TQM

Chapter One

TQM: An Overview

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cost of poor quality
https://www.youtube.com/watch?v=lPbFVzs3syQ

Quality
https://www.youtube.com/watch?v=jpM0Jp6X9-4

Introduction

In today's global competitive marketplace the demands of customers are for ever increasing as they require improved quality of products and services. Also, in some markets there is an increasing supply of competitively priced products and services from low labour cost countries such as those in the Far East, the former Eastern bloc, China, Vietnam and India. Continuous improvement in total business activities with a focus on the customer throughout the entire organization and an emphasis on flexibility and quality is one of the main means by which companies face up to these competitive threats. This is why quality and its management and the associated continuous improvement are looked upon by many organizations as the means by which they can survive in increasingly aggressive markets and maintain a competitive edge over their rivals. The companies that do not manage this change will fail. As a result of the efforts made by organizations to respond to these marketplace demands the quality of products, services and processes has increased considerably during the last two decades. Feigenbaum and Feigenbaum (1999) point out that:

> Total Quality is a major factor in the business quality revolution that has proven itself to be one of the 20th century's most powerful creators of sales and revenue growth, genuinely good new jobs, and soundly based and sustainable business expansion.

Having said this, it should be pointed out that in many markets today quality, narrowly defined as the reliability of products and services, is not the competitive weapon it once was. It is now expected as a given requirement and is considered an entry-level characteristic to the marketplace.

These days, many organizations have had experiences with working on the transformation towards total quality management (TQM) and this is coupled with

its spread, from the manufacturing to the service sector and on to public services. What is TQM? In simple terms, it is the mutual co-operation of everyone in an organization and associated business processes to produce value-for-money products and services which meet and, hopefully, exceed the needs and expectations of customers. TQM is an ever-evolving practice of doing business in a bid to develop methods and processes which cannot be imitated by competitors.

This chapter provides an overview of TQM and introduces the reader to the subject. Many of the themes outlined are explored later in the book. It opens by examining the different interpretations which are placed on the term 'quality'. It then examines why quality has grown in importance during the last decades. The evolution of quality management ('Co-ordinated activities to direct and control an organization with regard to quality': BS EN ISO 9000 (2000)) is described through the stages of inspection, quality control, quality assurance and onwards to TQM. In presenting the details of this evolution the drawbacks of a detection-based approach to quality are compared to the recommended approach of prevention. Having described these stages the chapter examines the key elements of TQM – commitment and leadership of the chief executive officer (CEO), planning and organization, using tools and techniques, education and training, employee involvement, teamwork, measurement and feedback, and culture change.

The chapter ends by presenting a summary of the points which organizations need to keep in mind when developing and advancing TQM. This is done under the broad groupings of organizing, systems and techniques, measurement and feedback, and changing the culture.

What is Quality?

'Quality' is now a familiar word. However, it has a variety of interpretations and uses, and there are many definitions. Today, and in a variety of situations, it is perhaps an over-used word. For example, when a case is being made for extra funding and resources, to prevent a reduction in funding, or to keep a unit in operation and in trying to emphasize excellence, just count the number of times the word 'quality' is used in the argument or presentation.

Many people say they know what is meant by quality, they typically claim 'I know it when I see it' (i.e. by sensing and/or instinct). This simple statement and the interpretations of quality made by lay people mask the need to define quality and its attributes in an operational manner. In fact, quality as a concept is quite difficult for many people to grasp and understand, and much confusion and myth surround it.

In a linguistic sense, quality originates from the Latin word 'qualis' which means 'such as the thing really is'. There is an international definition of quality, the

'degree to which a set of inherent characteristics fulfils requirements' (BS EN ISO 9000 (2000)). However, in today's business world there is no single accepted definition of quality. Irrespective of the context in which it is used, it is usually meant to distinguish one organization, event, product, service, process, person, result, action, or communication from another. For the word to have the desired effect as intended by the user and to prevent any form of misunderstanding in the communication, the following points need to be considered:

- The person using the word must have a clear and full understanding of its meaning.
- The people/audience to whom the communication is directed should have a similar understanding of quality to the person making the communication.
- Within an organization, to prevent confusion and ensure that everyone in each department and function is focused on the same objectives, there should be an agreed definition of quality. For example, Betz Dearborn Ltd. define quality as: 'That which gives complete customer satisfaction', and Rank Xerox (UK) as 'Providing our customers, internal and external, with products and services that fully satisfy their negotiated requirements'. North-West Water Ltd. use the term 'business quality' and define this as:
  - Understanding and then satisfying customer requirements in order to improve our business results.
  - Continuously improving our behaviour and attitudes as well as our processes, products and services.
  - Ensuring that a customer focus is visible in all that we do.

There are a number of ways or senses in which quality may be defined, some being broader than others but they all can be boiled down to either meeting requirements and specifications or satisfying and delighting the customer. These different definitions are now examined.

Qualitative

When the word quality is used in a qualitative way, it is usually in a non-technical situation. BS EN ISO 9000 (2000) says that 'the term "quality" can be used with adjectives such as poor, good or excellent'. The following are some examples of this:

- In advertising slogans to assist in building an image and persuade buyers that its production and services are the best: Esso – Quality at Work; Hayfield Textiles – Committed to Quality; Kenco – Superior Quality; Philips Whirlpool – Brings Quality to Life; Thompson Tour Operations – Thompson Quality Makes the World of Difference.

- By television and radio commentators (a quality player, a quality goal, a quality try).
- By directors and managers (quality performance, quality of communications).
- By people, in general (quality product, top quality, high quality, original quality, quality time, quality of communications, quality person, loss of quality, German quality, 100 per cent quality).

It is frequently found that in such cases of 'quality speak' the context in which the word quality is used is highly subjective and in its strictest sense is being misused. For example, there is more than one high street shop which trades under the name of 'Quality Seconds', and some even advertise under the banner of 'Top Quality Seconds'. There is even a company with the advertising slogan 'Quality Part-Worn Tyres' on the side of its vans.

Quantitative

The traditional quantitative term which is still used in some situations is acceptable quality level (AQL). This is defined in BS 4778 (1991) as: 'When a continuing series of lots is considered, a quality level which for the purposes of sampling inspection is the limit of a satisfactory process'. This is when quality is paradoxically defined in terms of non-conforming parts per hundred (i.e. some defined degree of imperfection).

An AQL is often imposed by a customer on its supplier in relation to a particular contract. In this type of situation the customer will inspect the incoming batch according to the appropriate sampling scheme. If more than the allowed number of defects are found in the sample the entire batch is returned to the supplier or the supplier can, at the request of the customer, sort out the conforming from non-conforming product on the customer's site. The employment of an AQL is also used by some companies under the mistaken belief that trying to eliminate all defects is too costly.

The setting of an AQL by a company can work against a 'right first time' mentality in its people as it appears to condone the production and delivery of non-conforming parts or services, suggesting that errors are acceptable to the organization. It is tantamount to planning for failure. For example, take a final product which is made up of 3,000 parts: if the standard set is a 1 per cent AQL, this would mean that the product is planned to contain 30 non-conforming parts. In reality there are likely to be many more because of the vagaries of the sampling used in the plan or scheme, whereby acceptance or rejection of the batch of product is decided.

Another example of a quantitative measure is to measure processes using sigmas (a sigma is a statistical indication of variation) and defects per million opportunities (DPMO). A sigma is essentially a measuring device that is an indication

Table 1.1 Levels of service performance requirements

Comparative measure	*Grade*	*Billing queries: % answered within 5 days*	*Written complaints: % answered within 10 days*	*Billing metered customers: % read minus % unread*
Well above average	A	>95	>98	>99.4
Above average	B	92–95	96–98	98.5–99.4
Average	C	89–92	94–96	96.0–98.4
Below average	D	86–89	92–94	93.0–95.9
Well below average	E	<86	<92	<93.0

Source: Office of Water Services (OFWAT) (1995/6).

of how good a product or service is. The higher the sigma value the lower the number of defects. For example, 3 sigma equals 66,807 DPMO, while 6 sigma equals 3.4 DPMO (these values assume a normal distribution with a process shift of 1.5 sigma). The sigma level is a means of calibrating performance in relation to customer needs.

The concept of six sigma (a quality improvement framework) has developed from its origins in Motorola in the 1980s as an approach to improving productivity and quality and reducing costs. Six sigma is the pursuit of perfection and represents a complete way of tackling process improvement from a quantitative approach, involving many of the concepts, systems, tools and techniques described in this book. The six sigma concept is currently very popular as a business improvement approach. The key features include a significant training commitment in statistics and statistical tools, problem-solving methodology and framework, project management, a team-based project environment, people who can successfully carry out improvement projects (these are known as black belts and green belts, based on the martial arts hierarchy), leaders (master black belts) and project champions.

3 Yet another example of a quantitative measure of quality are levels of service performance requirements; see the data in table 1.1.

Uniformity of the product characteristics or delivery of a service around a nominal or target value

If product or service dimensions are within the design specification or tolerance limits they are considered acceptable; conversely, if they are outside the specification they are not acceptable (see figure 1.1). The difference between what is considered to be just inside or just outside the specification is marginal. It may also be questioned whether this step change between pass and fail has any scientific basis and validity.

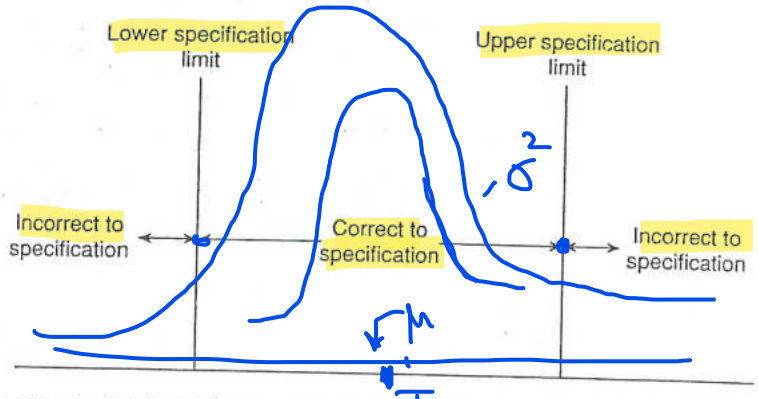


Figure 1.1 The inside/outside specification dilemma

Designers often establish specification limits without sufficient knowledge of the process by which the product and/or service is to be produced/delivered and its capability. It is often the case that designers cannot agree amongst themselves about the tolerances/specification to be allocated, and it is not uncommon to find outdated reasoning being used. They also tend to define and establish a tighter tolerance than is justified to provide safeguards and protect themselves. In many situations there is inadequate communication on this matter between the design and operation functions. Fortunately, this is changing with the increasing use of simultaneous or concurrent engineering.

The problem with working to the specification limits in a manufacturing situation is that it frequently leads to tolerance stack-up and parts not fitting together correctly at the assembly stage. This is especially the case when one part which is just inside the lower specification limit is assembled to one which is just inside the upper specification. If the process is controlled such that a part is produced around the nominal or a target dimension with limited variation (see figure 1.2), this problem does not occur and the correctness of fit and smooth operation of the final assembly and/or end product are enhanced.

The idea of reducing the variation of part characteristics and process parameters so that they are centred around a target value can be attributed to Taguchi (1986). He writes that the quality of a product is the (minimum) loss imparted by the product to the society from the time the product is shipped. This is defined by a quadratic loss curve. Among the losses he includes time and money spent by customers, consumers' dissatisfaction, warranty costs, repair costs, wasted natural resources, loss of reputation and, ultimately, loss of market share.

The relationship of design specification and variation of the process can be quantified by a capability index, for example, Cp which is a process potential capability index:

$$Cp = \frac{\text{Total specification width}}{\text{Process variation width}}$$

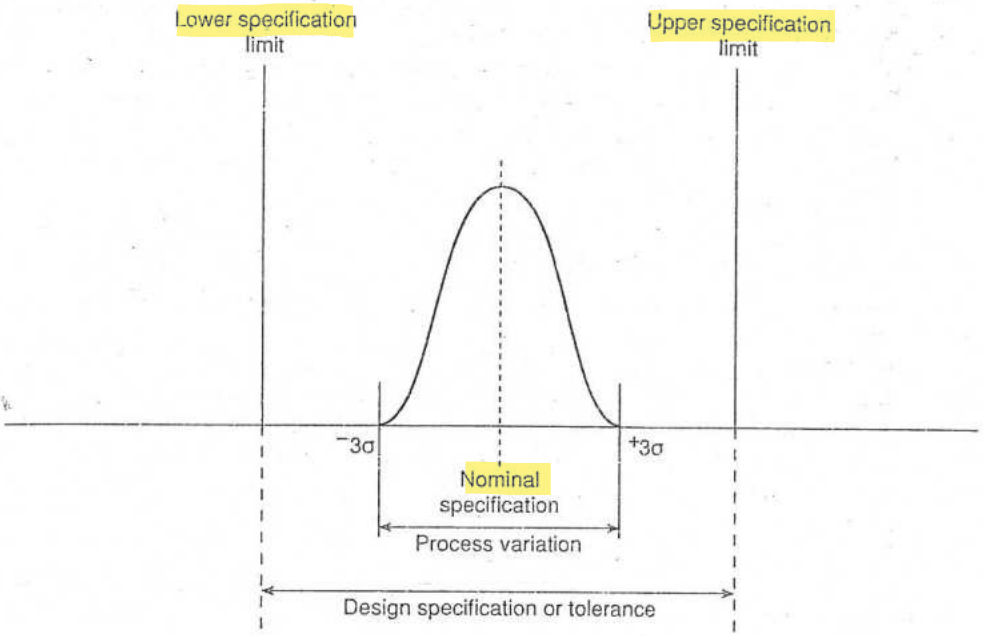


Figure 1.2 Design tolerance and process variation relationship

Conformance to agreed and fully understood requirements

This definition is attributed to Crosby (1979). He believed that quality is not comparative and that there is no such thing as high quality or low quality, or quality in terms of goodness, feel, excellence and luxury. A product or service either conforms to requirements or it does not. In other words, quality is an attribute (a characteristic which, by comparison to a standard or reference point, is judged to be correct or incorrect) not a variable (a characteristic which is measurable). Crosby made the point that the requirements are all the actions required to produce a product and/or deliver a service that meets the customer's expectations, and that it is management's responsibility to ensure that adequate requirements are created and specified within the organization.

