management Accounting* (July 1992): 28–32. This article is an excellent introduction to ISO 9000 certification and includes a useful listing of quality definitions.

States; worldwide, over 500,000 certifications have been issued.[11] ISO 9000 standards have been adopted by 90 countries. Many large companies, including **DuPont**, **GE**, **Eastman Kodak**, and **British Telecom**, are urging their suppliers to obtain certificates.

OBJECTIVE 4

Describe and prepare three different types of quality performance reports.

Controlling Quality Costs

Good quality cost management requires that quality costs be reported and controlled (control having a cost reduction emphasis). Control enables managers to compare actual outcomes with standard outcomes to gauge performance and take any necessary corrective actions. Quality cost performance reports have two essential elements: actual outcomes and standard or expected outcomes. Deviations of actual outcomes from the expected outcomes are used to evaluate managerial performance and provide signals concerning possible problems.

Performance reports are essential to quality improvement programs. A report like the one shown in Exhibit 14-5 (see page 629) forces managers to identify the various costs that should appear in a performance report, to identify the current quality performance level of the organization, and to begin thinking about the level of quality performance that should be achieved. Identifying the quality standard is a key element in a quality performance report. The standard should emphasize cost reduction opportunities.

Choosing the Quality Standard

The Traditional Approach

In the traditional approach, the appropriate quality standard is an acceptable quality level (AQL). An AQL is simply an admission that a certain number of defective products will be produced and sold. For example, the AQL may be set at 3 percent. In this case, any lot of products (or production run) that has no more than 3 percent defective units will be shipped to customers. Typically, the AQL reflects the current operating status, not what is possible if a firm has an excellent quality program. As the basis for a quality standard, AQL has the same problems as historical experience does for materials and labor usage standards: it may perpetuate past operating mistakes.

Unfortunately, AQL has additional problems. Setting a 3 percent AQL is a commitment to deliver defective products to customers. Out of every 1 million units sold, 30,000 will yield dissatisfied customers. Why plan to make a certain number of defective units? Why not plan instead to make the product according to its specifications? Is there not a matter of integrity involved here? How many customers would accept a product if they knew that it was defective? How many people would consult a surgeon if they knew that the surgeon planned to botch three of every 100 operations?

The Total Quality Approach

These questions reflect a new attitude toward quality. A more sensible standard is to produce products as they are intended to be. This standard will be referred to as the robust *zero-defects standard*. It reflects a philosophy of total quality control and calls for products and services to be produced and delivered that meet the targeted value. Thus, when we say zero defects, we are referring to defective units in the robust sense. Recall that the need for total quality control is inherent in a JIT manufacturing approach. Thus, the movement toward total quality control is being sustained by the firms adopting JIT. JIT, however, is not a prerequisite for moving toward total quality control. This approach can stand by itself.

Admittedly, the total quality standard is one that may not be completely attainable; however, evidence exists that it can be closely approximated. Defects are caused either

11. Charles J. Corbett, Maria J. Montes, David A. Kirsch, and Maria Jose Alvarez-Gil, "Does ISO Certification Pay?" *Special Reports*, at www.iso.org/iso/fr/iso9000-14000/articles/specialreports.html, accessed December 16, 2004.

by lack of knowledge or by lack of attention. Lack of knowledge can be corrected by proper training and lack of attention by effective leadership. Note also that total quality control implies the ultimate elimination of failure costs. Those who believe that no defects should be permitted will continue to search for new ways to improve quality costs.

Some may wonder whether adherence to the ideal is a realistic standard. Consider the following anecdote. An American firm placed an order for a particular component with a Japanese firm. In the order, the American firm specified that 1,000 components should be delivered with an AQL of 5 percent defects. When the order arrived, it came in two boxes—one large and one small. A note explained that the large box contained 950 good components and the small one held the 50 defective components; the note also asked why the firm wanted 50 defective parts (implying the capability of delivering no defective parts).

Consider another case. A firm engaged in a significant volume of business through mailings. On average, fifteen percent of the mailings were sent to the wrong address. Returned merchandise, late payments, and lost sales all resulted from this error rate. In one case, a tax payment was sent to the wrong address. By the time the payment arrived, it was late, causing a penalty of $300,000. Why not spend the resources (surely less than $300,000) to get the mailing list right and have no errors? Is a mailing list that is 100 percent accurate really impossible to achieve? Why not do it right the first time?

Quantifying the Quality Standard

Quality can be measured by its costs; as the costs of quality decrease, higher quality results—at least up to a point. Even if the standard of zero defects is achieved, a company must still have prevention and appraisal costs. A company with a well-run quality management program can get by with quality costs of about 2.5 percent of sales. (If zero defects are achieved, this cost is for prevention and appraisal.) This 2.5 percent standard is accepted by many quality control experts and many firms that are adopting aggressive quality improvement programs.

The 2.5 percent standard is for total costs of quality. Costs of individual quality factors, such as quality training or materials inspection, will be less. Each organization must determine the appropriate standard for each individual factor. Budgets can be used to set spending for each standard so that the total budgeted cost meets the 2.5 percent goal.

Physical Standards

For line managers and operating personnel, physical measures of quality—such as number of defects per unit, the percentage of external failures, billing errors, contract errors, and other physical measures—may be more meaningful. For physical measures, the quality standard is zero defects or errors. The objective is to get everyone to do it right the first time.

Use of Interim Standards

For most firms, the standard of zero defects is a long-range goal. The ability to achieve this standard is strongly tied to supplier quality. For most companies, materials and services purchased from outside parties make up a significant part of a product's cost. For example, more than 65 percent of the product cost for **Tennant Company** was from materials and parts purchased from more than 500 different suppliers. To achieve the desired quality level, Tennant had to launch a major campaign to involve its suppliers in similar quality improvement programs. Developing the relationships and securing the needed cooperation from suppliers takes time—in fact, it takes years. Similarly, getting people within the company itself to understand the need for quality improvement and to have confidence in the program can take several years.

Because improving quality to the zero-defects level can take years, yearly quality improvement standards should be developed so that managers can use performance reports to assess the progress made on an interim basis. These **interim quality standards** express quality goals for the year. Progress should be reported to managers and employees in order to gain the confidence needed to achieve the ultimate standard of zero

defects. Even though reaching the zero-defects level is a long-range project, management should expect significant progress on a yearly basis. For example, Tennant cut its quality costs from 17 percent of sales to 8 percent of sales over a period of six years—an average reduction of more than 1 percent per year. Furthermore, once the 2.5 percent goal is reached, efforts must be expended continuously to maintain it. Performance reports, at this stage, assume a strict control role.

Types of Quality Performance Reports

Quality performance reports measure the progress realized by an organization's quality improvement program. Three types of progress can be measured and reported:

1. Progress with respect to a current-period standard or goal (an interim standard report)
2. The progress trend since the inception of the quality improvement program (a multiple-period trend report)
3. Progress with respect to the long-range standard or goal (a long-range report)

Interim Standard Report

The organization must establish an interim quality standard each year and make plans to achieve this targeted level. Since quality costs are a measure of quality, the targeted level can be expressed in dollars budgeted for each category of quality costs and for each cost item within the category. At the end of the period, the **interim quality performance report** compares the actual quality costs for the period with the budgeted costs. This report measures the progress achieved within the period relative to the planned level of progress for that period. Exhibit 14-10 illustrates such a report.

The interim report reveals the within-period quality improvement relative to specific objectives as reflected by the budgeted figures. For AMD, the overall performance is close to what was planned: total actual quality costs differ by $29,000 from total budgeted quality costs and the actual costs, a mere 0.36 percent as a percentage of sales.

Multiple-Period Trend Report

The report in Exhibit 14-10 provides management with information concerning the within-period progress measured relative to specific goals. Also useful is a picture of how the quality improvement program has been doing since its inception. Is the multiple-period trend—the overall change in quality costs—moving in the right direction? Are significant quality gains being made each period? Answers to these questions can be given by providing a chart or graph that tracks the change in quality from the beginning of the program to the present. Such a graph is called a **multiple-period quality trend report**. By plotting quality costs as a percentage of sales against time, the overall trend in the quality program can be assessed. The first year plotted is the year prior to the implementation of the quality improvement program. Assume that AMD, Inc., has experienced the following:

	Quality Costs	*Actual Sales*	*Costs as a Percentage of Sales*
2003	$1,000,000	$5,000,000	20.0%
2004	990,000	5,500,000	18.0
2005	900,000	6,000,000	15.0
2006	868,000	6,200,000	14.0
2007	800,000	8,000,000	10.0

Letting 2003 be Year 1, 2004 be Year 2, and so on, Exhibit 14-11, on page 641, shows a bar graph that reveals the trend in quality cost as a percentage of sales. Periods of time are plotted on the horizontal axis and percentages on the vertical.

EXHIBIT 14-10 Interim Quality Performance Report

AMD, Inc.
Interim Standard Performance Report: Quality Costs
For the Year Ended June 30, 2007

	Actual Costs	Budgeted Costs	Variance
Prevention costs:			
Quality training	$ 80,000	$ 80,000	$ 0
Reliability engineering	160,000	160,000	0
Total prevention costs	$240,000	$240,000	$ 0
Appraisal costs:			
Materials inspection	$ 75,000	$ 83,000	$ 8,000 F
Product acceptance	40,000	40,000	0
Process acceptance	65,000	55,000	10,000 U
Total appraisal costs	$180,000	$178,000	$ 2,000 U
Internal failure costs:			
Scrap	$ 50,000	$ 44,000	$ 6,000 U
Rework	100,000	96,500	3,500 U
Total internal failure costs	$150,000	$140,500	$ 9,500 U
External failure costs:			
Customer complaints	$ 65,000	$ 65,000	$ 0
Warranty	78,000	68,500	9,500 U
Repair	87,000	79,000	8,000 U
Total external failure costs	$230,000	$212,500	$17,500 U
Total quality costs	$800,000	$771,000	$29,000 U
Percentage of actual sales of $8,000,000	10.0%	9.64%	0.36% U

The graph reveals that there has been a steady downward trend in quality costs expressed as a percentage of sales. The graph also reveals that there is still ample room for improvement toward the long-run target percentage.

Additional insight can be provided by analyzing the trend for each individual quality category. Assume that each category is expressed as a percentage of sales for the same period of time.

	Prevention	*Appraisal*	*Internal Failure*	*External Failure*
2003	2.0%	2.0%	6.0%	10.0%
2004	3.0	2.4	4.0	8.6
2005	3.0	3.0	3.0	6.0
2006	4.0	3.0	2.5	4.5
2007	4.1	2.4	2.0	1.5

The graph showing the trend for each category (as a percentage of sales) is displayed in Exhibit 14-12. From Exhibit 14-12, we can see that AMD has had dramatic success in reducing external and internal failures. More money is being spent on prevention (the amount has doubled as a percentage). Appraisal costs have increased and then decreased.

EXHIBIT 14-11 Multiple-Period Trend Graph: Total Quality Costs

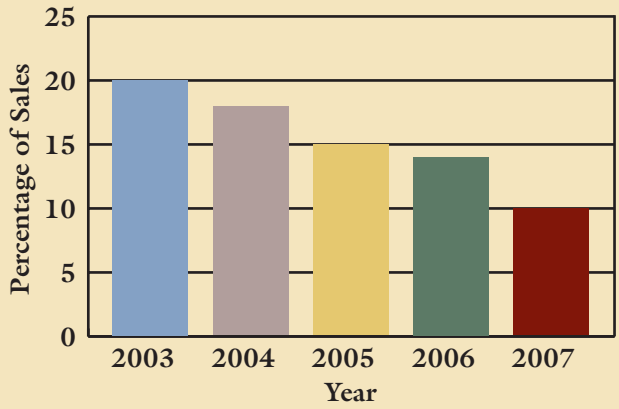
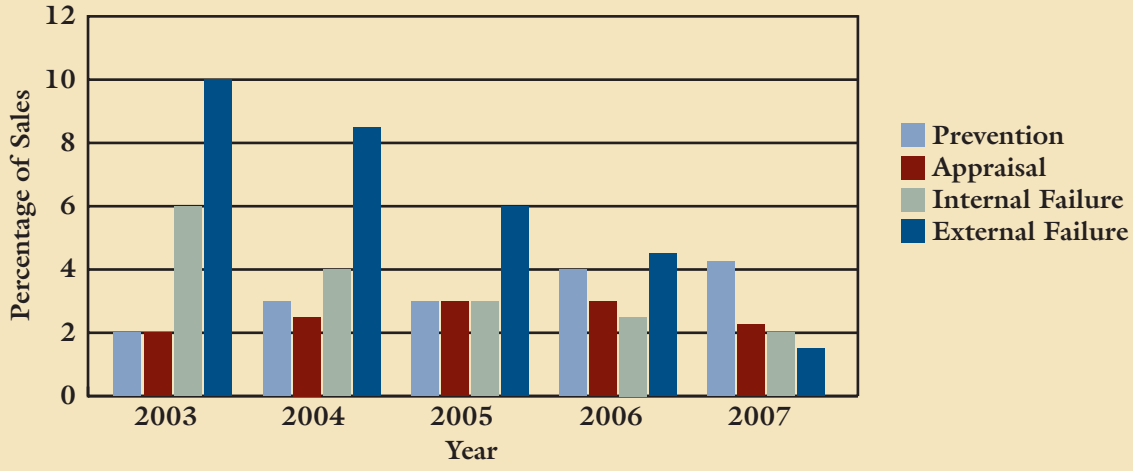
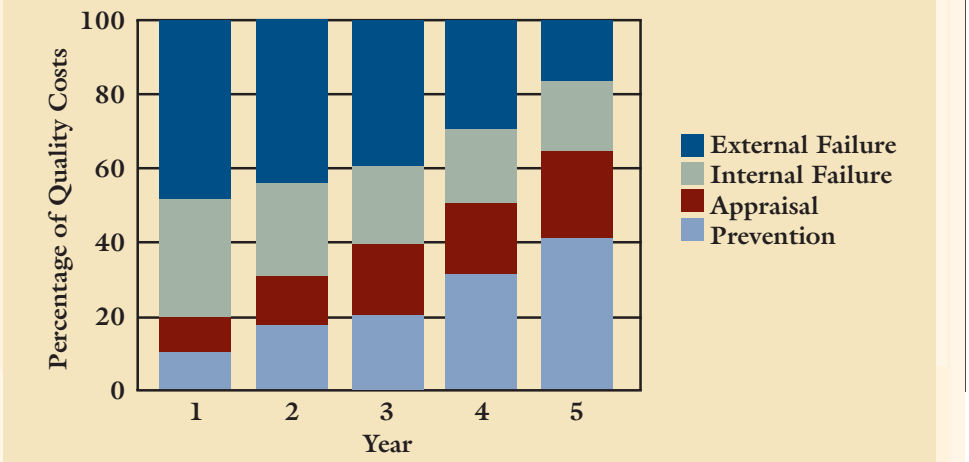


EXHIBIT 14-12 Multiple-Period Trend Graph: Individual Quality Cost Categories



Additional insight can be obtained by examining the trend in the relative distribution of quality costs. Exhibit 14-13 provides a graph showing this feature. Note also that the relative distribution of costs has changed. In 2003, failure costs were 80 percent of the total quality costs (16%/20%). In 2007, they are 35 percent of the total (3.5%/10%). Note also that control costs have increased from 20% (4%/20%) to 65% (6.5%/10%). Combining the two, we see evidence that the mix of quality costs is the key to cost reduction. Increasing prevention costs causes non-value-added quality costs to decrease.