This is a useful definition to use in the development of service-level agreements (SLAs). Some products and services are highly sophisticated in terms of their design but are poor in terms of conformance to requirements. On the other hand, some are simple in terms of their design but exhibit high levels of conformance to requirements. The 'quality of design' (the degree to which the design of the product and/or service achieves its purpose) can be confused with the 'quality of conformance' (how well the product and/or service conforms to the design). Stemming from this confusion about design and conformance there can be a tendency to believe that 'better' quality means higher costs. This view results

from the confusion between quality and grade. Grade represents the addition of features and characteristics to satisfy the additional needs of customers and this clearly requires extra monies, but grade is different to quality.

Fitness for purpose/use

This is a standard definition of quality first used by Juran (Juran 1988, Juran and Godfrey 1999). Juran classifies 'fitness for purpose/use' into the categories of: quality of design, quality of conformance, abilities and field service. Focusing on fitness for use helps to prevent the over-specification of products and services. Over-specification can add greatly to costs and tends to militate against a right-first-time performance. How fit a product or service is for use obviously has to be judged by the purchaser, customer or user.

Satisfying customer expectations and understanding their needs and future requirements

A typical definition which reflects this aim is: 'The attributes of a product and/or service which, as perceived by the customer, makes the product/service attractive to them and gives them satisfaction.' The focus of the definition is adding value to the product and/or service.

Satisfying customers and creating customer enthusiasm through understanding their needs and future requirements is the crux of TQM, and all organizations are dependent on having satisfied customers. TQM is all about customer orientation and many company missions are based entirely on satisfying customer perceptions. Customer requirements for quality are becoming stricter and more numerous, and there are increasing levels of intolerance of poor-quality goods and services and low levels of customer service and care. The customer is the major reason for an organization's existence and customer loyalty and retention is perhaps the only measure of organizational success. In most situations customers have a choice: they need not place future orders with a supplier who does not perform as they expected or who they feel has deceived them. They will certainly not jeopardize their own business interest out of loyalty to a supplier whose products and service fail to perform properly, and will simply go to a competitor. In the public sector the customer may not have the choice to go elsewhere; however, they can go to litigation, write letters of complaint, cause disruption, and use elections to vote officials out of office. The aim of superior-performing companies is to become the supplier of choice to their customers and to 'lock' themselves into their customers' mode of operation by becoming their sole supplier, and by adding value to their customers' businesses by process improvement and cost-down activities. A number of countries have developed a customer

satisfaction index. The American index (see <www.theacsi.org>), for example, indicates satisfaction with the quality of goods and services in numerous industries.

The superior-performing organizations go beyond satisfying their customers: they emphasize the need to delight them by giving them more than what is required in the contract; they also talk about winning customers and becoming infatuated with their customers. These organizations create a total experience for their customers, which is unique in relation to the offerings of competitors (which is called 'the experience economy', see Pine and Gilmore (1999)). The wisdom of this can be clearly understood when we consider the situation where a supplier has given more than the customer expected (e.g. an extra glass of wine on an aircraft; a sales assistant going out of their way to be courteous and helpful and providing very detailed information) and the warm feelings generated by this type of action.

A customer-focused organization also puts considerable effort into anticipating the future expectations of its customers (i.e. surprising quality), and, by working with them in long-term relationships, helps them to define their future needs and expectations. They listen very closely to their customers and 'real' users of the product or service, in order to gain a clearer perspective on customer experiences. They aim to build quality into the product, service, system and/or process as upstream as is practicable. Excitement and loyalty are the words used to describe this situation.

Those companies intent on satisfying customer needs and expectations will have in place a mechanism for facilitating a continuous two-way flow of information between themselves and their customers. There are a variety of means available to companies for them to assess issues such as:

- How well they are meeting customer expectations
- How well the brand is respected
- What customers' chief causes of concern are
- What the main complaints are
- What suggestions for improvements customers might have
- How they might add value to the product and/or service
- How well they act on what the customer says
- The best means of differentiating themselves in the marketplace

The trend is for increasing the level of contact with the customer. These 'moments of truth' (Carlzon 1987) occur far more frequently in commerce, public organizations, the Civil Service and service-type situations than in manufacturing organizations. The means for increasing the level of customer contact include:

- Customer workshops
- Panels and clinics
- Using 'test' consumers and mystery shoppers

- Focus groups
- Customer interviews
- Market research
- Dealer information
- Questionnaire surveys
- Product reports
- Trailing the service and/or product
- Trade shows

What is a focus group? By definition a focus group is designed to provide exploratory rather than conclusive research data so you can understand not only what your customers think, but also how and why they think the way they do.

Customer complaints are one indication of customer satisfaction, and many organizations have a number of metrics measuring such complaints. BS 8600 (1999) provides guidance on how to develop an effective complaints management system in order to analyse and use complaints effectively. The rationale is that managing complaints in a positive manner can enhance customer perceptions of an organization, increase lifetime sales and values and provide valuable market intelligence.

Having listened to 'customer voices' an organization should put in place appropriate strategy and actions for making the necessary changes and improvements. It is also important to clarify and identify the elements and characteristics of the product and service which the customer finds attractive. The service quality questionnaire (SERVQUAL) developed by Parasuraman et al. (1988) may be used to track these kinds of issues. This customer-required quality (i.e. their wants) should be translated into the language of internal needs and driven back through all levels in the organizational hierarchy. It is important that the requirements are put into terms that are measurable, realistic and achievable; the use of quality function deployment (QFD) is useful in this respect (for a detailed discussion of QFD, see chapter 17). Customer needs and requirements are for ever changing, and organizations have to live up to their customers' expectations; they are never satisfied, even though the supplying organization may think they are.

Strategies to Increase Customer Satisfaction
https://www.youtube.com/watch?v=nZQP-0axwHE

Why is Quality Important?

To answer this question, just consider the unsatisfactory examples of product and/or quality service that you, the reader, have experienced, the bad feelings it gave, the resulting actions taken and the people you told about the experience and the outcome. Goodman et al. (2000), based on a range of studies carried out by TARP (Technical Assistance Research Programs), outline two arguments that are effective in selling quality to senior management.

- First, quality and service improvements can be directly and logically linked to enhanced revenue within one's own company; and secondly, higher quality allows companies to obtain higher margins.

file:///C:/Users/user/Desktop/Abbas/Structural%20equation%20model%20for%20effective%20CRM%20of%20information%20infrastructure%20industry%20in%20Korea.pdf

The following extracts some quantitative evidence in relation to these arguments:

- 'Problems decrease customer loyalty by 15 per cent to 30 per cent'
- '50 per cent of individual consumers and 25 per cent of business customers who have problems never complain to anyone at the company'
- 'If the call centre can resolve a customer's problem using quality service, thus changing a dissatisfied customer to a satisfied one, the company usually gets an increase in loyalty of 50 percentage points'
- 'One potential customer will be lost for every 50 who hear someone complain about a product or service'
- 'Market leaders can charge between 5 per cent and 10 per cent premiums for outstanding quality and service'

The customer service information in box 1.1 provides additional quantitative facts about this. These data emphasize the importance of customer acquisition and retention.

BOX 1.1 CUSTOMER SERVICE FACTS

Customer Service Facts: Did You Know That* . . .

1 If 20 customers are dissatisfied with your service, 19 won't tell you. 14 of the 20 will take their business elsewhere.
2 Dissatisfied customers tell an average of 10 other people about their bad experience; 12 per cent tell up to 20 people.
3 Satisfied customers will tell an average of 5 people about their positive experience.
4 It costs five times more money to attract a new customer than to keep an existing one.
5 Up to 90 per cent of dissatisfied customers will not buy from you again, and they won't tell you why.
6 In many industries, quality of service is one of the few variables that can distinguish a business from its competition.
7 Providing high-quality service can save your business money. The same skills that lead to increased customer satisfaction also lead to increased employee productivity.
8 Customers are willing to pay more to receive better service.
9 95 per cent of dissatisfied customers will become loyal customers again if their complaints are handled well and quickly.

* *Statistics compiled by Mattson & Associates from service sector companies in the USA.*

Source: CMC Partnership Ltd. (1991).

The following are examples of survey data which have focused on the perceived importance of product and service quality.

Public perceptions of product and service quality

In 1988 the American Society for Quality (ASQ) commissioned the Gallup organization to survey public perceptions on a variety of quality-related issues. This survey was the fourth in a series which began in 1985; the 1985 and 1988 surveys focused on US consumers and the 1986 and 1987 studies surveyed attitudes of company executives. The 1988 study was done by conducting telephone interviews with 1,005 adults in the United States during the summer of 1988. A selection of results, as reported by Ryan (1988) and Hutchens (1989), is outlined below:

- The following is a ranking of factors that people consider important when they purchase a product:
  - Performance
  - Durability
  - Ease of repair, service availability, warranty, and ease of use (these four factors were ranked about the same)
  - Price
  - Appearance
  - Brand name
- People will pay a premium to get what they perceive to be higher quality.
- Consumers are willing to pay substantially more for better intrinsic quality in a product.
- According to the respondents, the following are the factors what make for 'higher' quality in services:
  - Courtesy
  - Promptness
  - A basic sense that one's needs are being satisfied
  - Attitudes of the service provider
- When consumers do experience a problem with the product, they appear reluctant to take positive action with the manufacturer. The 1987 survey revealed that executives regard customer complaints, suggestions and enquiries as key indicators of product and service quality.

An ASQ/Gallup survey (ASQ/Gallup 1991) was conducted to survey the attitudes and opinions of consumers in Japan, West Germany and the United States in relation to questions such as: 'What does quality really mean to them? How do they define it and does it influence their buying behaviour? What is

their perception of the quality from other parts of the world? and What are the dynamics underlying a consumer's reasons for buying or not buying something produced in a foreign country?' On a number of issues, this survey updates American attitudes expressed in the 1988 survey. Over 1,000 people in each country were questioned. A selection of summary highlights from the report are outlined below:

- 'Consumers in the US, Japan and West Germany in many respects are alike in terms of the attributes they consider important in determining the quality of the products they buy. For example, approximately one in five look to the brand name of a product. Durability is also important to at least 10 per cent of the consumers in each of the countries surveyed.'
- 'Asked what factors are most important in influencing their decision to buy a product, price is the leading response in West Germany (64 per cent) and in the US (31 per cent). Performance (40 per cent) is most important among Japanese consumers, followed by price (36 per cent).'
- 'A majority (61 per cent) of US consumers believe it is very important to US workers to produce high-quality products or service.'
- 'Price and quality are the reasons given most frequently by American consumers for buying a product made in Japan or Germany.'

Views and roles of senior management

1 In 1992 ASQ commissioned the Gallup organization to study the nature of leadership for quality within American business organizations by surveying opinions of senior management in both large and small organizations. The objective was to explore their views concerning quality improvement and the role of directors with regard to quality. Some 684 executives were interviewed. The following is a summary of the main findings extracted from ASQ/ Gallup (1992).
   - 'At least six in ten executives report that they have a great deal of personal leadership impact on customer focus and satisfaction, strategic quality planning, quality and operational results and financial results.'
   - 'Most executives believe management plays a greater role than the board in determining quality policy within their company.'
   - 'More than four in ten (45 per cent) report their board does discuss quality frequently.'
   - 'Four in ten (43 per cent) executives report their board reports on consumer satisfaction frequently, and almost as many (38 per cent) report the board reviews reports on customer retention or loyalty frequently.'
2 The European Foundation for Quality Management (EFQM) contracted McKinsey and Company to survey the CEOs of the top 500 west European

corporations in relation to quality performance and the management of quality; 150 CEOs responded to the survey. The following are some of the main findings as reported by McKinsey and Company (1989).

- Over 90 per cent of CEOs consider quality performance to be 'critical' for their corporation.
- 60 per cent of CEOs said that quality performance had become a lot more important than before (late 1970s).
- The four main reasons why quality is perceived to be important are:
  - Primary buying argument for the ultimate customer
  - Major means of reducing costs
  - Major means for improving flexibility/responsiveness
  - Major means for reducing throughput time.
- The feasible improvement in gross margin on sales through improved quality performance was rated at an average of 17 per cent.
- More than 85 per cent of the leading CEOs in Europe consider the management of quality to be one of the top priorities for their corporations.

3 Lascelles and Dale (1990), reporting on a survey they carried out of 74 UK CEOs, say that 'Almost all the respondents believe that product and service quality is an important factor in international competitiveness. More than half have come to this conclusion within the past four years.'

4 Ahire and O'Shaughnessy (1998) conducted a large-scale survey of quality management practices at suppliers in the automotive industry, looking at such practices as top management commitment, customer focus, supplier quality management, design quality management, benchmarking, statistical process control, internal quality information usage, employee training, employee empowerment, employee involvement, and product quality. They conclude that:

- 'Firms with high top management commitment implement the other nine TQM implementation elements more rigorously than those with low top management commitment.'
- 'In firms with high top management commitment, variations among the other nine TQM implementation constructs do not affect product quality significantly.'
- 'In firms with low top management commitment, four of the nine implementation constructs, namely, customer focus, empowerment, internal quality information usage, and supplier quality management are primary predictors of quality.'

Quality is not negotiable

An order, contract or customer which is lost on the grounds of non-conforming product and/or service quality is much harder to regain than one lost on price

or delivery terms. In a number of cases the customer could be lost for ever; in simple terms the organization has been outsold by the competition.

If you have any doubt about the truth of this statement just consider the number of organizations that have gone out of business or lost a significant share of a market, and consider the reported reasons for them getting into that position. Quality is one of the factors which is not negotiable and in today's business world the penalties for unsatisfactory product quality and poor service are likely to be punitive.

Quality is all-pervasive

There are a number of single-focus business initiatives which an organization may deploy to increase profit. However, with the improvements made by companies in their mode of operation, reduction in monopolies, government legislation, deregulation, changes in market share, mergers, takeovers, collaborative joint ventures, there is less distinction between companies than there was some years ago. TQM is a much broader concept than previous initiatives, encompassing not only product, service and process improvements but those relating to costs and productivity and to people involvement and development. It also has the added advantage that it is totally focused on satisfying customer needs.

A related issue is that organizations are often willing to pay more for what they perceive as a quality product; see the results of the ASQ/Gallup survey of 1992, as outlined in table 1.2.