EXHIBIT 14-13 Multiple-Period Trend Graph: Relative Quality Costs



Long-Range Report

At the end of each period, a report that compares the period's actual quality costs with the costs that the firm eventually hopes to achieve should be prepared. This report forces management to keep the ultimate quality goal in mind, reveals the room left for improvement, and facilitates planning for the coming period. Under a zero-defects philosophy, the costs of failure should be virtually nonexistent. (They are non-value-added costs.) Reducing the costs of failure increases a firm's competitive ability. **Tennant Company**, for example, is now able to offer warranties that last two to four times longer than those of its competitors because of improved quality resulting in lower external failure rates. Thus, not only have quality costs been reduced by almost 50 percent, but because of improved quality, sales performance has increased.

Remember that achieving higher quality will not totally eliminate prevention and appraisal costs. (In fact, increased emphasis on zero defects may actually increase the cost of prevention, depending on the type and level of prevention activities initially present.) Generally, we would expect appraisal costs to decrease. Product acceptance, for example, may be phased out entirely as product quality increases; however, increased emphasis on process acceptance is likely. The firm must have assurance that the process is operating in a zero-defects mode. Exhibit 14-14 illustrates a **long-range quality performance report**. It compares the current actual costs with the costs that would be allowed if the zero-defects standard were being met (assuming a sales level equal to that of the current period). The target costs are, if chosen properly, value-added costs. The variances are non-value-added costs. Thus, the long-range performance report is simply a variation of the value- and non-value-added cost report.

The report emphasizes the fact that the company is still spending too much money on quality—too much money for not doing things right the first time. As quality improves, savings can be realized by having fewer workers correcting the mistakes made initially. Rework costs, for example, will disappear when there is no more rework, warranty costs will stop when there are no failures in the field, and so on.

By spending less money on defects, a company can use the money to expand and to employ additional people to support this expansion. Increased quality may naturally

EXHIBIT 14-14 Long-Range Quality Performance Report

AMD, Inc.
Long-Range Quality Performance Report
For the Year Ended June 30, 2007

	Actual Costs	Target Costs*	Variance
Prevention costs:			
Fixed:			
Quality training	$ 80,000	$ 50,000	$ 30,000 U
Reliability engineering	160,000	100,000	60,000 U
Total prevention costs	$240,000	$150,000	$ 90,000 U
Appraisal costs:			
Variable:			
Materials inspection	$ 75,000	$ 5,000	$ 70,000 U
Product acceptance	40,000	0	40,000 U
Process acceptance	65,000	20,000	45,000 U
Total appraisal costs	$180,000	$ 25,000	$155,000 U
Internal failure costs:			
Variable:			
Scrap	$ 50,000	$ 0	$ 50,000 U
Rework	100,000	0	100,000 U
Total internal failure costs	$150,000	$ 0	$150,000 U
External failure costs:			
Fixed:			
Customer complaints	$ 65,000	$ 0	$ 65,000 U
Variable:			
Warranty	78,000	0	78,000 U
Repair	87,000	0	87,000 U
Total external failure costs	$230,000	$ 0	$230,000 U
Total quality costs	$800,000	$175,000	$625,000 U
Percentage of actual sales	10%	2.2%	7.81% U

*Based on actual current sales of $8,000,000. These costs are value-added costs.

cause expansion by increasing the competitive position of a firm. By having fewer problems with existing products, a firm can focus more attention on growth. Thus, although improved quality may mean fewer jobs in some areas, it also means that additional jobs will be created through expanded business activity. In fact, more jobs will probably be added than are lost.

Incentives for Quality Improvement

Most organizations provide both monetary and nonmonetary recognition for significant contributions to quality improvement. Of the two types of incentives, many quality experts believe that the nonmonetary are more useful.

Nonmonetary Incentives As with budgets, participation helps employees internalize quality improvement goals as their own. One approach used by many companies

in their efforts to involve employees is the use of error cause identification forms. **Error cause identification** is a program in which employees describe problems that interfere with their ability to do the job right the first time. The error-cause-removal approach is one of the 14 steps in Philip Crosby's quality improvement program.[12] To ensure the success of the program, each employee submitting an entry should receive a note of appreciation from management. Additional recognition should be given to those who submit particularly beneficial information.

Other nonfinancial awards can also be given to recognize employees for their efforts. One restaurant, for example, gives monthly awards to food servers who have made no errors when punching diners' orders into the kitchen printout computer. Servers who make the most errors see their names posted on an error list (no punishment, just names). The error rate plummeted, saving the restaurant thousands of dollars a month in wasted food.[13] The important thing is not the award itself but the public recognition of outstanding achievement. By publicly recognizing significant quality contributions, management underscores its commitment to quality improvement. Also, the individuals and groups so recognized feel the benefits of that recognition, which include pride, job satisfaction, and a further commitment to quality.

Monetary Incentives **Gainsharing** provides cash incentives for a company's entire workforce that are keyed to quality or productivity gains. For example, suppose a company has a target of reducing the number of defective units by 10 percent during the next quarter for a particular plant. If the goal is achieved, the company estimates that $1,000,000 will be saved (through avoiding such things as reworks and warranty repairs). Gainsharing provides an incentive by offering a bonus to the employees equal to a percentage of the cost savings. At **Tennant Company**, for example, employees who submitted adopted proposals for quality changes receive 20 percent of the first year's savings realized from these submissions.

Ford Motor Company has proposed overhauling its compensation program for its top 5,000 executives, implementing a new compensation program that replaces profit-driven bonus structures with performance-based measures such as overall product quality. The size of the bonus pool can grow or shrink depending on how well productivity and quality targets are met. **Sun Microsystems** provides another example.[14] Bonuses are tied to customer loyalty and customer quality indices. Sun Microsystems has found that such quality measures as late deliveries and software defects have declined steadily, while the customer loyalty measures have increased. Pay-for-performance plans allowing employees to share in the benefits seem to create additional interest and commitment. Gainsharing plans are entirely complementary, and perhaps even essential, to an integrated measurement system such as the Balanced Scorecard.

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12. Phillip Crosby, *Quality Is Free* (New York: New American Library, 1980).
13. Leonard L. Berry and A. Parasuramna, *Marketing Services: Competing Through Quality* (New York: The Free Press, Macmillan, 1991).
14. Both examples are taken from the following source: Melissa Larson, "Betting Your Bonus on Quality." *Quality*. Vol. 37, Issue 5 (May 1998): 30.

SUMMARY

To understand quality costs, it is first necessary to understand what is meant by quality. Quality means goodness, but its operational meaning is more relevant. Operationally, a quality product is one that meets customer expectations. Customer expectations are closely connected with conformance to specifications. Quality of conformance, thus, is concerned with meeting the specifications claimed by the product.

Two philosophical approaches to quality were described. The zero-defects approach allows variation from a target within certain specification limits. The robust quality approach stresses reduction of variation, noting that any variation entails hidden quality costs. The Taguchi quality loss function illustrates the hidden quality costs associated with the robustness philosophy.

Quality costs are those costs that are incurred because products may fail or actually fail to meet design specifications (and are, therefore, associated with quality of conformance). There are four categories of quality costs: prevention, appraisal, internal failure, and external failure. Prevention costs are those incurred to prevent poor quality. Appraisal costs are those incurred to detect poor quality. Internal failure costs are those incurred because products fail to conform to requirements, and this lack of conformity is discovered before an external sale. External failure costs are those incurred because products fail to conform to requirements after an external sale is made.

A quality cost report is prepared by listing costs for each item within each of the four major quality cost categories (see Exhibit 14-2 on page 625). Two views concern the optimal distribution of quality costs: the AQL view and the zero-defects view. The AQL view holds that there is a trade-off between costs of failure and prevention and appraisal costs. This trade-off produces an optimal level of performance called the acceptable quality level (the level at which the number of defects allowed minimizes total quality costs). The zero-defects view, on the other hand, espouses total quality control. Total quality control maintains that the conflict between failure and appraisal and prevention costs is more conjecture than real. The actual optimal level of defects is the zero-defects level; companies should be striving to achieve this level of quality. Although quality costs do not vanish at this level, they are much lower than the optimal envisioned by the now outmoded AQL view.

Quality cost information is needed to help managers control quality performance and to serve as input for decision making. It can be used to evaluate the overall performance of quality improvement programs. It can also be used to help improve a variety of managerial decisions, for example, strategic pricing and cost-volume-profit analysis. Perhaps the most important observation is that quality cost information is fundamental in a company's pursuit of continual improvement. Quality is one of the major competitive dimensions for world-class competitors. Many companies now have their dedication to quality certified by an external reporting firm under, for example, ISO 9000 specifications.

Three quality performance reports are mentioned in the chapter: (1) the interim report, (2) the multiple-period trend report, and (3) the long-range report. The interim report is used to evaluate the firm's ability to meet its budgeted quality costs. Managers use the report to compare the actual quality costs with those that were targeted for the period. The multiple-period trend report is a trend graph for several years. The graph allows managers to assess the direction and magnitude of change since the inception of a total quality program. Finally, the long-range report compares actual costs with the ideal level.

REVIEW PROBLEM AND SOLUTION

Quality Cost Classification, Quality Improvement, and Profitability

At the beginning of the year, Kare Company initiated a quality improvement program. Considerable effort was expended to reduce the number of defective units produced. By the end of the year, reports from the production manager revealed that scrap and rework had both decreased. The president of the company was pleased to hear of the

success but wanted some assessment of the financial impact of the improvements. To make this assessment, the following financial data were collected for the current and preceding years:

	Preceding Year (2006)	*Current Year (2007)*
Sales	$10,000,000	$10,000,000
Scrap	400,000	300,000
Rework	600,000	400,000
Product inspection	100,000	125,000
Product warranty	800,000	600,000
Quality training	40,000	80,000
Materials inspection	60,000	40,000

Required:

1. Classify the costs as prevention, appraisal, internal failure, or external failure.
2. Compute quality cost as a percentage of sales for each of the two years. By how much has profit increased because of quality improvements? Assuming that quality costs can be reduced to 2.5 percent of sales, how much additional profit is available through quality improvements (assume that sales revenues will remain the same)?

SOLUTION

1. Prevention costs: Quality training
   Appraisal costs: Product inspection and materials inspection
   Internal failure costs: Scrap and rework
   External failure costs: Warranty

2. *Preceding year*—Total quality costs: $2,000,000; percentage of sales: 20 percent ($2,000,000/$10,000,000). *Current year*—Total quality costs: $1,545,000; percentage of sales: 15.45 percent ($1,545,000/$10,000,000). Profit has increased by $455,000. If quality costs drop to 2.5 percent of sales, another $1,295,000 of profit improvement is possible ($1,545,000 − $250,000).

KEY TERMS

Acceptable quality level (AQL) 629
Appraisal costs 624
Control activities 624
Control costs 624
Costs of quality 624
Defective product 623
Error cause identification 644
External failure costs 625
Failure activities 624
Failure costs 624
Gainsharing 644
Hidden quality costs 625
Interim quality performance report 639
Interim quality standards 638
Internal failure costs 625
Long-range quality performance report 642
Multiple-period quality trend report 639
Observable quality costs 625
Prevention costs 624
Quality of conformance 623
Quality product or service 623
Robustness 623
Taguchi loss function 626
Zero defects 623

QUESTIONS FOR WRITING AND DISCUSSION

1. What is the difference between quality of design and quality of conformance?
2. Why are quality costs the costs of doing things wrong?
3. What is the difference between the zero-defects philosophy and the robust quality philosophy?
4. Describe the Taguchi quality loss function, and relate it to robust quality.
5. Identify and discuss the four kinds of quality costs.
6. Explain why external failure costs can be more devastating to a firm than internal failure costs.
7. Many quality experts maintain that quality is free. Do you agree or disagree? Why or why not?
8. What is the purpose of interim quality standards?
9. Describe the three types of quality performance reporting. How can managers use each report to help evaluate their quality improvement programs?
10. Discuss the different kinds of incentives that can be used to motivate employees to become involved in quality improvement programs. Explain gainsharing.
11. If a firm's annual sales are $200 million, what percentage of sales should be spent on quality costs? Suppose that the firm is spending 18 percent of sales on quality costs. What is the potential savings from quality improvement?
12. Explain why it is important for a manager to assess the relative distribution of quality costs among the four categories.
13. Discuss the benefits of quality cost reports that simply list the quality costs for each category.
14. Explain why the accounting department should be responsible for producing quality cost reports.
15. What is ISO 9000? Why do so many companies want this certification?

EXERCISES

14-1 Quality Definition and Quality Costs

LO1

Rachel Boyce, president of a company that manufactures electronic components, has a number of questions concerning quality and quality costs. She has heard a few things about quality and has asked you to respond to the following:

Required:

1. What does it mean to have a quality product or service? Explain how product quality and conformance are related.
2. Yesterday, my quality manager told me that we need to redefine what we mean by a defective product. He said that conforming to specifications ignores the cost of product variability and that further reduction of product variability is a veritable gold mine—just waiting to be mined. What did he mean?

14-2 Quality Definition and Quality Costs

LO1

Quality attributes such as performance and aesthetics are important to customers. Performance refers to how consistently and how well a product functions. Aesthetics is concerned with the appearance of tangible products as well as the appearance of the facilities, equipment, personnel, and communication materials associated with services.

Required:

1. Do you agree that aesthetics is an important quality dimension for services? Use dental services as the framework for providing your response.
2. For services, performance can be more carefully defined by expanding its definition to include responsiveness, assurance, and empathy. Describe what you think is meant by these three characteristics as applied to service quality.

14-3 Taguchi Loss Function

LO1 Gray Company estimates its hidden external failure costs using the Taguchi loss function. Gray produces plastic sheets that vary in thickness and grade. For one of its large-volume products, it was determined that $k = \$20{,}000$ and $T = 0.20$ inches in diameter. A sample of four units produced the following values:

Unit No.	*Actual Diameter (y)*
1	0.23
2	0.22
3	0.18
4	0.19

Required:

1. Calculate the average loss per unit.
2. Assuming that 30,000 units were produced, what is the total hidden cost?
3. Assume that the multiplier for Gray's hidden external failure costs is five. What are the measured external costs? Explain the difference between measured costs and hidden costs.

14-4 Quality Cost Classification

LO1 Classify the following quality costs as prevention costs, appraisal costs, internal failure costs, or external failure costs:

1. Inspection of reworked units
2. Inspecting and testing a newly developed product (not yet being sold)
3. Retesting a reworked product
4. Repairing a computer still under warranty
5. Discount allowed to customers because products failed to meet customer specifications
6. Goods returned because they failed to meet specifications
7. The cost of evaluating and certifying suppliers
8. Stopping work to correct process malfunction (discovered using statistical process control procedures)
9. Testing products in the field
10. Discarding products that cannot be reworked
11. Lost sales because of recalled products
12. Inspection of incoming materials
13. Redesigning a product to eliminate the need to use an outside component with a high defect rate
14. Purchase order changes
15. Replacing a defective product
16. Inspecting and testing prototypes
17. Repairing products in the field
18. Correcting a design error discovered during product development
19. Engineering resources used to help selected suppliers improve their product quality
20. Packaging inspection

21. Processing and responding to consumer complaints
22. Training production line workers in new quality procedures
23. Sampling a batch of goods to determine if the batch has an acceptable defect rate

14-5 Activity-Based Quality Costing

LO1, LO2 Maxwell Company produces two different carburetors and is concerned about their quality. The company has identified the following quality activities and costs associated with the two products:

	Carburetor A	*Carburetor B*
Units produced	170,000	340,000
Warranty work (units)	1,700	850
Scrapped units (number)	3,400	850
Inspection (hours)	3,400	1,700
Quality training (hours)	85	85
Activities:		
Performing warranty work	$204,000	
Scrapping units	153,000	
Inspecting	76,500	
Quality training	42,500	

Required:

1. Calculate the quality cost per unit for each product, and break this unit cost into quality cost categories. Which of the two seems to have the lowest quality?
2. How might a manager use the unit quality cost information?