Quality increases productivity

Cost, productivity and quality improvements are complementary and not alternative objectives. Managers sometimes say that they do not have the time and

Table 1.2 Customers willing to pay for quality

Industry type	*Number of customers willing to pay more for a quality product*	*Number of customers unwilling to pay extra for better quality*
Clothing/textiles	135	5
Furniture	74	4
TV/audio	66	6
Home	55	4
Automotive	36	10

Source: ASQ/Gallup (1992)

resources to ensure that product and/or service quality is done right the first time. They go on to argue that if their people concentrate on planning for quality then they will be losing valuable operational time, and as a consequence output will be lost and costs will rise. Despite this argument, management and their staff will make the time to rework the product and service a second or even a third time, and spend considerable time and organizational resources on corrective action and placating customers who have been affected by the non-conformances.

Remember 'Murphy's Law' – 'There is never time to do it right but always time to do it once more.'

Quality leads to better performance in the marketplace

The Profit Impact of Market Strategy (PIMS), conducted under the Strategic Planning Institute in Cambridge, Massachusetts, have a database which contains records of detailed business performance of over 3,000 business units. The Institute is a co-operative run by its members. The database allows a detailed analysis of the parameters which influence business performance. A key PIMS concept is relative perceived quality (RPQ); this is the product and service offering as perceived by the customer. PIMS data are often used to model options before adapting a change initiative and to assess how improvements translate into improved profits and enhanced customer loyalty. It has been established that the factors having most leverage on return on investment are RPQ and relative market share, and that companies with large market shares are those whose quality is relatively high, whereas companies with small market shares are those whose quality is relatively low (see Buzzell and Gale 1987). Another key finding is that businesses who know and understand customers' priorities for quality improvements can achieve a threefold increase in profitability (Roberts 1996).

Quality means improved business performance

Kano et al. (1983) carried out an examination of 26 companies which won the Deming Application Prize (this is a prize awarded to companies for their effective implementation of company-wide quality control; for details see chapter 25). Between 1961 and 1980 they found that the financial performance of these companies in terms of earning rate, productivity, growth rate, liquidity, and net worth was above the average for their industries.

A report published by the US General Accounting Office (GAO) (1991) focused on the top 20 scorers of the Malcolm Baldrige National Quality Award (MBNQA) in the period 1988–9. Its purpose was to determine the importance of TQM practices on the performance of US companies. Using a combination

of questionnaire and interview methods, the companies were asked to provide information on four broad classes of 20 performance measures – employee-related indicators, operating indicators, customer satisfaction indicators and business performance indicators. Improvements were claimed in all these indicators (e.g. market share, sales per employee, return on assets, and return on sales). Useful information on financial performance was obtained from 15 of the 20 companies who experienced the following annual average increases:

- Market share: 13.7 per cent
- Sales per employee: 8.6 per cent
- Return on assets: 1.3 per cent
- Return on sales: 0.4 per cent

Larry (1993) reports on a study carried out on the winners of the MBNQA and found that they 'Yielded a cumulative 89 per cent gain, whereas the same investment in the Standard and Poor (S&P) 500 – Stock Index delivered only 33.1 per cent.' Wisner and Eakins (1994) also carried out an operation and financial review of the MBNQA winners from 1988 to 1993. One of the conclusions reached was that the winners appear to be performing financially as well as or better than their competitors.

As reported by Bergquist and Ramsing (1999), Bergquist carried out a study in 1996, entitled 'An Assessment of the Operational and Financial Impact on Companies of Quality Awards in the United States', which used the same approach as the 1991 GAO study, expanding to 40 the original 20 performance measures. The focus of the study was a questionnaire survey of winners and applicants of MBNQA and State Quality Awards, between the years 1990 and 1995. They conclude:

> 89 per cent of the winners and 77 per cent of the applicants who responded to the mail survey believed that using award criteria did have a positive impact on company performance, a link appears to exist between award criteria and perceived company performance.

The Bradford study (Letza et al. 1997), carried out at the University of Bradford Management Centre, identified 29 companies within the UK which display characteristics associated with TQM. Following the US GAO work the study was first carried out over the period 1987 to 1991 and has been repeated for the period 1991 to 1995. Nine measures have been used by the study team to compare company performance with the median for the particular industry. The second study reveals the following:

- 81 per cent of companies are above the industry median for turnover per employee.

- 81 per cent of the companies provide a higher salary to turnover ratio than their peers.
- 74 per cent of the organizations remunerate their employees above the median for the industry.
- 65 per cent of the organizations produce above-median profit per employee for their industry.
- 62 per cent of the organizations have a higher net asset turnover than their peer group.

The authors also go on to say that 'Four of the nine measures are marginally below the median for their industry but this is to be expected as quality becomes institutionalized and more widespread.'

Easton and Jarrell (1998) have undertaken an extremely thorough study which has examined the impact of TQM on financial performance for a sample of 108 firms. The impact of TQM has been assessed by examining the unexpected changes in financial performance for a five-year period following the introduction of TQM. Easton and Jarrell (1998) conclude that 'The findings indicate that performance, measured by both accounting variables and stock returns, is improved for the firms adopting TQM. The improvement is consistently stronger for firms with more advanced TQM.'

Another very thorough study is that undertaken by Hendricks and Singhal (1996) in America, which began in 1991. They have measured the effects of TQM on long-term business performance. The study sample comprised nearly 600 award-winners (e.g. MBNQA, State Quality Awards and Supplier Awards) and compared their performance with that of similar companies that had not won such an award. The study found that it required a long time period to establish the link between TQM and financial performance because of its evolutionary nature. For the implementation period which started six years before a company won an award, they found no difference between award-winners and non-award-winners. The following are some of the key results from the post-implementation period:

- Winners experienced a 91 per cent increase in operating income compared with their respective controls (43 per cent).
- Winners gained a 69 per cent increase in sales compared with their controls (32 per cent) and attained a 79 per cent increase in total assets compared with the respective controls (37 per cent).
- Winners increased their employees by 23 per cent compared with their respective controls (7 per cent).
- Over the five-year study period the award-winners outperformed the S&P 500 index by 34 per cent.

In the *X Factor Report* (British Quality Foundation 1999) the award submissions from 14 European and UK quality/business excellence award-winning

companies were analysed regarding financial performance. The results were examined for (1) three-year trends and sustained good performance; (2) five-year trends and sustained excellent performance; and (3) favourable comparisons with set targets. Strong positive trends and/or sustained excellent performance over three years were demonstrated by over 70 per cent of the companies using three main financial measures:

- Revenue growth
- Operating profit
- Return on assets

Other financial measures against which these role-model companies performed well over three and five years and against targets/benchmarks, included:

- Cashflow
- Liquidity
- Debtor days
- Shareholder funds

George (2002) reports on the Q-100 index, which was established in 1998. This is based on investments in American-based organizations which are using TQM. The search for such companies is undertaken by the Malcolm Baldrige National Quality Award criteria. The Q-100 consists of approximately 100 of the 500 S&P companies, which are weighted and diversified to align them with the weightings and sectors in the S&P 500. Among the findings reported by George (2002) are:

> From September 30th, 1998 to December 31st, 2001 the Q-100 returned 26.97 per cent compared with the S and P 500 return of 17.59 per cent.
>
> A $10,000 investment in both indices on September 30th, 1998 would have grown to $12,697 for the Q-100 on the last day of 2001, compared with $11,759 for the S and P 500.

Perhaps the best-known quality/financial metric is the 'Baldrige Index'. This is a fictitious stock fund made up of publicly traded US companies that have received the MBNQA during the years 1993 to 2002. The US Commerce Department's National Institute of Technology (NIST) invested a hypothetical $1,000 in each of the whole company winners and the parent companies of 18 subsidiary winners. They also made the same investment in the S&P 500 index at the same time. The investments have been tracked from the first business day of the month following the announcement of the award receipts through to 1 December 2003. NIST (2006) reported that the award winners outperformed the S&P 500 by more than 6.5 to 1, until December 2001. The two following years of the study showed that the Baldrige Index underperformed the S&P 500.

The cost of non-quality is high

Based on a variety of companies, industries and situations, the cost of quality (or to be more precise the cost of not getting it right the first time) ranges from 5 to 25 per cent of an organization's annual sales turnover in manufacturing or annual operating costs in service-type situations; see chapter 9 and Dale and Plunkett (1999) for details. An organization should compare its profit-to-sales turnover ratio to that of its quality costs-to-sales turnover ratio in order to gain an indication of the importance of product and service quality to corporate profitability. A study by Halevy and Naveh (2000), found that some 30 per cent of Israel's national product 'is wasted due to poor quality of planning and workmanship'.

A related cost issue is that of product liability, which is concerned with the legal liability of a manufacturer or supplier of goods for personal injuries or damage to property suffered as a result of a product which is defective and unsafe; see European Commission Directive (1985). A powerful example of the cost and implications of the failure to get a product right is provided by Wilks (1999):

> In July this year General Motors was fined a record $4.9 billion following a crash in 1993 which seriously burned six people involved in a rear end car collision. The severity of their injuries – some suffered 60 per cent burns – was put down to design fault in placing the petrol tank too close to the rear bumper. The victims' lawyers discovered that an internal GM study had highlighted this danger and that the manufacturer had known 'for years' that this model was potentially unsafe. To alter the design would have cost the company $8.59 per car.

Customer is king

In today's markets, customer requirements are becoming increasingly more rigorous and their expectations of the product and/or service in terms of conformance, reliability, dependability, durability, interchangeability, performance, features, appearance, serviceability, user-friendliness, safety, and environmental friendliness is also increasing. These days many superior-performing companies talk in terms of being 'customer-obsessed'. At the same time, it is likely that the competition will also be improving and, in addition, new and low-cost competitors may emerge in the marketplace. Consequently there is a need for continuous improvement in all operations of a business, involving everyone in the company. The organization which claims that it has achieved TQM will be overtaken by the competition. Once the process of continuous improvement has been halted, under the mistaken belief that TQM has been achieved, it is much harder to restart and gain the initiative on the competition, (see figure 1.3). This is why TQM should always be referred to as a process and not a programme.

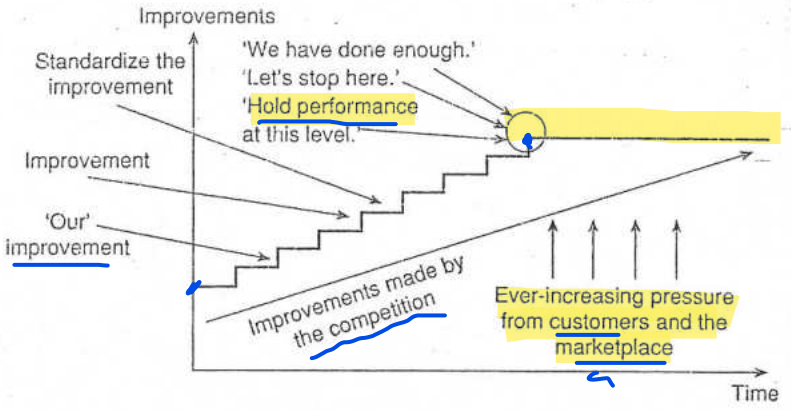


Figure 1.3 Quality improvement: a continuous process

Quality is a way of life

Quality is a way of organizational and everyday life. It is a way of doing business, living and conducting one's personal affairs. In whatever each person does, and in whatever situation, the task(s) must be undertaken in a quality-conscious way. Quality is driven by a person's own internal mechanisms – 'heart and soul', 'personal beliefs'. Belief in it can be likened to that of people who follow a religious faith. Companies like Toyota emphasize strongly the need for the commitment of all employees to managing and improving quality, which is an essential part of the famous Toyota Production System (Liker 2003).

An organization committed to quality needs quality of working life of its people in terms of participation, involvement and development and quality of its systems, processes and products.

The Evolution of Quality Management

Systems for improving and managing quality have evolved rapidly in recent years. During the last two decades or so simple inspection activities have been replaced or supplemented by quality control, quality assurance has been developed and refined, and now many companies, using a process of continuous and company-wide improvement, are working towards TQM. In this progression, four fairly discrete stages can be identified: inspection, quality control, quality assurance and total quality management; it should be noted that the terms are used here to indicate levels in a hierarchical progression of quality management (figure 1.4). British and International Standards definitions of these terms are given to

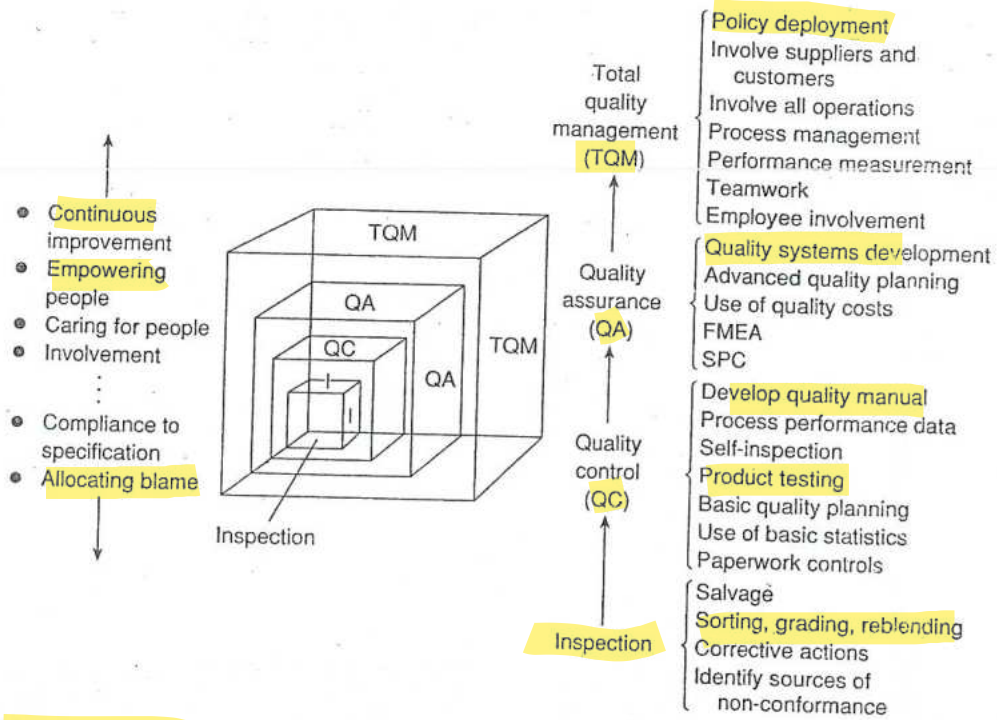


Figure 1.4 The four levels in the evolution of TQM

provide the reader with some understanding, but the discussion and examination are not restricted by these definitions.