14-6 Quality Cost Report

LO2 Benton Company reported sales of $8,100,000 in 2007. At the end of the year, the following quality costs were reported:

Design review	$405,000
Recalls	135,000
Reinspection	67,500
Materials inspection	54,000
Quality training	135,000
Process acceptance	67,500
Scrap	47,250
Lost sales	270,000
Product inspection	40,500
Returned goods	128,250

Required:

1. Prepare a quality cost report.
2. Prepare a graph (pie chart or bar graph) that shows the relative distribution of quality costs, and comment on the distribution.

14-7 Quality Improvement and Profitability

LO2, LO3 Reading Company reported the following sales and quality costs for the past four years. Assume that all quality costs are variable and that all changes in the quality cost ratios are due to a quality improvement program.

Year	*Sales Revenues*	*Quality Costs as a Percent of Revenues*
1	$10,000,000	21%
2	11,000,000	18
3	11,000,000	14
4	12,000,000	10

Required:

1. Compute the quality costs for all four years. By how much did net income increase from Year 1 to Year 2 because of quality improvements? From Year 2 to Year 3? From Year 3 to Year 4?
2. The management of Reading Company believes it is possible to reduce quality costs to 2.5 percent of sales. Assuming sales will continue at the Year 4 level, calculate the additional profit potential facing Reading. Is the expectation of improving quality and reducing costs to 2.5 percent of sales realistic? Explain.
3. Assume that Reading produces one type of product, which is sold on a bid basis. In Years 1 and 2, the average bid was $200. In Year 1, total variable costs were $125 per unit. In Year 3, competition forced the bid to drop to $190. Compute the total contribution margin in Year 3 assuming the same quality costs as in Year 1. Now, compute the total contribution margin in Year 3 using the actual quality costs for Year 3. What is the increase in profitability resulting from the quality improvements made from Year 1 to Year 3?

14-8 Quality Costs: Profit Improvement and Distribution across Categories, Gainsharing

LO2, LO3, LO4

Pawnee Company had sales of $30,000,000 in 2003. In 2007, sales had increased to $37,500,000. A quality improvement program was implemented at the beginning of 2003. Overall conformance quality was targeted for improvement. The quality costs for 2003 and 2007 follow. Assume any changes in quality costs are attributable to improvements in quality.

	2003	*2007*
Internal failure costs	$2,250,000	$112,500
External failure costs	3,000,000	75,000
Appraisal costs	1,350,000	281,250
Prevention costs	900,000	468,750
Total quality costs	$7,500,000	$937,500

Required:

1. Compute the quality cost-to-sales ratio for each year. Is this type of improvement possible?
2. Calculate the relative distribution of costs by category for 2003. What do you think of the way costs are distributed? (A pie chart or bar graph may be of some help.) How do you think they will be distributed as the company approaches a zero-defects state?
3. Calculate the relative distribution of costs by category for 2007. What do you think of the level and distribution of quality costs? (A pie chart or bar graph may be of some help.) Do you think further reductions are possible?
4. The quality manager for Pawnee indicated that the external failure costs reported are only the measured costs. He argued that the 2007 external costs were much higher than those reported and that additional investment ought to be made in control costs. Discuss the validity of his viewpoint.

5. Suppose that the manager of Pawnee received a bonus equal to 10 percent of the quality cost savings each year. Do you think that gainsharing is a good or a bad idea? Discuss the risks of gainsharing.

14-9 Trade-Offs among Quality Cost Categories, Total Quality Control, Gainsharing

LO2, LO4

Javier Company has sales of $8 million and quality costs of $1,600,000. The company is embarking on a major quality improvement program. During the next three years, Javier intends to attack failure costs by increasing its appraisal and prevention costs. The "right" prevention activities will be selected, and appraisal costs will be reduced according to the results achieved. For the coming year, management is considering six specific activities: quality training, process control, product inspection, supplier evaluation, prototype testing, and redesign of two major products. To encourage managers to focus on reducing non-value-added quality costs and select the right activities, a bonus pool is established relating to reduction of quality costs. The bonus pool is equal to 10 percent of the total reduction in quality costs.

Current quality costs and the costs of these six activities are given in the following table. Each activity is added sequentially so that its effect on the cost categories can be assessed. For example, after quality training is added, the control costs increase to $320,000, and the failure costs drop to $1,040,000. Even though the activities are presented sequentially, they are totally independent of each other. Thus, only beneficial activities need be selected.

	Control Costs	*Failure Costs*
Current quality costs	$ 160,000	$1,440,000
Quality training	320,000	1,040,000
Process control	520,000	720,000
Product inspection	600,000	656,000
Supplier evaluation	720,000	200,000
Prototype testing	960,000	120,000
Engineering redesign	1,000,000	40,000

Required:

1. Identify the control activities that should be implemented, and calculate the total quality costs associated with this selection. Assume that an activity is selected only if it increases the bonus pool.
2. Given the activities selected in Requirement 1, calculate the following:
   a. The reduction in total quality costs
   b. The percentage distribution for control and failure costs
   c. The amount for this year's bonus pool
3. Suppose that a quality engineer complained about the gainsharing incentive system. Basically, he argued that the bonus should be based only on reductions of failure and appraisal costs. In this way, investment in prevention activities would be encouraged, and eventually, failure and appraisal costs would be eliminated. After eliminating the non-value-added costs, focus could then be placed on the level of prevention costs. If this approach were adopted, what activities would be selected? Do you agree or disagree with this approach? Explain.

14-10 Trend, Long-Range Performance Report

LO4

In 2006, Tru-Delite Frozen Desserts, Inc., instituted a quality improvement program. At the end of 2007, the management of the corporation requested a report to show

the amount saved by the measures taken during the year. The actual sales and quality costs for 2006 and 2007 are as follows:

	2006	*2007*
Sales	$600,000	$600,000
Scrap	15,000	15,000
Rework	20,000	10,000
Training program	5,000	6,000
Consumer complaints	10,000	5,000
Lost sales, incorrect labeling	8,000	—
Test labor	12,000	8,000
Inspection labor	25,000	24,000
Supplier evaluation	15,000	13,000

Tru-Delite's management believes that quality costs can be reduced to 2.5 percent of sales within the next five years. At the end of 2012, Tru-Delite's sales are projected to grow to $750,000. The projected relative distribution of quality costs at the end of 2012 is as follows:

Scrap	15%
Training program	20
Supplier evaluation	25
Test labor	25
Inspection labor	15
Total quality costs	100%

Required:

1. Profits increased by what amount due to quality improvements made in 2007?
2. Prepare a long-range performance report that compares the quality costs incurred at the end of 2007 with the quality cost structure expected at the end of 2012.
3. Are the targeted costs in the year 2012 all value-added costs? How would you interpret the variances if the targeted costs are value-added costs?
4. What would be the profit increase in 2012 if the 2.5 percent performance standard is met in that year?

14-11 Multiple-Year Trend Reports

LO4

The controller of Willson Company has computed quality costs as a percentage of sales for the past five years (2004 was the first year the company implemented a quality-improvement program). This information is as follows:

	Prevention	*Appraisal*	*Internal Failure*	*External Failure*	*Total*
2003	2%	3%	8.0%	12%	25.0%
2004	3	4	7.0	10	24.0
2005	4	5	5.5	6	20.5
2006	5	4	3.0	5	17.0
2007	6	3	1.0	2	12.0

Required:

1. Prepare a trend graph for total quality costs. Comment on what the graph has to say about the success of the quality improvement program.
2. Prepare a graph that shows the trend for each quality cost category. What does the graph have to say about the success of the quality improvement program? Does this graph supply more insight than the total cost trend graph does?