Inspection

> Conformity evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging. (BS EN ISO 9000 (2000))

At one time inspection was thought to be the only way of ensuring quality, the 'degree to which a set of inherent characteristics fulfils requirements' (BS EN ISO 9000 (2000)). Under a simple inspection-based system, one or more characteristics of a product, service or activity are examined, measured, tested, or assessed and compared with specified requirements to assess conformity with a specification or performance standard. In a manufacturing environment the system is applied to incoming goods and materials, manufactured components and assemblies at appropriate points in the process and before finished goods are passed into the warehouse. In service, commercial and public service-type situations the system is also applied at key points, sometimes called appraisal points, in the production and delivery processes. The inspection activity is, in the main, carried

out by dedicated staff employed specifically for the purpose, or by self-inspection of those responsible for a process. Materials, components, paperwork, forms, products and goods which do not conform to specification may be scrapped, reworked, modified or passed on concession. In some cases inspection is used to grade the finished product as, for example, in the production of cultured pearls. The system is an after-the-event screening process with no prevention content other than, perhaps, identification of suppliers, operations, or workers, who are producing non-conforming products/services. There is an emphasis on reactive quick-fix corrective actions and the thinking is department-based. Simple inspection-based systems are usually wholly in-house and do not directly involve suppliers or customers in any integrated way.

Quality control

> Part of quality management focused on fulfilling quality requirements. (BS EN ISO 9000 (2000))

Under a system of quality control one might expect, for example, to find in place detailed product and performance specifications, a paperwork and procedures control system, raw material and intermediate-stage product-testing and reporting activities, logging of elementary process performance data, and feedback of process information to appropriate personnel and suppliers. With quality control there will have been some development from the basic inspection activity in terms of sophistication of methods and systems, self-inspection by approved operators, use of information and the tools and techniques which are employed. While the main mechanism for preventing off-specification products and services from being delivered to customers is screening inspection, quality control measures lead to greater process control and a lower incidence of non-conformance.

Those organizations whose approach to the management of quality is based on inspection and quality control are operating in a detection-type mode (i.e. finding and fixing mistakes).

What is detection?

In a detection or 'firefighting' environment, the emphasis is on the product, procedures and/or service deliverables and the downstream producing and delivery processes; it is about getting rid of the bad things after they have taken place. Considerable effort is expended on after-the-event inspecting, troubleshooting, checking, and testing of the product and/or service and providing reactive 'quick fixes' in a bid to ensure that only conforming products and services are delivered to the customer. In this approach, there is a lack of creative and systematic work activity, with planning and improvements being neglected and defects being identified late in the process, with all the financial implications of this in terms

of the working capital employed. Detection will not improve quality but only highlight when it is not present, and sometimes it does not even manage to do this. Problems in the process are not removed but contained, and are likely to come back. Inspection is the primary means of control in a 'policeman'- or 'goalkeeper'-type role and thereby a 'producing' versus 'checking' situation is encouraged, leading to confusion over people's responsibilities for quality – 'Can I, the producer, get my deliverables past the checker?' It also leads to the belief that non-conformances are due to the product/service not being inspected enough and also that operators, not the system, are the sole cause of the problem.

A question which organizations operating in this mode must answer is: does the checking of work by inspectors affect an operator's pride in the job? The production–inspection relationship is vividly described by McKenzie (1989).

With a detection approach to quality, non-conforming 'products' (products are considered in their widest sense) are culled, sorted and graded, and decisions made on concessions, rework, reblending, repair, downgrading, scrap, and disposal. It is not unusual to find products going through this cycle more than once. While a detection-type system may prevent non-conforming product, services and paperwork from being delivered to the customer (internal or external), it does not prevent them being made. Indeed, it is questionable whether such a system does in fact find and remove all non-conforming products and services. Physical and mental fatigue decreases the efficiency of inspection and it is commonly claimed that, at best, 100 per cent inspection is only 80 per cent effective. It is often found that with a detection approach the customer also inspects the incoming product/service; thus the customer becomes a part of the organization's quality control system.

In this type of approach a non-conforming product must be made and a service delivered before the process can be adjusted; this is inherently inefficient in that it creates waste in all its various forms: all the action is 'after the event' and backward-looking. The emphasis is on 'today's events', with little attempt to learn from the lessons of the current problem or crisis. It should not be forgotten that the scrap, rework, retesting, reblending, etc. are extra efforts, and represent costs over and above what has been budgeted and which ultimately will result in a reduction of bottom-line profit. Figure 1.5, taken from the Ford Motor Company three-day statistical process control course notes (1985), is a schematic illustration of a detection-type system.

An environment in which the emphasis is on making good non-conformance rather than preventing it from arising in the first place is not ideal for engendering team spirit, co-operation and a good climate for work. The focus tends to be on switching the blame to others, people making themselves 'fireproof', not being prepared to accept responsibility and ownership, and taking disciplinary action against people who make mistakes. In general, this behaviour and attitude emanate from middle management and quickly spread downwards through all levels of the organizational hierarchy.

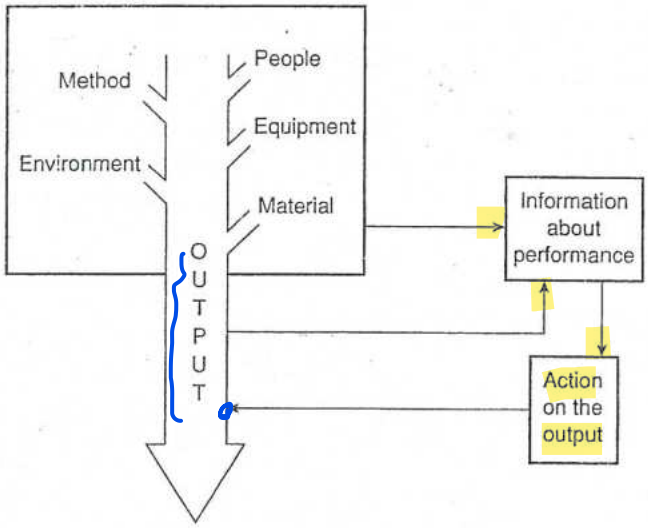


Figure 1.5 A detection-based quality system
Source: Ford Motor Company (1985)

Organizations operating in a detection manner are often preoccupied with the survival of their business and little concerned with making improvements.

Quality assurance

Finding and solving a problem after a non-conformance has been created is not an effective route towards eliminating the root cause of a problem. A lasting and continuous improvement in quality can only be achieved by directing organizational efforts towards planning and preventing problems from occurring at source. This concept leads to the third stage of quality management development, which is quality assurance:

> Part of quality management focused on providing confidence that quality requirements will be fulfilled. (BS EN ISO 9000 (2000))

Examples of additional features acquired when progressing from quality control to quality assurance are, for example, a comprehensive quality management system to increase uniformity and conformity, use of the seven quality control tools (histogram, check sheet, Pareto analysis, cause-and-effect diagram, graphs, control chart and scatter diagram), statistical process control, failure mode and effects analysis (FMEA), and the gathering and use of quality costs. The quality systems and practices are likely to have met, as a minimum, the requirements of the BS EN ISO 9001 (2000). Above all one would expect to see a shift in emphasis from mere detection towards prevention of non-conformances. In short,

more emphasis is placed on advanced quality planning, training, critical problem-solving tasks, improving the design of the product, process and services, improving control over the process and involving and motivating people.

What is prevention?

Quality assurance is a prevention-based system which improves product and service quality, and increases productivity by placing the emphasis on product, service and process design. By concentrating on source activities and integrating quality into the planning and design stage, it stops non-conforming product being produced or non-conforming services being delivered in the first place; even when defects occur they are identified early in the process. This is a proactive approach compared with detection, which is reactive. There is a clear change of emphasis from downstream to the upstream processes and from product to process (see figure 1.6); 'product out' to 'customer in'. This change of emphasis can also be considered in terms of the plan, do, check, act (PDCA) cycle. In the detection approach the 'act' part of the cycle is limited, resulting in an incomplete cycle, whereas, with prevention, act is an essential part of individuals and teams striving for continuous improvement as part of their everyday work activities. With

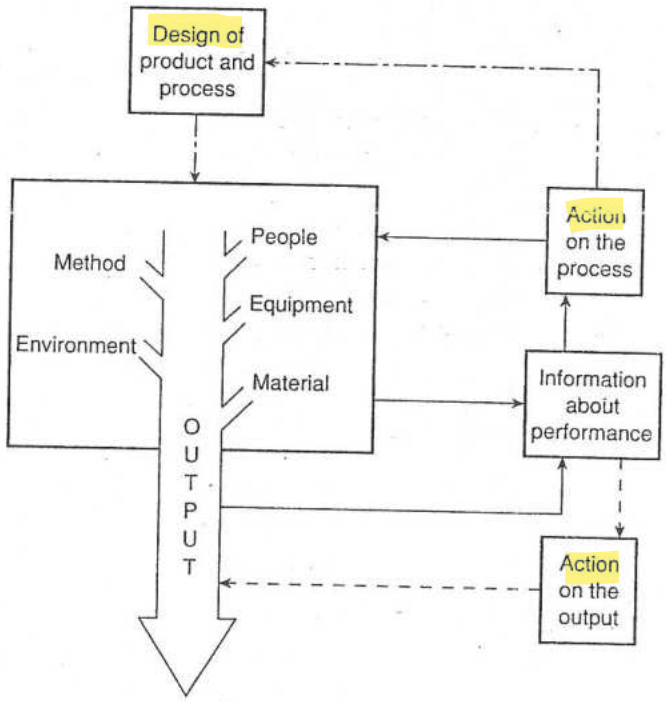


Figure 1.6 A prevention-based quality system
Source: Ford Motor Company (1985)

prevention there is a clearly defined feedback loop with both negative and positive feedback into the process, product, and service development system.

Quality is created in the design stage and not at the later control stage; the majority of quality-related problems are caused by poor or unsuitable designs of products and processes. In the prevention approach, there is a recognition of the process as defined by its input of people, machines, materials, method, management and environment. It also brings a clearer and deeper sense of responsibility for quality and eliminates the root cause of waste and non-value-adding activity to those actually producing and delivering the product and/or service.

Changing from detection to prevention requires not just the use of a set of tools and techniques, but the development of a new operating philosophy and approach which requires a change in management style and way of thinking. It requires the various departments and functions to work and act together in cross-functional teams to discover the root cause of problems and pursue their elimination. Quality planning and continuous improvement truly begin when top management includes prevention as opposed to detection in its organizational policy and objectives and starts to integrate the improvement efforts of various departments. This leads to the next level, that of total quality management.

Total quality management

The fourth level – TQM – involves the application of quality management principles to all aspects of the organization, including customers and suppliers, and their integration with the key business processes.

Total quality management requires that the principles of quality management should be applied in every branch and at every level in the organization with an emphasis on integration into business practices and a balance between technical, managerial and people issues. It is a company-wide approach to quality, with improvements undertaken on a continuous basis by everyone in the organization. Individual systems, procedures and requirements may be no higher than for a quality assurance level of quality management, but they will pervade every person, activity and function of the organization. It will, however, require a broadening of outlook and skills and an increase in creative activities from those required at the quality assurance level. The spread of the TQM philosophy would also be expected to be accompanied by greater sophistication in the application of tools and techniques, increased emphasis on people (the so-called soft aspects of TQM), process management, improved training and personal development and greater efforts to eliminate wastage and non-value-adding activities. The process will also extend beyond the organization to include partnerships with suppliers and customers and all stakeholders of the business. Activities will be reoriented to focus on the customer, internal and external with the aim to build partnerships and go beyond satisfying the customer to delighting them. The need to self-assess progress towards business excellence is also a key issue.

There are many interpretations and definitions of TQM. Put simply, TQM is the mutual co-operation of everyone in an organization and associated business processes to produce value-for-money products and services which meet and hopefully exceed the needs and expectations of customers. TQM is both a philosophy and a set of guiding principles for managing an organization to the benefit of all stakeholders. The eight quality management principles are defined in BS EN ISO 9000 (2000) as:

- *Customer focus.* Organizations depend on their customers and therefore should understand current and future customer needs, meet customer requirements and strive to exceed customer expectations.
- *Leadership.* Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.
- *Involvement of people.* People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.
- *Process approach.* A desired result is achieved more efficiently when activities and related resources are managed as a process.
- *System approach to management.* Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objective.
- *Continual improvement.* Continual improvement of the organization's overall performance should be a permanent objective of the organization.
- *Factual approach to decision-making.* Effective decisions are based on the analysis of data and information.
- *Mutually beneficial supplier relationships.* An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

The Key Elements of TQM

Despite the divergence of views on what constitutes TQM, there are a number of key elements in the various definitions which are now summarized. Other chapters will provide more detail of these elements.

Commitment and leadership of the chief executive officer

Without the total demonstrated commitment of the chief executive officer and his or her immediate executives and other senior managers, nothing much will happen and anything that does will not be permanent. They have to take charge

personally, lead the process, provide direction, and exercise forceful leadership, including dealing with those employees who block improvement and impetus. However, while some specific actions are required to give TQM a focus, as quickly as possible it must be seen as the style of management and the natural way of operating a business.

(2) Planning and organization

Planning and organization feature in a number of facets of the improvement process, including:

- Developing a clear long-term strategy for TQM which is integrated with other strategies such as information technology, production/operations and human resources and also with the business plans of the organization.
- Deployment of the policies through all stages of the organizational hierarchy with objectives, targets, projects and resources agreed with those responsible for ensuring that the policies are turned from words into actions (see chapter 8).
- Building product and service quality into designs and processes.
- Developing prevention-based activities (e.g. mistake-proofing devices).
- Putting quality assurance procedures into place which facilitate closed-loop corrective action.
- Planning the approach to be taken to the effective use of quality systems, procedures and tools and techniques, in the context of the overall strategy.
- Developing the organization and infrastructure to support the improvement activities. This includes allocating the necessary resources to support them. While it is recommended that some form of steering activity should be set up to provide direction and support and make people responsible for co-ordinating and facilitating improvement, the infrastructure should not be seen as separate from the management structure.
- Pursuing standardization, systematization and simplification of work instructions, procedures and systems.