3. Prepare a graph that compares the trend in relative quality costs. What does this graph tell you?

PROBLEMS

14-12 Quality Cost Report, Taguchi Loss Function

LO1, LO2

Marlene Briggs, president of Shorts Company, was concerned with the trend in sales and profitability. The company had been losing customers at an alarming rate. Furthermore, the company was barely breaking even. Investigation revealed that poor quality was at the root of the problem. At the end of 2007, Marlene decided to begin a quality improvement program. As a first step, she identified the following costs in the accounting records as quality related:

	2007
Sales (400,000 units @ $100)	$40,000,000
Reinspection	1,200,000
Downtime (due to defects)	1,600,000
Vendor certification	480,000
Consumer complaints	800,000
Warranty	1,600,000
Test labor	1,200,000
Inspection labor	1,000,000
Design reviews	120,000

Required:

1. Prepare a quality cost report by quality cost category.
2. Calculate the relative distribution percentages for each quality cost category. Comment on the distribution.
3. Using the Taguchi loss function, an average loss per unit is computed to be $15 per unit. What are the hidden costs of external failure? How does this affect the relative distribution?
4. Shorts's quality manager decided not to bother with the hidden costs. What do you think was his reasoning? Any efforts to reduce measured external failure costs will also reduce the hidden costs. Do you agree or disagree? Explain.

14-13 Taguchi Loss Function

LO2

Timpanogas Company manufactures a component for small portable DVD players (designed for use on automobile trips). Weight and durability of the component are the two most important quality characteristics for the DVD manufacturers. With respect to the weight dimension, the component has a target value of 240 grams. Specification limits are 240 grams, plus or minus 10 grams. Products produced at the lower specification limit of 230 grams lose $40. A sample of five units produced the following weight measures:

Unit No.	*Measured Weight*
1	250
2	260
3	270
4	220
5	225

During the first quarter, 100,000 units were produced.

Required:

1. Calculate the loss for each unit. Calculate the average loss for the sample of five.
2. Using the average loss, calculate the hidden quality costs for the first quarter.
3. Durability is another important quality characteristic. The target value is 18,000 hours of operation before failure. The lower specification limit set by engineering and marketing is 17,000 hours. They agreed that there should be no upper specification limit. They also noted that there is a $750 loss at the lower specification limit. Explain why there would be no upper specification limit. Use the lower limit and the *left half* of the Taguchi quadratic loss function to estimate the loss for components with the following lives: 4,500 hours, 9,000 hours, and 13,500 hours. What does this reveal about the importance of durability?

14-14 Quality Costs, Pricing Decisions, Market Share

LO3

Gaston Company manufactures furniture. One of its product lines is an economy-line kitchen table. During the last year, Gaston produced and sold 100,000 units for $100 per unit. Sales of the table are on a bid basis, but Gaston has always been able to win sufficient bids using the $100 price. This year, however, Gaston was losing more than its share of bids. Concerned, Larry Franklin, owner and president of the company, called a meeting of his executive committee (Megan Johnson, marketing manager; Fred Davis, quality manager; Kevin Jones, production manager; and Helen Jackson, controller).

LARRY: I don't understand why we're losing bids. Megan, do you have an explanation?

MEGAN: Yes, as a matter of fact. Two competitors have lowered their price to $92 per unit. That's too big a difference for most of our buyers to ignore. If we want to keep selling our 100,000 units per year, we will need to lower our price to $92. Otherwise, our sales will drop to about 20,000 to 25,000 per year.

HELEN: The unit contribution margin on the table is $10. Lowering the price to $92 will cost us $8 per unit. Based on a sales volume of 100,000, we'd make $200,000 in contribution margin. If we keep the price at $100, our contribution margin would be $200,000 to $250,000. If we have to lose, let's just take the lower market share. It's better than lowering our prices.

MEGAN: Perhaps. But the same thing could happen to some of our other product lines. My sources tell me that these two companies are on the tail-end of a major quality improvement program—one that allows them significant savings. We need to rethink our whole competitive strategy—at least if we want to stay in business. Ideally, we should match the price reduction and work to reduce the costs to recapture the lost contribution margin.

FRED: I think I have something to offer. We are about to embark on a new quality improvement program of our own. I have brought the following estimates of the current quality costs for this economy line. As you can see, these costs run about 16 percent of current sales. That's excessive, and we believe that they can be reduced to about 4 percent of sales over time.

Scrap	$ 700,000
Rework	300,000
Rejects (sold as seconds to discount houses)	250,000
Returns (due to poor workmanship)	350,000
	$1,600,000

LARRY: This sounds good. Fred, how long will it take for you to achieve this reduction?

FRED: All these costs vary with sales level, so I'll express their reduction rate in those terms. Our best guess is that we can reduce these costs by about 1 percent of sales per quarter. So it should take about 12 quarters, or three years, to achieve the full benefit. Keep in mind that this is with an improvement in quality.

MEGAN: This offers us some hope. If we meet the price immediately, we can maintain our market share. Furthermore, if we can ever reach the point of reducing the price below the $92 level, then we can increase our market share. I estimate that we can increase sales by about 10,000 units for every $1 of price reduction beyond the $92 level. Kevin, how much extra capacity for this line do we have?

KEVIN: We can handle an extra 30,000 or 40,000 tables per year.

Required:

1. Assume that Gaston immediately reduces the bid price to $92. How long will it be before the unit contribution margin is restored to $10, assuming that quality costs are reduced as expected and that sales are maintained at 100,000 units per year (25,000 per quarter)?
2. Assume that Gaston holds the price at $92 until the 4 percent target is achieved. At this new level of quality costs, should the price be reduced? If so, by how much should the price be reduced, and what is the increase in contribution margin? Assume that price can be reduced only in $1 increments.
3. Assume that Gaston immediately reduces the price to $92 and begins the quality improvement program. Now, suppose that Gaston does not wait until the end of the 3-year period before reducing prices. Instead, prices will be reduced when profitable to do so. Assume that prices can be reduced only by $1 increments. Identify when the first future price change should occur (if any).
4. Discuss the differences in viewpoints concerning the decision to decrease prices and the short-run contribution margin analysis done by Helen, the controller. Did quality cost information play an important role in the strategic decision making illustrated by the problem?

14-15 Classification of Quality Costs

LO1 Classify the following quality costs as prevention, appraisal, internal failure, or external failure. Also, label each cost as variable or fixed with respect to sales volume.

1. Quality engineering
2. Scrap
3. Product recalls
4. Returns and allowances because of quality problems
5. Sales data re-entered because of keying errors
6. Supervision of in-process inspection
7. Quality circles
8. Component inspection and testing
9. Quality training
10. Reinspection of reworked product
11. Product liability
12. Internal audit assessing the effectiveness of quality system
13. Disposal of defective product
14. Downtime attributable to quality problems
15. Quality reporting
16. Proofreading
17. Correction of typing errors
18. In-process inspection
19. Process controls
20. Pilot studies

14-16 QUALITY COST SUMMARY

LO2

Wayne Johnson, president of Banshee Company, recently returned from a conference on quality and productivity. At the conference, he was told that many American firms have quality costs totaling 20 to 30 percent of sales. He, however, was skeptical about this statistic. But even if the quality gurus were right, he was sure that his company's quality costs were much lower—probably less than 5 percent. On the other hand, if he was wrong, he would be passing up an opportunity to improve profits significantly and simultaneously strengthen his competitive position. The possibility was at least worth exploring. He knew that his company produced most of the information needed for quality cost reporting—but there never was a need to bother with any formal quality data gathering and analysis.

This conference, however, had convinced him that a firm's profitability can increase significantly by improving quality—provided the potential for improvement exists. Thus, before committing the company to a quality improvement program, Wayne requested a preliminary estimate of the total quality costs currently being incurred. He also indicated that the costs should be classified into four categories: prevention, appraisal, internal failure, or external failure. He has asked you to prepare a summary of quality costs and to compare the total costs to sales and profits. To assist you in this task, the following information has been prepared from the past year, 2007:

a. Sales revenue, $15,000,000; net income, $1,500,000.
b. During the year, customers returned 90,000 units needing repair. Repair cost averages $1 per unit.
c. Four inspectors are employed, each earning an annual salary of $60,000. These four inspectors are involved only with final inspection (product acceptance).
d. Total scrap is 150,000 units. Of this total, sixty percent is quality related. The cost of scrap is about $5 per unit.
e. Each year, approximately 750,000 units are rejected in final inspection. Of these units, eighty percent can be recovered through rework. The cost of rework is $0.75 per unit.
f. A customer cancelled an order that would have increased profits by $150,000. The customer's reason for cancellation was poor product performance.
g. The company employs three full-time employees in its complaint department. Each earns $40,500 a year.
h. The company gave sales allowances totaling $45,000 due to substandard products being sent to the customer.
i. The company requires all new employees to take its 3-hour quality training program. The estimated annual cost of the program is $30,000.

Required:

1. Prepare a simple quality cost report classifying costs by category.
2. Compute the quality cost-sales ratio. Also, compare the total quality costs with total profits. Should Wayne be concerned with the level of quality costs?
3. Prepare a pie chart for the quality costs. Discuss the distribution of quality costs among the four categories. Are they properly distributed? Explain.
4. Discuss how the company can improve its overall quality and at the same time reduce total quality costs.
5. By how much will profits increase if quality costs are reduced to 2.5 percent of sales?

14-17 QUALITY COST REPORT, INTERIM PERFORMANCE REPORT

LO1, LO2, LO4

Recently, Ulrich Company received a report from an external consulting group on its quality costs. The consultants reported that the company's quality costs total about 21

percent of its sales revenues. Somewhat shocked by the magnitude of the costs, Rob Rustin, president of Ulrich Company, decided to launch a major quality-improvement program. For the coming year, management decided to reduce quality costs to 17 percent of sales revenues. Although the amount of reduction was ambitious, most company officials believed that the goal could be realized. To improve the monitoring of the quality-improvement program, Rob directed Pamela Golding, the controller, to prepare quarterly performance reports comparing budgeted and actual quality costs. Budgeted costs and sales for the first two months of the year are as follows:

	January	*February*
Sales	$500,000	$600,000
Quality costs:		
Warranty	$15,000	$ 18,000
Scrap	10,000	12,000
Incoming materials inspection	2,500	2,500
Product acceptance	13,000	15,000
Quality planning	2,000	2,000
Field inspection	12,000	14,000
Retesting	6,000	7,200
Allowances	7,500	9,000
New product review	500	500
Rework	9,000	10,800
Complaint adjustment	2,500	2,500
Downtime (defective parts)	5,000	6,000
Quality training	1,000	1,000
Total budgeted costs	$86,000	$100,500
Quality costs-sales ratio	17.2%	16.75%

The following actual sales and actual quality costs were reported for January:

Sales	$550,000
Quality costs:	
Warranty	17,500
Scrap	12,500
Incoming materials inspection	2,500
Product acceptance	14,000
Quality planning	2,500
Field inspection	14,000
Retesting	7,000
Allowances	8,500
New product review	700
Rework	11,000
Complaint adjustment	2,500
Downtime (defective parts)	5,500
Quality training	1,000

Required:

1. Reorganize the quarterly budgets so that quality costs are grouped in one of four categories: appraisal, prevention, internal failure, or external failure. (Essentially, prepare a budgeted cost of quality report.) Also, identify each cost as variable or fixed. (Assume that no costs are mixed.)
2. Prepare a performance report for January that compares actual costs with budgeted costs. Comment on the company's progress in improving quality and reducing its quality costs.

14-18 Quality Cost Performance Reporting: One-Year Trend, Long-Range Analysis

LO4 In 2007, Major Company initiated a full-scale, quality improvement program. At the end of the year, Jack Aldredge, the president, noted with some satisfaction that the defects per unit of product had dropped significantly compared to the prior year. He was also pleased that relationships with suppliers had improved and defective materials had declined. The new quality training program was also well accepted by employees. Of most interest to the president, however, was the impact of the quality improvements on profitability. To help assess the dollar impact of the quality improvements, the actual sales and the actual quality costs for 2006 and 2007 are as follows by quality category:

	2006	*2007*
Sales	$8,000,000	$10,000,000
Appraisal costs:		
Packaging inspection	320,000	300,000
Product acceptance	40,000	28,000
Prevention costs:		
Quality circles	4,000	40,000
Design reviews	2,000	20,000
Quality improvement projects	2,000	100,000
Internal failure costs:		
Scrap	280,000	240,000
Rework	360,000	320,000
Yield losses	160,000	100,000
Retesting	200,000	160,000
External failure costs:		
Returned materials	160,000	160,000
Allowances	120,000	140,000
Warranty	400,000	440,000

All prevention costs are fixed (by discretion). Assume all other quality costs are unit-level variable.

Required:

1. Compute the relative distribution of quality costs for each year. Do you believe that the company is moving in the right direction in terms of the balance among the quality cost categories? Explain.
2. Prepare a 1-year trend performance report for 2007 (compare the actual costs of 2007 with those of 2006, adjusted for differences in sales volume). How much have profits increased because of the quality improvements made by Major Company?
3. Estimate the additional improvement in profits if Major Company ultimately reduces its quality costs to 2.5 percent of sales revenues (assume sales of $25 million).

14-19 Distribution of Quality Costs

LO2 Paper Products Division produces paper diapers, napkins, and paper towels. The divisional manager has decided that quality costs can be minimized by distributing quality costs evenly among the four quality categories and reducing them to no more than 5 percent of sales. He has just received the following quality cost report:

Paper Products Division
Quality Cost Report
For the Year Ended December 31, 2007

	Diapers	*Napkins*	*Paper Towels*	*Total*
Prevention costs:				
Quality training	$ 3,000	$ 2,500	$ 2,000	$ 7,500
Quality engineering	3,500	1,000	2,500	7,000
Quality audits	—	500	1,000	1,500
Quality reporting	2,500	2,000	1,000	5,500
Total prevention costs	$ 9,000	$ 6,000	$ 6,500	$ 21,500
Appraisal costs:				
Inspection, materials	$ 2,000	$ 3,000	$ 3,000	$ 8,000
Process acceptance	4,000	2,800	1,200	8,000
Product acceptance	2,000	1,200	2,300	5,500
Total appraisal costs	$ 8,000	$ 7,000	$ 6,500	$ 21,500
Internal failure costs:				
Scrap	$10,000	$ 3,000	$ 2,500	$ 15,500
Disposal costs	7,000	2,000	1,500	10,500
Downtime	1,000	1,500	2,500	5,000
Total internal failure costs	$18,000	$ 6,500	$ 6,500	$ 31,000
External failure costs:				
Allowances	$10,000	$ 3,000	$ 2,750	$ 15,750
Customer complaints	4,000	1,500	3,750	9,250
Product liability	1,000	—	—	1,000
Total external failure costs	$15,000	$ 4,500	$ 6,500	$ 26,000
Total quality costs	$50,000	$24,000	$26,000	$100,000

Assume that all prevention costs are fixed and that the remaining quality costs are variable (unit-level).