(3) Using tools and techniques

To support and develop a process of continuous improvement an organization will need to use a selection of tools and techniques within a problem-solving approach. Without the effective employment and mix of tools and techniques it will be difficult to solve problems. The tools and techniques should be used to facilitate improvement and be integrated into the routine operation of the business. The organization should develop a route map for the tools and techniques which it intends to apply. The use of tools and techniques as the means will help to get the process of improvement started: employees use them feel involved and that they are

making a contribution, quality awareness is enhanced, behaviour and attitude change starts to happen, and projects are brought to a satisfactory conclusion.

Education and training

Employees, from top to bottom of an organization, should be provided with the right level and standard of education and training to ensure that their general awareness and understanding of quality management concepts, skills, competencies, and attitudes are appropriate and suited to the continuous improvement philosophy; it also provides a common language throughout the business. A formal programme of education and training needs to be planned and provided on a timely and regular basis to enable people to cope with increasingly complex problems. It should suit the operational conditions of the business: is training done in a cascade mode (everyone is given the same basic training within a set time-frame) or is an infusion mode (training provided as a gradual progression to functions and departments on a need-to-know basis) more suitable? This programme should be viewed as an investment in developing the ability and knowledge of people and helping them realize their potential. Without training it is difficult to solve problems, and, without education, behaviour and attitude change will not take place. The training programme must also focus on helping managers think through what improvements are achievable in their areas of responsibility. It also has to be recognized that not all employees will have received and acquired adequate levels of education. The structure of the training programme may incorporate some updating of basic educational skills in numeracy and literacy, but it must promote continuing education and self-development. In this way, the latent potential of many employees will be released and the best use of every person's ability achieved.

Involvement

There must be a commitment and structure to the development of employees, with recognition that they are an asset which appreciates over time. All available means, from suggestion schemes to various forms of teamwork, must be considered for achieving broad employee interest, participation and contribution in the improvement process; management must be prepared to share information and some of their powers and responsibilities and loosen the reins. This also involves seeking and listening carefully to the views of employees and acting upon their suggestions. Part of the approach to TQM is to ensure that everyone has a clear understanding of what is required of them, how their processes relate to the business as a whole and how their internal customers are dependent upon them. The more people who understand the business and what is going on around

them, the greater the role they can play in the improvement process. People have got to be encouraged to control, manage and improve the processes which are within their sphere of responsibility.

Teamwork

Teamwork needs to be practised in a number of forms. Consideration needs to be given to the operating characteristics of the teams employed, how they fit into the organizational structure and the roles of member, team leader, sponsor and facilitator. Teamwork is one of the key features of involvement, and without it difficulty will be found in gaining the commitment and participation of people throughout the organization. It is also a means of maximizing the output and value of individuals.

There is also a need to recognize positive performance and achievement and celebrate and reward success. People must see the results of their activities and that the improvements they have made really do count. This needs to be constantly encouraged through active and open communication. If TQM is to be successful it is essential that communication must be effective and widespread. Sometimes managers are good talkers but poor communicators.

Measurement and feedback

Measurement, from a baseline, needs to be made continually against a series of key results indicators – internal and external – in order to provide encouragement that things are getting better (i.e. fact rather than opinion). External indicators are the most important as they relate to customer perceptions of product and/or service improvement. The indicators should be developed from existing business measures, external, competitive and functional generic and internal benchmarking, as well as customer surveys and other means of external input. This enables progress and feedback to be clearly assessed against a roadmap or checkpoints. From these measurements, action plans must be developed to meet objectives and bridge gaps.

Ensuring that the culture is conducive to continuous improvement activity

It is necessary to create an organizational culture which is conducive to continuous improvement and in which everyone can participate. Quality assurance also needs to be integrated into all an organization's processes and functions. This requires changing people's behaviour, attitudes and working practices in a number of ways. For example:

- Everyone in the organization must recognize that whatever they do can be improved. They must be involved in 'improving' the processes under their control on a continuous basis and take personal responsibility for their own quality assurance.
- Employees must be encouraged to identify wastage in all its various forms to take out cost and get more value into a product or service.
- Employees can stop a process without reference to management if they consider it to be not functioning correctly.
- Employees must be inspecting their own work.
- Defects must not be passed, in whatever form, on to the next process. The internal customer–supplier relationship (everyone for whom you perform a task or service or to whom you provide information is a customer) must be recognized.
- Each person must be committed to satisfying their customers, both internal and external.
- External suppliers and customers must be integrated into the improvement process.
- Mistakes must be viewed as an improvement opportunity. In the words of the Japanese, every mistake is a pearl to be cherished.
- Honesty, sincerity and care must be an integral part of daily business life.

Changing people's behaviour and attitudes is one of the most difficult tasks facing management, requiring considerable powers and skills of motivation and persuasion; considerable thought needs to be given to facilitating and managing culture change. In the words of a government chief engineer in the Hong Kong civil engineering department, 'Getting the quality system registered to ISO 9001 is the easy bit, it is changing people's attitudes and getting them committed to continuous improvement that is presenting the greatest challenge.'

Summary: Developing TQM

In concluding this chapter a list of points is offered which organizations should keep in mind when developing TQM. Many of them are expanded upon in the chapters that follow.

Organizing

- There is no ideal way of assuring the quality of an organization's products or services. What matters is that improvement does occur, that it is cost-effective, and that it is never-ending.
- There is no one best way of starting a process of continuous improvement which suits all organizations and cultures.

- Senior management's commitment is vital in order to gain credibility, assure continuity and establish longevity of the process. They need to think deeply about the subject and commit to it the necessary resources. Managers must also place more emphasis on leadership and create an environment in which people can develop and apply, to full potential, all their skills.
- Planning should have a 10-year horizon in order to ensure that the principles of TQM are firmly rooted in the culture of the organization. Patience and tenacity are key virtues.
- Quality objectives and strategies must be developed and deployed down through the organizational hierarchy, along with agreeing goals for improvement.
- The improvement process needs to be integrated with other organizational improvement initiatives and business strategies.
- A multi-disciplinary TQM steering committee chaired by the chief executive must be established and appropriate infrastructure established to support the improvement process. It is important that this infrastructure is integrated into the existing structure.
- At the outset the main quality problems must be identified and tackled by the senior management team – 'lead by example'.

Systems and techniques

- The quality management system must be well documented, provide direction and feedback and be audited internally on a regular and effective basis.
- The day-to-day control and assurance activity must be separated from the improvement process.
- There must be a dedication to removing basic causes of errors and wastage.
- At the design stage all potential non-conformances must be identified and eliminated.
- A system by which all staff can raise those problems which prevent them turning in an error-free performance should be in place.
- It should be recognized that tools, techniques, systems, and packages are used at different stages in different organizations in their development of TQM.
- The timing of the introduction of a particular tool, technique, system or package is crucial to its success.
- Mistake-proofing of operations should be investigated.
- Statistical methods should be used.

Measurement and feedback

- It should be recognized that customer satisfaction is a business issue and that all processes should work towards satisfying the customer.

- All available means must be used to determine customer requirements and develop systems and procedures to assess conformance.
- It should be easy for the internal and external customer to complain. Ensure that all customer complaints are picked up and analysed, and that there is appropriate feedback.
- The attitude that 'the next process/person is the customer' must be encouraged.
- Measures of customer satisfaction and quality indicators for all internal departments must be developed.
- Regular self-assessment of the progress being made with quality improvement against the criteria of the Malcolm Baldrige National Quality Award for Performance Excellence (2005) and the EFQM excellence model (2006), or a similar model should be carried out. This will assist in making the quality improvement efforts more efficient and cost effective.

Changing the culture

- All aspects of customer and supplier relationships should be developed, improved and assessed on a regular basis.
- Teamwork must be practised at all levels.
- People must be involved at all stages of the improvement process, and not simply in those aspects which directly affect their role.
- Education and training should be continuous and widespread, in order to foster changes in attitudes and behaviour and to improve the skills base of the organization.
- Recognize that change is continuous and must be embedded in the culture of the organization.

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Chapter Thirteen

Quality Management Systems

B. G. Dale

Introduction

This chapter opens by examining the concept of quality assurance and the responsibilities of people within an organization for carrying out the activity. A quality system is defined and the background of quality system standards traced, the key features of the ISO 9000 series (1994) are examined, implementation guidelines and issues outlined, the quality system assessment and registration reviewed and the benefits and limitations highlighted. A model is also presented which outlines what is required for a small company to successfully achieve ISO 9000 series registration. Much has already been written about quality systems and standards (Dale and Oakland 1994; Davies 1997; Hall 1992; Jackson and Ashton 1993; Lamprecht 1992, 1993; Rothery 1993), and there are the standards themselves. This chapter is therefore restricted to an overview of the key features and issues.

What is Quality Assurance?

Quality assurance is defined in BS EN ISO 9000 (2000) as:

> Part of quality management, focused on providing confidence that quality requirements will be fulfilled.

Quality assurance is often regarded as discreet policing by the quality assurance department. This is not so. The ideal role of the department is to oversee the whole process of quality assurance within an organization, provide guidance, advice on the assignment of roles and responsibilities to be undertaken by each

function and person, and address weaknesses in the system. Quality assurance needs to be an integral part of all of an organization's processes and functions, from the conception of an idea and throughout the life-cycle of the product or service: determining customer needs and requirements, planning and designing, production, delivery and after-sales service.

The objective should be to get every person in the organization to take personal responsibility for the quality of the processes for which they are accountable. This includes treating following processes as 'customers' and endeavouring to transfer conforming products, services, materials and documents to them, monitoring quality performance, analysing non-conformance data, taking both short- and long-term action to prevent the repetition of mistakes, and promoting the feed forward and feedback of data. The emphasis should be on the pursuance of corrective and preventative actions and procedures and non-conformance investigation in a thorough manner with closed-loop effectiveness. It is also necessary for everyone to perform their tasks in accordance with their training, their procedures and as defined by the quality management system.

The main objective of quality assurance activity is to build quality into the product and/or service during the upstream design and planning processes and in this way give confidence to a customer that a product and/or service performs as they expect. Quality function deployment, FMEA, design of experiments, design reviews, design for manufacturability/assembly and quality audits are all part of an advanced product quality planning process, and of considerable assistance in the pursuance of this goal.

Quality assurance activity which is planned and managed along these lines will strengthen an organization's TQM efforts.

What is a Quality Management System?

A quality management system is defined in BS EN ISO 9000 (2000) as:

> a management system to direct and control an organization with regard to quality.

The purpose of a quality management system is to establish a framework of reference points to ensure that every time a process is performed the same information, methods, skills and controls are used and applied in a consistent manner. In this way it helps to define clear requirements, communicate policies and procedures, monitor how work is performed and improve teamwork.

Documentary evidence about the quality management system is fundamental to quality assurance and takes several forms.

- A company quality manual (sometimes called a level 1 document) provides a concise statement of the quality policy and quality management objectives as part of the company objectives. ISO 10013 (2001) provides useful guidelines on the development and preparation of quality manuals. A quality manual is defined in BS EN ISO 9000 (2000) as:

> a document specifying the quality management system of an organization.

A procedures manual (sometimes referred to as a level 2 document) describes how the system functions, gives the structure and responsibilities for each department/unit and details the practices to be followed in the organization.

2. Work instructions, specifications, methods of performance and detailed methods for performing work activities for a third level of documents.
3. In addition there is often a database containing all other reference documents (e.g. forms, standards, drawings, reference information, supplier list, etc.).

The quality management system documentation helps to ensure that employees know what they should be doing, along with the appropriate means for doing it. It also provides evidence to those who wish to assess the system.

The quality management system should define and cover all facets of an organization's operation, from identifying and meeting the needs and requirements of customers to design, planning, purchasing, manufacturing, packaging, storage, delivery, installation and service, together with all relevant activities carried out within these functions. It deals with organization, responsibilities, procedures and processes. Put simply, a quality system is good management practice.

A quality management system, if it is to be comprehensive and effective, must cover all these activities and facets and must be developed in relation to the corporate strategy of the company. The system developed can be tested against a reference base and improvements made. This reference base is a 'quality management system standard' which describes demonstrable features or conditions that are assessable. An organization's quality management system is usually assessed by the customer (known as second-party certification) or by a party which is independent of the customer and organization (known as third-party certification). It is usual to certify that the system conforms to a specific quality management system standard (e.g. ISO 9001) and whether the system is fully implemented and effective. This process is known as certification.

A quality management system which embraces quality management objectives, policies, organization and procedures, and which can demonstrate, by assessment, compliance with ISO 9001 or that of a major purchaser, provides an effective managerial framework on which to build a company-wide approach to a process of continuous improvement.

The Development of Quality Management System Standards

Irrespective of the approach taken to TQM and the quality management maturity of the organization, a business may need to demonstrate to customers that its processes are both effective and under control and that there is effective control over procedures and systems. The pressure for proof that systems and procedures are in place, and working in an effective manner, led to the demand for quality assurance based on the development of quality management system standards. The origins of this can be traced back to the 1950s when the US Department of Defense and the UK Ministry of Defence saw a need for greater reliability in purchased products and a reduced reliance on customer or purchaser inspection as the main assurances of quality.

The early standards were contractual requirements by major purchasers of their suppliers. Such standards were customer- and sector-specific and designed to be used in contractual situations in the industries for which they were designed and in which they operated; the standards had a strong bias towards internal quality control, which was primarily inspection. Many purchasers developed their own requirements and methods of assessment, which involved visiting the supplier to examine the degree to which their operating procedures and systems followed their requirements. This method of assessment is called second-party certification.

The current quality management system standards evolved from military standards, for example, the American Military Standard MIL-Q-9858(a), the North Atlantic Treaty Organization (NATO) Allied Quality Assurance Publications (AQAPs), and nuclear and power industry requirements such as the Canadian Standards Association (CSA) CSA-Z299. There had also been a considerable contribution to formalized quality assurance procedures by NASA, the controlling body for the American space programme, the Polaris submarine programme and the nuclear power-generating industry. There has been considerable co-operation between America, Canada and Britain in relation to quality system development.

The UK defence standard for quality systems was first published in 1973 by the Procurement Executive of the Ministry of Defence (MOD) – the DEF-STAN 05-21 series. This was a result of its change in policy on the acceptance of contractor-manufactured product. The previous acceptance policy of the MOD involved inspecting the manufactured product by its own team of inspectors. This policy required considerable resources involved with the inspection and the paperwork associated with contract release forms. These standards were virtual copies of the American-derived NATO AQAPs used by NATO in defence procurement, which were based on MIL-Q-9858(a). The AQAP standards (AQAP 1–14) addressed the problem of achieving consistency and total product interchangeability in the supply of standardized weapons and ammunition coming from many different suppliers and intended for the different national military units which

make up NATO. The MOD used the DEF-STAN O5-21 series to approve potential suppliers and audit current suppliers in contractual situations. It was a requirement that a supplier developed their quality management system to meet the clauses set out in these standards for them to be included on the MOD defence contractors list. These standards made the contractor responsible for the quality and reliability of his product; they became the basis for contracts with the MOD from April 1973. One principle is that the prime contractors must conduct assessments of their own suppliers in line with the requirements of these standards. The O5-21 series was withdrawn in 1985 and MOD assessments were carried out using the similar AQAP standards. From September 1991, the MOD has, in the main, relied on third-party assessment against the ISO 9000 series of standards. This type of situation relates to specific military applications such as aircraft construction, ammunition and explosives, packaging and software. A new set of defence standards (the 05–90 series, 05–91 to 05–95), which includes the ISO 9000 series plus special military purchase requirements, is used to assess suppliers in contractual situations.

In 1972 the British Standards Institution (BSI) published BS 4891 (1972), *A Guide to Quality Assurance*, which set out guidance to organizations on quality and its management, and was intended as a guide to companies developing their quality management systems; this standard was withdrawn in 1994. This was followed in 1974 by the issue of BS 5179, which was a three-part standard *A Guide to the Operation and Evaluation of Quality Assurance Systems*; this standard was withdrawn in 1981 after being superseded in 1979 by the first issue of BS 5750.

During the mid-1970s there was a proliferation of quality system standards produced by a variety of second- and third-party organizations. The Warner report (1977), *Standards and Specifications in the Engineering Industries*, stressed the need for a national standard for quality management systems, to reduce the number of assessments to which suppliers were being subjected by their customers. It pointed to the shortcomings and fragmented nature of the British system of standards. It was recommended that British Standards be produced to provide the single base document for quality systems. Subsequently, in 1979, the British Standards Institution issued the BS 5750 series of quality management system standards.

It was the British Standards Institution which formally proposed the formation of a new technical committee (ISO/TC 176) to develop international standards for quality assurance, techniques and practices (this committee is responsible for developing and maintaining the ISO 9000 family of standards). Some 20 countries originally participated in the development of what was to become the ISO 9000 series. In 1987 the series of international standards on quality management systems was first published by the International Organization for Standardization (ISO; a federation of some 140 countries' national standards institutes). This initial version of the standards, while reflecting various national approaches and international requirements, was based largely on the 1979

version of the BS 5750 series and the eight or so years of UK user experience, mainly in manufacturing industry, and the Canadian CSA Z299 series. The text of these international standards was approved as suitable for issue as a British Standard with dual numbers – BS 5750: Parts 0 to 3 (1987) and extended in 1991 to services and software as Parts 8 and 13 (1991), but these were as guidance-only documents.

The ISO 9000 series was adopted by CEN (the European Committee for Standardization) and CENELEC (the European Committee for Electrotechnical Standardization) as the EN 29000 series, thus harmonizing the approach to quality systems in the European Community, the standard at this stage having three numbers: national, European and international. It has perhaps had the most significant and far-reaching impact on international standardization of any set of standards. An excellent account of the historical background of the ISO 9000 series is provided by Spickernell (1991).

The ISO 9000 series has been revised on the basis of international implementation experience and was reissued in summer 1994. This revision was meant to be interim, involving minor changes pending a full revision (ISO standards are meant to be reviewed and, if necessary, revised every five years). All ISO standards go through at least three phases – working draft (WD), committee draft (CD) and draft international standard (DIS) – during their development. This process aims to get as much feedback as possible from users. Drafts at any stage can be circulated many times until the required consensus is reached. The phase 1 minor revisions (1994) were undertaken with the aim that no new requirements should be introduced, and that the standards should be clarified to aid implementation and assessment and to remove internal inconsistencies. The second and more thorough set of revisions in the 2000 version has seen a major rewrite which has enhanced the existing standards by including requirements for concepts typically associated with TQM and continuous improvement. The standards, which are now more in-depth, represent a business-oriented approach and will be more demanding for many organizations.

Government initiatives

In July 1982 a UK government White Paper was published on standards, quality and international competitiveness which triggered a National Quality Campaign and suggested that, to maintain standards, more independent certification should be encouraged and that accreditation by a central agency would uphold the standards of certification bodies. The National Accreditation Council for Certification Bodies (NACCB) was set up in June 1985 by the Department of Trade and Industry as the national statutory body with the task of assessing the independence, integrity and technical competence of any certification bodies applying for government accreditation in four areas: approval of quality systems,

product conformity, product approval, and approval of personnel engaged in quality verification. At the same time the National Measurement Accreditation Service (NAMAS) was set up to register laboratories and test houses. NAMAS was formed by the amalgamation of the British Calibration Service (BCS) and the National Testing Laboratory Accreditation Service (NATLAS), also in 1985, and both parts of the Civil Service. In August 1995 and in response to market demand, NACCB and NAMAS merged to create a single accreditation authority – the United Kingdom Accreditation Service (UKAS), which is recognized and promoted by the DTI. The objective is to bring economies of scale and improved efficiency to UK accreditation. Accreditation allows a certification body to demonstrate its competence and independence. The accreditation of certification bodies by UKAS is to enhance mutual recognition of test results and certification among those certification bodies operating to an agreed set of principles and methodologies. UKAS is also subjected to assessment by similar bodies elsewhere in the world for multilateral recognition with other accreditation bodies.

To be eligible for accreditation, third-party certification bodies are required to meet criteria outlined in three European (CEN) standards, available in the UK as British Standards, based on the European EN 45000 series for certification bodies issuing certificates of product conformity; for certification bodies certificating that suppliers' quality systems comply with appropriate standards, normally BS EN ISO 9001, 9002 and 9003; and for certification bodies certificating the competence of personnel. These standards will be incorporated into International Standards, as ISO already have guides such as ISO 62 and ISO 25.

This set of standards helps to promote confidence in the way in which product and quality system certification activities are performed and in the accreditation systems and bodies themselves. From the accreditation granted it will be clear whether the certification body is accredited for quality system assessment only, and in which fields, or whether it has the additional qualification of being accredited to certificate conformity of product.

Those companies which have been assessed by an accredited certification body can use the symbol of the Royal Crown if the scope of the certification applied for falls within the scope of accreditation of the accredited certification body. The use of this Royal Crown lends authority and assurance. This is known as the National Accreditation mark. However, there is a degree of independent accreditation and, in the UK, a number of certification bodies are registered with the Accreditation Service for Certifying Bodies, providing an alternative to UKAS. International accreditation is now well established through the International Accreditation Forum (IAF) and a range of mutual recognition agreements (MRAs). The aim is for audit, certification and accreditation to be accepted across the world.

The Department of Trade and Industry, through the National Quality Campaign initiated as a result of the 1982 White Paper, and its 'Managing into the 1990s' programme, actively encouraged British industry to consider its approach

to quality management more seriously; one of the methods advocated is registration with the BS EN ISO 9000 quality management system series. They issue a central register of quality-assured companies. This register lists the firms whose quality management system has been approved by major users or independent third-party assessment bodies, which means the investigation is done by an independent organization, unrelated to buyer or seller. It also identifies the assessment standard used – the BS EN ISO 9000 series or its equivalent -- and details of the certification body.

ISO 9000 is a set of international standards that define quality management systems, while QS 9000 is a quality management system standard used in the automotive industry.
ISO 9000 focuses on customer satisfaction and continuous improvement, while QS 9000 includes additional requirements like product planning, design, and development.
ISO 9000 certification applies to various industries, while QS 9000 certification is designed for the automotive industry.

Acceptance of the ISO 9001 series of standards

The set of requirements outlined in ISO 9001 can be supplemented for specific industries or products by 'quality assurance specifications', 'ISO guidance notes and codes of practice' which provide more detail.

The Chrysler Corporation, Ford Motor Company and General Motors Corporation (the so-called 'Big Three') have produced a common quality system assessment standard ('QS 9000') which is an industry-specific scheme. This standard, on which development work started in 1988, was first released in August 1994, with a world-wide version in February 1995. It harmonizes the separate quality system standard requirements of these three companies and will reduce the current level of duplication in terms of information requested from suppliers leading to economic advantage. These three organizations have had comprehensive quality assurance systems in place at their sites for some considerable time, and have required suppliers to meet the standards of these systems. They view this as a platform to enhance the quality and performance of their suppliers. The first section of QS 9000 aligns itself with the elements of ISO 9001. This industry standard has recently been incorporated into the ISO network and issued as ISO TS 16949. The following are some examples of the prescriptive requirements:

- Advanced product quality planning shall be in place, supported by a multi-disciplinary approach for decision-making.
- Trends in quality, operational performance, current quality levels and customer satisfaction shall be determined and documented. These should be compared by competitive analysis and/or benchmarking and be reviewed by management.
- Failure mode and effects analysis shall be used.
- Capability studies are mandatory and minimum capability indices are stipulated.

The second (sector-specific) section contains additional but common and harmonized requirements of Chrysler, Ford and General Motors covering the production part approval process, continuous improvement, identification of key product and process parameters, process capability performance and measurement system studies on product and process parameters, and development of

control plans. Sixteen typical examples are cited of areas of such activities, together with 14 techniques/methodologies to support them. The third section addresses customer-specific additional and non-general requirements.

QS 9000 was initially confined to the first-tier suppliers of manufacturing plants in the US, but its implementation has spread world-wide and down the supplier chain. Registration to QS 9000 has now become the norm in the automotive industry.

Other similar sector-specific derivatives of ISO 9001 include TL 9000, which is the world's first quality system metrics for the global telecommunications industry developed and managed by the Quality Excellence for Suppliers of Telecommunications Forum and AS 9000 in the aviation and aerospace industry. The ISO has a policy and commitment to sector versions of ISO 9001 where a need is demonstrated.

Registration to ISO 9001 is a useful foundation leading to the development of a quality system to meet the independent system requirements of customers. A number of major purchasers use this registration as the 'first pass' over a supplier's quality system. They will take ISO 9001 as the base, and only assess those elements of the system which they believe are particularly sensitive to them as purchasers (e.g. those clauses which are not covered in the ISO 9000 series – customers often require the supplier to have additional features to the series supplanted within the system or those clauses without sufficient detail amended to the satisfaction of the customer).

In 1993 Dr John Symonds (internal consultant for environment, health and safety, and quality of Mobil Services Company) launched the first world-wide survey of ISO 9000 certificates issued in different countries by independent quality system certification bodies. The International Organization for Standardization has taken over responsibility for this annual survey, which has been extended to cover the ISO 14000 environmental management systems standards. The survey report details world, regional and country breakdowns of registrations and also industry-sector breakdown by country. The thirteenth cycle of the survey (ISO 2005) shows that up to the end of 2005 at least 776.608 ISO 9000 certificates had been awarded in 161 countries. The survey also shows that in the same time-frame at least 111.162 ISO 14000 certificates had been awarded in 138 countries. The trend in registrations is upwards.

The ISO 9000 Series of Standards: An Overview

Introduction

In simple terms, the objective of the ISO 9000 series is to give purchasers an assurance that the quality of the products and/or services provided by a supplier meets their requirements. The series of standards defines and sets out a

definitive list of features and characteristics which it is considered should be present in an organization's management control system through documented policies, manual and procedures, which help to ensure that quality is built into a process and is achieved. Amongst other things it ensures that an organization has a quality policy, that procedures are standardized, that defects are monitored, that corrective and preventative action systems are in place, and that management reviews the system. The aim is systematic quality assurance and control. It is the broad principles of control, in general terms, which are defined in the standards, and not the specific methods by which control can be achieved. This allows the standard to be interpreted and applied in a wide range of situations and environments, and allows each organization to develop its own system and then test it against the standard. However, this leads to criticisms of vagueness.

The series of standards can be used in three ways:

- Provision of guidance to organizations to assist them in developing their quality systems
- As a purchasing standard (when specified in contracts)
- As an assessment standard to be used by both second-party and third-party organizations

Functions of the standards and their various parts

The ISO 9000 family of standards consists of four primary standards: ISO 9000, ISO 9001, ISO 9004 and ISO 19011:

- ISO 9000: Quality Management Systems: Fundamentals and Vocabulary
- ISO 9001: Quality Management Systems: Requirements
- ISO 9004: Quality Management Systems: Guidelines for Performance Improvement
- ISO 19011: Guidelines on Quality and Environmental Auditing

The standards have two main functions. The first function identifies the aspects to be covered by an organization's quality system and gives guidance on quality management and application of the standards. The second function defines in detail the features and characteristics of a quality management system which are considered essential for the purpose of quality assurance in contractual situations.

ISO 9000 outlines the fundamentals of quality management systems and provides the definitions of the key terms used in ISO 9001 and ISO 9004.

ISO 9001 presents quality management system requirements applicable to all organizations' products and services. It is used for demonstrating system

compliance to customers, for certification of quality management systems, and as the basis for contractual requirements. It requires the following:

- A detailed documentation of quality requirements, processing steps and results.
- Implementation of a set of controls to maintain the system.
- Compliance with the requirements of the 22 sub-elements.

ISO 9004 is a quality management system guidance specification that embraces a holistic approach to performance improvement and customer satisfaction.

ISO 9001 and ISO 9004 are based on a process model that uses the following eight quality management principles that reflect best practice:

- Customer focus
- Leadership
- Involvement of people
- Process approach
- System approach to management
- Continual improvement
- Factual approach to decision-making
- Mutually beneficial supplier relationship

These two standards employ common vocabulary and structure to facilitate their use and are intended to be used together by organizations wishing to develop their systems beyond the minimum requirements of ISO 9001.

ISO 19011 will provide guidance on managing and conducting environmental and quality activities. This standard combines the quality system auditing standard (ISO 10011: Parts 1 to 3) with the environmental system audit standards (ISO 14010, ISO 14011 and ISO 14012).