Required:

1. Assume that the sales revenue for the year totaled $2 million, with sales for each product as follows: diapers, $1 million; napkins, $600,000; paper towels, $400,000. Evaluate the distribution of costs for the division as a whole and for each product line. What recommendations do you have for the divisional manager?
2. Now, assume that total sales are $1 million and have this breakdown: diapers, $500,000; napkins, $300,000; paper towels, $200,000. Evaluate the distribution of costs for the division as a whole and for each product line in this case. Do you think it is possible to reduce the quality costs to 5 percent of sales for each product line and for the division as a whole and, simultaneously, achieve an equal distribution of the quality costs? What recommendations do you have?
3. Assume total sales of $1 million with this breakdown: diapers, $500,000; napkins, $180,000; paper towels, $320,000. Evaluate the distribution of quality costs. What recommendations do you have for the divisional manager?
4. Discuss the value of having quality costs reported by segment.

14-20 Trend Analysis, Quality Costs

LO4 In 2003, Milton Thayne, president of Carbondale Electronics, received a report indicating that quality costs were 31 percent of sales. Faced with increasing pressures from

imported goods, Milton resolved to take measures to improve the overall quality of the company's products. After hiring a consultant in 2004, the company began an aggressive program of total quality control. At the end of 2007, Milton requested an analysis of the progress the company had made in reducing and controlling quality costs. The accounting department assembled the following data:

	Sales	*Prevention*	*Appraisal*	*Internal Failure*	*External Failure*
2003	$500,000	$ 5,000	$10,000	$80,000	$60,000
2004	600,000	25,000	15,000	60,000	50,000
2005	700,000	35,000	30,000	35,000	25,000
2006	600,000	40,000	15,000	25,000	20,000
2007	500,000	50,000	5,000	12,000	8,000

Required:

1. Compute the quality costs as a percentage of sales by category and in total for each year.
2. Prepare a multiple-year trend graph for quality costs, both by total costs and by category. Using the graph, assess the progress made in reducing and controlling quality costs. Does the graph provide evidence that quality has improved? Explain.
3. Using the 2003 quality cost relationships (assume all costs are variable), calculate the quality costs that would have prevailed in 2006. By how much did profits increase in 2006 because of the quality improvement program? Repeat for 2007.

14-21 Case on Quality Cost Performance Reports

LO4

Iona Company, a large printing company, is in its fourth year of a 5-year, quality improvement program. The program began in 2003 with an internal study that revealed the quality costs being incurred. In that year, a 5-year plan was developed to lower quality costs to 10 percent of sales by the end of 2007. Sales and quality costs for each year are as follows:

	Sales Revenues	*Quality Costs*
2003	$10,000,000	$2,000,000
2004	10,000,000	1,800,000
2005	11,000,000	1,815,000
2006	12,000,000	1,680,000
2007*	12,000,000	1,320,000

*Budgeted figures.

Quality costs by category are expressed as a percentage of sales as follows:

	Prevention	*Appraisal*	*Internal Failure*	*External Failure*
2003	1.0%	3.0%	7.0%	9.0%
2004	2.0	4.0	6.0	6.0
2005	2.5	4.0	5.0	5.0
2006	3.0	3.5	4.5	3.0
2007	3.5	3.5	2.0	2.0

The detail of the 2007 budget for quality costs is also provided.

Prevention costs:	
Quality planning	$ 150,000
Quality training	20,000
Quality improvement (special project)	80,000
Quality reporting	10,000
Appraisal costs:	
Proofreading	500,000
Other inspection	50,000
Failure costs:	
Correction of typos	150,000
Rework (because of customer complaints)	75,000
Plate revisions	55,000
Press downtime	100,000
Waste (because of poor work)	130,000
Total quality costs	$1,320,000

All prevention costs are fixed; all other quality costs are variable.

During 2007, the company had $12 million in sales. Actual quality costs for 2006 and 2007 are as follows:

	2007	*2006*
Quality planning	$150,000	$140,000
Quality training	20,000	20,000
Special project	100,000	120,000
Quality reporting	12,000	12,000
Proofreading	520,000	580,000
Other inspection	60,000	80,000
Correction of typos	165,000	200,000
Rework	76,000	131,000
Plate revisions	58,000	83,000
Press downtime	102,000	123,000
Waste	136,000	191,000

Required:

1. Prepare an interim quality cost performance report for 2007 that compares actual quality costs with budgeted quality costs. Comment on the firm's ability to achieve its quality goals for the year.
2. Prepare a 1-period quality performance report for 2007 that compares the actual quality costs of 2006 with the actual costs of 2007. How much did profits change because of improved quality?
3. Prepare a graph that shows the trend in total quality costs as a percentage of sales since the inception of the quality improvement program.
4. Prepare a graph that shows the trend for all four quality cost categories for 2003 through 2007. How does this graph help management know that the reduction in total quality costs is attributable to quality improvements?
5. Assume that the company is preparing a second 5-year plan to reduce quality costs to 2.5 percent of sales. Prepare a long-range quality cost performance report assuming sales of $15 million at the end of five years. Assume that the final planned relative distribution of quality costs is as follows: proofreading, 50 percent; other inspection, 13 percent; quality training, 30 percent; and quality reporting, 7 percent.

14-22 Collaborative Learning Exercise

LO1, LO3

Lindell Manufacturing embarked on an ambitious quality program that is centered around continual improvement. This improvement is operationalized by declining quality costs from year to year. Lindell rewards plant managers, production supervisors, and workers with bonuses ranging from $100 to $1,000 if their factory meets its annual quality cost goals.

Len Smith, manager of Lindell's Boise plant, felt obligated to do everything he could to provide this increase to his employees. Accordingly, he has decided to take the following actions during the last quarter of the year to meet the plant's budgeted quality cost targets:

a. Decrease inspections of the process and final product by 50 percent and transfer inspectors temporarily to quality training programs. Len believes this move will increase the inspectors' awareness of the importance of quality; also, decreasing inspection will produce significantly less downtime and less rework. By increasing the output and decreasing the costs of internal failure, the plant can meet the budgeted reductions for internal failure costs. Also, by showing an increase in the costs of quality training, the budgeted level for prevention costs can be met.
b. Delay replacing and repairing defective products until the beginning of the following year. While this may increase customer dissatisfaction somewhat, Len believes that most customers expect some inconvenience. Besides, the policy of promptly dealing with dissatisfied customers could be reinstated in three months. In the meantime, the action would significantly reduce the costs of external failure, allowing the plant to meet its budgeted target.
c. Cancel scheduled worker visits to customers' plants. This program, which has been very well received by customers, enables Lindell workers to see just how the machinery they make is used by the customer and also gives them first-hand information on any remaining problems with the machinery. Workers who went on previous customer site visits came back enthusiastic and committed to Lindell's quality program. Lindell's quality program staff believes that these visits will reduce defects during the following year.

Required:

Form groups of four. Each group will review the answers to the following requirements. In each group, select one member that will rotate to another group. The rotating member has the responsibility of comparing and contrasting the solution of his or her group with that of the group being visited.

1. Evaluate Len's ethical behavior. In this evaluation, consider his concern for his employees. Was he justified in taking the actions described? If not, what should he have done?
2. Assume that the company views Len's behavior as undesirable. What can the company do to discourage it?
3. Assume that Len is a CMA and a member of the IMA. Refer to the ethical code for management accountants in Chapter 1. Were any of these ethical standards violated?

14-23 Cyber Research Case

LO1, LO3

The ISO 9000 series and QS 9000 have had a significant impact in industrial practice. Web sites that provide a good starting point for information about these quality standards include http://www.isoeasy.org, http://www.aiag.org, and http://www.findarticles.com. The last address allows you to search for articles that deal with ISO 9000 and QS 9000. Using these sources and others you might locate on the Internet, answer the following questions:

1. What is the International Standards Organization?
2. What standards make up the ISO 9000 family?
3. Describe the revised ISO 9000 standards.
4. What are the differences between ISO 9000 and QS 9000? Be specific.
5. What is the average cost to register and maintain QS 9000? What is the average benefit?
6. Describe the experience of one company that has implemented QS 9000. Include in your description some of the quality improvements that were the result of QS 9000 registration.