Principal elements of ISO 9001

The format of the new standard has now just five requirement clauses rather than the 20 of the 1994 version. However, while there are some additional and important requirements in the new standard, all the 20 clauses in the 1994 version can be recognized.

The five main elements are:

1 *Quality management system*
   - General requirements ('The organization shall establish, document, implement and maintain a quality management system and continually

improve its effectiveness in accordance with the requirements of this international standard' – BS EN ISO 9001 (2000))
- Documentation requirements

2 *Management responsibility*
- Management commitment
- Customer focus
- Quality policy
- Planning
- Responsibility, authority and communication

3 *Resource management*
- Provision of resources
- Human resources
- Infrastructure
- Work environment

4 *Product realization*
- Planning of product realization
- Customer-related processes
- Design and development
- Purchasing
- Production and service provision
- Control of monitoring and measuring devices

5 *Measurement, analysis and improvement*
- General ('The organization shall plan and implement the monitoring, measurement, analysis and improvement processes needed: (a) to demonstrate conformity of the product; (b) to ensure conformity of the quality management system and (c) to continually improve the effectiveness of the quality management system' – BS EN ISO 9001 (2000))
- Monitoring and measurement
- Control of non-conforming product
- Analysis of data
- Improvement

The set of requirements outlined in ISO 9001 can be supplemented for specific industries or products by 'quality assurance specifications', 'quality assurance guidance notes' and 'codes of practice' which provide more detail in their form as sector guides.

It is worth mentioning that ISO 14001 (2004) *Environmental Management Systems: Specification with Guidance for Use*, shares many management principles with the ISO 9000 series. The 2000 revision of ISO 9001 has ensured closer compatibility and synergy with the ISO 14001. A number of organizations are considering how they may develop their quality management system as a basis for environmental management: see Wilkinson and Dale (1999) and chapter 14.

Implementation Guidelines for ISO 9001

At this point in the chapter it is useful to quote the guidelines, with some development by the author, advanced by Long et al. (1991), based on their research into the application and use of the ISO 9000 quality system series in small and medium-sized enterprises; the guidelines are also applicable to larger organizations.

- An organization should be clear on the reasons for seeking ISO 9001. Implementation for the wrong reasons will prevent the organization from receiving the full benefits. In addition, it may be found that implementing and maintaining the requirements of the chosen standard is a burden in terms of costs and extra paperwork with no compensating benefits. ISO 9001 registration must therefore not be sought just to satisfy the contractual requirements of major customers or for marketing purposes. Indeed when most competitors have ISO 9001 registration there is little marketing advantage, and in many markets it is now a qualifying criterion.
- The development of a quality management system to meet the requirements of ISO 9001 should be managed as a project, with the identification of key steps, milestones and time-scales. This will prevent progress being sporadic and variable.
- Prior to a programme of ISO 9001 implementation it is important that an internal quality audit is conducted of the existing quality management system by a qualified auditor. This will determine the initial status of the company's quality management system, enable management to assess the amount of work required to meet its requirements and also to plan for systematic implementation of the standard (i.e. a gap analysis). Without this knowledge the project-planning process mentioned above would be impossible. It is important that a realistic timetable is established, because if it is too tight there will be a tendency to do things artificially and this will result in considerable time spent later in debugging the system. On the other hand, if it is too relaxed there may be a tendency to do little in the initial period. Involvement of the appointed management representative during the quality audit is essential.
- For those organizations developing a quality management system for the first time a steering committee should be established comprising all the heads of departments and chaired by the CEO. This type of representation is essential to gain cross-functional support for the project and to help ensure the smooth development and implementation of the system. Participation and commitment from all the heads of department is essential in order to gain employee support for the project, and this will help to ensure the smooth implementation and subsequent maintenance of the standard. In extremely small companies where there is little or no second-tier management

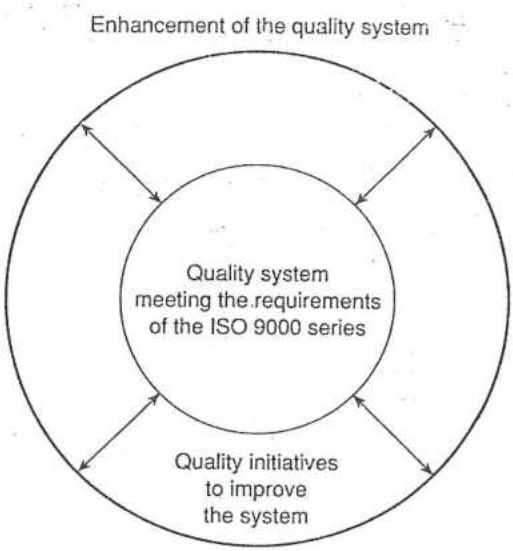


Figure 13.1 Quality system development

the whole-hearted commitment and involvement of the CEO is critical and essential.

- ISO 9001 should be considered as the minimum requirement. Without a documented quality management system there is neither basis nor connected reliable data to monitor the process of quality improvement. Organizations should, however, aim to have a quality system which surpasses the standard's requirements, with new quality initiatives built into the system, as illustrated in figure 13.1 (this is the objective of ISO 9004). A quality management system which meets the requirements of ISO 9001 should in no sense be regarded by senior management as the pinnacle of their quality management achievements. All it says to the outside world is that the organization has controls, procedures and disciplines in place. The organization should treat ISO 9001 registration as a precursor to developing its approach to TQM.
- There is a need to create a conducive environment for the development of a quality management system which meets the requirements of ISO 9001. This can be achieved by the formulation of organizational quality policy and quality objectives. The responsibility of executives in the establishment, maintenance, and development of an ISO 9001 system cannot be over-emphasized. The leadership of senior management and their total commitment to the process of quality system registration to ISO 9001 are vital: it is only they who can deliver the resources and co-operation of appropriate personnel and provide the necessary direction. The CEO, while accepting ultimate responsibility, has, as one would expect, to delegate a variety of tasks. Senior management must not only understand the principles of the ISO 9000 series

but should ensure that the quality policy is implemented and understood by all employees, and that everyone in the organization has quality improvement objectives for their jobs. They also need to react positively to the actions resulting from quality audits.

- Training at all levels within the company is required on the importance of product and service quality in general, and the reasons for the quality system and its benefits in particular. This will help to facilitate the right type of behaviour, attitude and values of employees towards the ISO 9000 series and will encourage total participation. It not only provides the opportunity to answer any questions which employees may have about the standard and the process and the reasons for registration; a systematic approach to quality, education and training will also reduce resistance to change and other obstacles. An element of this awareness can occur if the initial audit is well explained and sympathetically carried out, explaining the reasons for recommendations.
- Once all the above steps have been taken the organization is in a position to commence developing its system to meet the requirements of ISO 9001. Accurate procedures, including operating and working instructions, are required. These procedures must be practical, workable and easily implemented. Wherever possible, they should document what employees are currently doing; they are then most likely to continue in the same way, enabling assessment requirements to be met naturally. Only where the standard would suggest that some modification is required should it be introduced. In writing procedures it is worthwhile to keep in mind how to demonstrate to the auditor that the ISO 9001 requirements have been fulfilled. In simple terms this can be condensed into three principles:
  - Write down what you do
  - Do what you have written down
  - Be in a position to prove it
- 'Ownership' of the procedure is important as personnel who are given responsibilities for writing the procedures must be familiar with the requirements of the ISO 9000 series and be fully conversant with the procedures they are drafting. The use of consultants and management specialists to write procedures is undesirable as they are unlikely to understand fully the 'style' of the company. It is often found that when procedures are written in isolation and then pushed into the working environment as required mandates, it leads to two main problems. Initially there is the problem of changing the way that people work without any perceived gain and benefit. Secondly a formal assessment of the system may reveal differences between what is written and what is actually done. Also with respect to this, it is helpful to document a procedure before trying to improve it, unless the change is easy to make. The use of others to write procedures does not allow for the positive factor of employee involvement and the related communication issues,

and the 'ownership' of the processes by those operating them is lessened. This also happens when there is an over-use of technological aids in producing the procedures. The procedures as they are being developed and/or documented need to be checked to see that they meet the requirements of ISO 9001 and how they impact on other procedures, systems and activities.

- The quality management system must become an integral part of the management process. When it is treated in this way it will ensure that business improvements are incorporated into the system.

Quality Management System Assessment and Registration

When the organization has endorsed its process controls, written the necessary procedures and instructions, and developed its system to meet the requirements of ISO 9001 for which registration is sought, the following key activities need to be accomplished.

- Train and educate staff in the workings and operation of the system and test out the procedures which have been developed. Education and training is a key element for people following procedures, completing the appropriate documentation, taking corrective action seriously, providing timely and accurate information and being aware of what their responsibilities are. The internal audit process must identify any non-conformity with the procedures. In some companies, plans for training are supplemented by people's involvement, for which departmental achievements are rewarded. For example, snapshots of audit requirements undertaken by an implementation team and recognition of performance given by rewards such as mugs, writing blocks, pens, etc.
- It may be beneficial to arrange for a pre-assessment of the system to be carried out by the selected certification body.
- Decide the most appropriate time to go for assessment.
- ISO 9001 registration is conferred by certification bodies who have, in turn, been accredited in the UK by UKAS. The list of accredited certification bodies should be consulted and a 'supplier audit' of them carried out. It is important to establish the scope of the certification body's approval, its fee structure, relevant experience and knowledge in the organization's field of work, reputation, current workload, etc. Goodman (1997) and the British Quality Foundation (BQF) (1997) have published guidance on choosing a certification body, which serves as a useful checklist. In addition to specifying how to conduct the search for a certification body the BQF provides considerable detail on five factors in making this selection, namely cost, scope, sector or general, credibility of the certification body and comfort factors.

- Upon completion of the necessary forms, the chosen certification body will provide a quotation and details of fees. After agreeing a contract, the appropriate documentation is then sent to the certification body to check initial compliance against the standard. In general, a certification body will usually want to see proof that the quality system has been in effective operation for a period of six months. However, this depends on the size of the company and the maturity of its quality management system.
- If the documentation is acceptable as it stands, some certification bodies proceed to the on-site assessment for a preliminary review (pre-audit assessment). At this stage, the company is able to make appropriate modifications and establish corrective actions to take account of the assessors' initial findings and comments.
- The formal assessment involves an in-depth appraisal of the organization's quality management system for compliance with the appropriate part of the standard (see ISO 19011). This is carried out by a small team of independent assessors appointed by the certification body and generally under the supervision of a registered lead assessor, although increasingly for the smaller enterprise only one assessor is used. If the assessors discover a deviation from the requirements or identify a non-conformity with the procedures, a non-conformity report is raised. At the end of the assessment, the non-conformities are reviewed and the assessors make a verbal report to management with their recommendation. The recommendation can be unqualified registration, qualified registration or non-registration. Any non-conformity with the appropriate part of the standard or within the company's system must be rectified, within a prescribed time, before approval is given.
- Once the organization is registered the certification bodies have a system of routine surveillance. The frequency of these surveillance visits varies with the certification body but is generally twice a year. The certification body has the right to make these visits unannounced but rarely does so. The registration usually covers a fixed period of three years, subject to the successful surveillance visits. After three years a quality system reassessment is made. However, the main approach these days is continuous assessment during the surveillance visits. Continuing assessment is planned so that the cumulative effect over a three-year cycle is a complete audit of the quality system. This not only reduces the cost of registration but also minimizes the inconvenience caused to the organization. The continued registration is confirmed in writing following the site visit.

Long et al. (1991), from their research into the implementation of ISO 9001 by organizations, have identified four factors that determine the time taken:

1 The status of the quality management system prior to seeking registration. This status is determined by the presence or otherwise of activities which are

in accordance with one of these three standards and their existence in a documented form. When few activities are in place and/or activities are not documented then more time is required first to document and then to develop the system to meet the appropriate requirements.

2 The complexity of the company in terms of work locations, products manufactured, services offered, type of production and the type and number of production processes and operating instructions. With increasing complexity more procedures and work instructions are required to be documented.

3 The priority given by management to implementing the requirements of the standard and the time they are prepared to set aside for the activity from their normal day-to-day work responsibility affects the progress of implementation. This is especially the case when there are no full-time personnel responsible for quality assurance.

4 A conducive environment is required for the implementation and development of the standard. Resistance to change, lack of understanding about product and service quality and poor attitudes among employees to quality improvement are major obstacles in implementing the requirements of the chosen standard.

ISO 9000 Series Registration: A Model for Small Companies

McTeer and Dale (1996) have developed a model which outlines what is needed for a small company to successfully achieve ISO 9001 registration. The model, which is shown in figure 13.2, consists of the domains of motivation, information, resources and planning; by examining the interaction between them it highlights how progress towards ISO 9001 registration can be enhanced or diminished. The dynamics of the model require that the four domains are raised from their latent state through internal and external motivations. As the factors inflating or deflating the domains strengthen or weaken, so the rate of progress towards installing a quality management system to meet the requirements of ISO 9001 increases or decreases. It is argued that progress by a company towards ISO 9001 registration is only made when the demands of motivation, information and resources occlude. The union of only two domains is insufficient to generate sufficient momentum to promote progress towards registration, and if all the domains are sufficiently deflated the progress to ISO 9001 is halted. Drawing on the paper by McTeer and Dale (1996) the model is now described.

Motivation

In a small company's journey from a primitive quality management system to attaining registration to ISO 9001, the degree of motivation can be regarded as

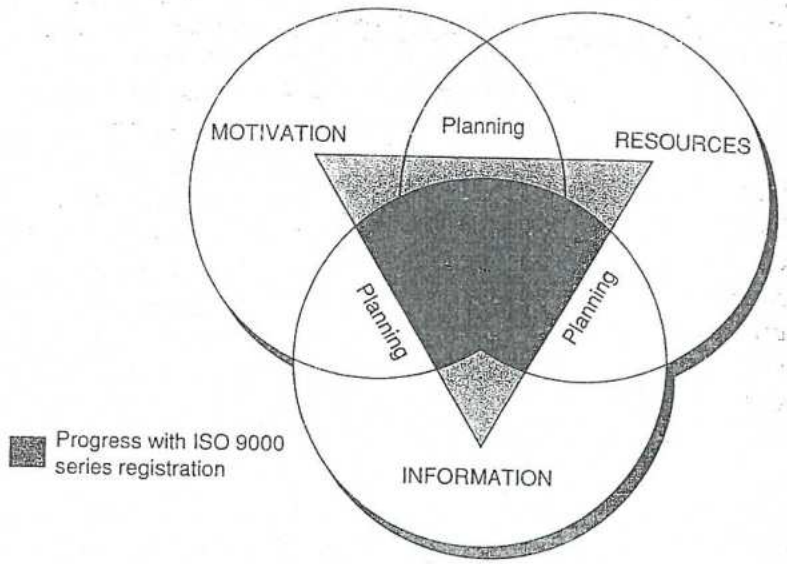


Figure 13.2 An active quality management system regime
Source: McTeer and Dale (1996)

the most important driving force. The degree of motivation can be influenced, both positively and negatively, by internal and external factors. The most powerful motivating force is demand from customers, in particular large ones, for registration and the fear of losing orders; this ensures that the momentum to introduce an ISO 9001 quality management system is maintained. Head office pressure and the impact of senior management are also factors influencing the degree of motivation, for example in making appropriate resources available. The motivation is also affected by employee attitudes and behaviour. Antagonism or apathy from employees towards the company's endeavours to obtain ISO 9001 registration make it difficult to progress quality management system development.

In addition to the primary forces there are a number of secondary forces, including the enhancement of company status in the marketplace, the urge to gain a commercial advantage, and advertising opportunities.

Information

As well as educating the company's quality management system champion to the requirements of ISO 9001, education and training on quality management system principles and practices must also be given to apprise the workforce of what is required from it. This can help to alleviate or avoid many of the problems associated with the acceptance of new working procedures, practices and disciplines. The solution for many companies is to employ management consultants to ensure that the detailed requirements of developing an ISO 9001 system are

achieved, and this can help to overcome many of the problems of comprehending the requirements of the standards. By strengthening the reservoir of quality management knowledge the quality management system champion is better able to communicate effectively with their consultant and better placed to understand the problems and pitfalls of introducing a quality management system. In this way delays in the process of documenting the system, nugatory work and over-documented and bureaucratic quality manuals can be avoided.

If a company is already able to build upon established quality assurance and quality control procedures (no matter how basic) this also helps to speed things up. Failure to raise the level of quality awareness and understand the demands of ISO 9001 leads to confused, frustrated and neglected employees and poorly briefed managers who will tend to restrict the progress towards registration.

Resources

Three resources are significant: time, finance and availability of personnel.

In failing to make or allocate time to the process of introducing a quality management system, programmes will slip, leading to suspension or abandonment as other more urgent tasks appear and take precedence. Time and the availability of personnel are closely coupled. If the quality management system champion is able to delegate work to staff or a management consultant, time pressures can be eased. Extra resources devoted to the development of a quality management system are also instrumental in increasing the pace of progress.

In small companies there is usually little slack time available in the owner's or managing director's day-to-day work activities to dedicate to the development of a quality management system. Further, there is a shortage of staff time to assist in this process and the problem becomes more acute as the number of employees in the company diminishes. Unless compensated by a greater stimulus to produce a quality management system, a lack of time or conflicting priorities will delay or lead to termination of progress. Also for many small companies the budgeting for the process of introducing and then maintaining an ISO 9001 system requires some minor restructuring of finances.

Planning

Planning is crucial to the successful introduction of an ISO 9001 system. Only by formulating a sensible plan which details a timetable of achievable events, milestones and target dates will a company succeed in this objective. This includes recognizing the need for education and training, additional skills, the use of external resources and, in some cases, the need to apprise company employees of the need for ISO 9001 registration. This domain is seen as both the magnet

which draws the motivation, information and resources domains together and the glue that binds them.

Only by drawing together motivation, information and resources can progress be made towards the installation of a quality management system to meet the requirements of the ISO 9001. Figure 13.2 illustrates the situation where the progress of a small company towards ISO 9001 registration is advancing and maturing: the three elements are overlapping and locked together by the planning element. The size of the area of occlusion between these four elements provides a portrayal of the intensity of a small company's progress towards acquiring ISO 9001 registration.

Benefits and Limitations of the ISO 9000 Series of Standards

Since its introduction, the ISO 9000 quality system series has been widely accepted throughout the world. A number of benefits are claimed for the system, including:

- Improved controls, discipline (e.g. prevents the use of short cuts and duplication of activities), procedures, documentation, communication, dissemination and customer satisfaction, quicker identification and resolution of problems, greater consistency (i.e. the job is done the same way, time after time and best practices are shared), increased quality awareness, in particular from those departments and people who traditionally perceived 'quality' not to be their major concern.
- A reduction in errors, customer complaints and non-conforming products, services and costs and the retention of customers.
- Assistance with the liberalization of trade through common rules and language.
- Responsibility for quality issues is placed firmly where it belongs, with the supplier and not the customer.
- Reduction in the number of customer audits and assessments and also a reduction in the time taken, leading to a saving in resources need for such activities.
- Identification of ineffective and surplus procedures and documents and other forms of waste.
- A better working environment.

For details see various BS, ISO and certification body literature, and also Atkin (1987), Bulled (1987), Collyer (1988), Dale and Oakland (1994), DeAngelis (1991), Ford (1988), Hele (1988), Long et al. (1991), Marquardt et al. (1991), Perry (1991) and Rayner and Porter (1991).

A survey carried out by PERA International and Salford University Business Services Limited (1992) of 2,317 firms who had completed a quality consultancy project under the DTI Enterprise Initiative prior to 31 December 1990 found the following benefits:

Overall, 89 per cent of all clients surveyed believed that the introduction of quality management systems had a positive effect on their internal operating efficiency.

Some 48 per cent of firms claimed increased profitability, 76 per cent improved marketing and 26 per cent improved export sales – all attributed the effect to the introduction of quality management systems.

A survey carried out in 1993 by Research International Ltd. for Lloyds Register Quality Assurance assessed the impact of the ISO 9000 series on British business. Some 400 managers from companies of varying size and industrial type were interviewed. Amongst the main findings were the following:

- 89 per cent of companies which had gained ISO 9000 series registration said it met or exceeded their expectations.
- 86 per cent of companies said registration had improved management control, 69 per cent said it had increased their efficiency and productivity and 40 per cent claimed it had reduced their costs.
- Disappointment expressed about the ISO 9000 series was relatively low. Only 3 per cent reported that it had increased their paperwork and 6 per cent said gaining approval was too costly.

A survey carried out by Vanguard Consulting Ltd. (1994) obtained responses from 647 organizations. The conclusion reached was that organizations which achieved success with the ISO 9000 series took a broader view with respect to its implementation than those which sought it because of some form of obligation. Since then there have been numerous surveys (e.g. Brown and van der Wiele 1995; Vloeburghs and Bellens 1996) in various parts of the world. A survey by Buttle (1996), which claims to be 'the most comprehensive national omnisectoral survey into the impact of ISO 9000 on UK business', obtaining data from 1,220 organizations, found, using factor analysis, that the three most important benefits sought from certification were profit improvement, process improvement and marketing benefits. The survey also pointed out widespread willingness to recommend the ISO 9000 series of standards to other firms. On the other hand, a number of difficulties, problems and shortcomings have been reported and discussed. These include:

- Deciding whether registration should be sought for the whole company or just one unit/division/site/premises or even a specific operation carried out on one site or certain defined activities, as in the case of local authorities.

- Applicability of the standards to certain situations, particular sectors of business, and management styles.
- Interpretations of various sections of the standard and understanding the requirements of the standards.
- Terminology used.
- Lack of flexibility and perceived restrictions on creativity.
- Lack of relevance to the real needs of the business, resulting in a view that it was bureaucracy gone mad (e.g. paper-shuffling) and a 'why bother' attitude from people at the operating end of the organization.
- The time and resources needed in writing procedures and training and retraining staff in the requirements of the ISO 9000 series and the internal auditing of the system.
- The bureaucracy involved in documentation and accreditation and the lack of mutual recognition of certificated bodies between countries.
- The cost involved in achieving ISO 9001 registration and then maintaining it. This applies, in particular, to small companies. The cost comprises the additional workload incurred by company personnel in writing the procedures, managerial time, increased paperwork, etc., the fee of the management consultancy (if a consultant is used to assist with the process of registration) and the certification body's fees.
- Perceived by small companies to be only applicable to large companies.
- Considered by those companies who have mature TQM approaches to be of no value.
- In some cases, in particular sales/service situations, the rigor and applicability of the standards are perceived as restrictive and as barriers to providing a flexible and responsive service to customers.
- Lack of internal and external audit rigor.

Details are given in the following sources: Association of British Certification Bodies and the NACCB (1994), Batchelor (1992), Brennan (1994), BSI Policy Committee for Small Businesses (1994), Burgess (1998), Campbell (1994), Commerce (1994), Dale and Oakland (1994), Hersan (1990), Jennings (1992), Long et al. (1991), Oliver (1991), Owen (1988), Rayner and Porter (1991), Sayle (1987), Terziovski et al. (1997), and Whittington (1989). Some of these reported difficulties have been eased by the 1994 and 2000 revisions of the ISO 9000 series in terms of clearing up the ambiguity regarding implied requirements, consistency of clause numbering between ISO 9001, ISO 9002 and ISO 9003, process control requirements and the emphasis given to preventative action and the provision of advice for small businesses (e.g. the BSI handbook *ISO 9000 for Small Businesses* (1997)). In addition, a number of the certification bodies have introduced a special service of assessment and surveillance to reduce the cost of ISO 9001 registration to small businesses. The fee structure of such services has been developed to help smaller businesses.

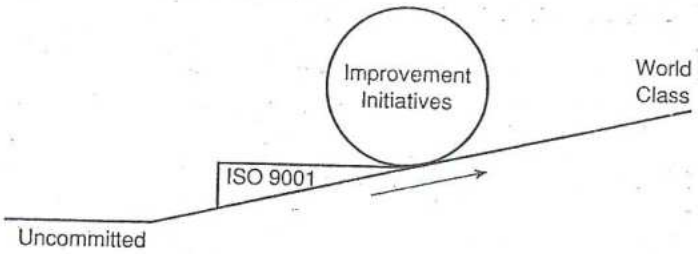


Figure 13.3 Quality improvement and the ISO 9000 series

Seddon (1997) has launched what is almost a one-man crusade against the ISO 9000 series, and his recent book provides some interesting reading of views of what he considers to be the damage inflicted on companies that adopt and implement the requirements of this series of standards.

The revised standards, with their provision for performance improvement; greater emphasis on the involvement of senior management; suitability for all sizes of organizations; increased compatibility with ISO 14001; and user/customer-friendliness, should lead to a reduction in these types of difficulty and criticism; however, only time will tell.

What now follows is an overview of the benefits and limitations of the ISO 9000 series as seen by the author.

- A quality management system is a fundamental pillar in an organization's approach to TQM and it helps to ensure that any improvements made are held in place (see figure 13.3). However, ISO 9001 registration is not a prerequisite of TQM. Some organizations, in particular those from the non-manufacturing sector, have analysed and improved their systems and working practices and have then gone straight to TQM.
- The guidance provided in the requirements of ISO 9001 and ISO 9004, and the independent assessment surveillance, are an indisputable aid in developing and maintaining the procedures, controls and discipline required in a quality management system. This is of particular value for those companies which are just commencing their quality journey. The system should help to ensure that more people within the organization are touched by quality, and in this way quality awareness is raised. However, there is a tendency to encourage the separation of a business into areas that complete the recording of requirements and those areas which do not. For example, functions such as finance, management information systems and human resources are little affected, except for training requirements. It is TQM which stimulates the business by creating the understanding that all its component parts have customers, that waste must be systematically eliminated, and that improvement is a continuous process. To help eradicate these weaknesses

relating to the separation of functions BSI Quality Assurance introduced in 1991 company-wide registration to extend quality system accreditation to the whole of the company (core businesses as well as supporting functions) (see Perry 1991 for details).

Experience indicates that, in most companies, it is not easy to get every function and person involved to take responsibility for their own quality assurance and to make quality improvements in the processes for which they are responsible. The ISO 9000 series of standards, albeit limited in respect of the point made above, can assist in making this happen.

- It is a contractual requirement of many customers that their suppliers are registered to ISO 9001; registration is also required to get on bid lists. Once a company has become registered, it is more than likely that it will ask its suppliers, distributors and providers of service to do the same, setting into motion a chain reaction or what might be classed as a form of pyramid selling. Therefore, in many sectors of industry and government procurement agencies, it is necessary from a marketing viewpoint, and without it a company will simply not get orders. In much of the world it is now a prerequisite condition of doing business and in some sectors of industry (e.g. the automotive industry) the rate of certification is very high. An increasing number of long-standing suppliers to companies have been told by them that they must get ISO 9001 registration to continue to be a supplier. This is in spite of the supplier having been the supplier of choice for a considerable period of time. Once ISO 9001 registration has been achieved an organization may not be able to afford to lose it. Within the European Union, directives (controlling the production and use of most safety-related products, from toys to pressure vessels) call up ISO 9001 as mandatory QA or QC.
- Suppliers have a habit of doing what their customers want and many organizations have achieved ISO 9001 registration to provide documented proof that they have an adequate quality system in place just to satisfy the demands of their major customers. This may not produce the required improvement ethos naturally, and any gains made will be short-lived if registration is perceived as a contractual condition rather than a foundation for ongoing improvement. Some suppliers also use it to demonstrate to customers (actual and potential) that they are committed to quality and have achieved what they often call 'the right level of quality'.
- A system based on the ISO 9000 series provides only the foundation blocks, and registration to ISO 9001 should be viewed as the minimum requirement; the objective should be to develop and improve the system in relation to the needs of the organization. An organization does not achieve superior-performing company status merely by ISO 9001 registration. It is clearly a pre-competitive issue, and separate from the ability to compete, which depends on many other factors. The winners will be those who have

a dedicated commitment to company-wide improvement through continuous self-assessment of what they do.

- The preparation of systems, procedures, working instructions, etc. to meet the requirements of ISO 9001 will have a beneficial effect on a company's performance in terms of improved process yields, reduced levels of non-conformance, improved management control, etc. However, the underlying mechanisms of the ISO 9000 series are such that they will tend towards a steady-state performance. The ISO 9000 series of standards is designed to produce consistency in actions, products and services. An organization can have a consistent performance with a high level of non-conformance. In the words of one executive, 'ISO 9000 is an excellent system for telling us where we have produced rubbish.' The achievement of consistency, while meritorious, leads to a goal which, once achieved, can result in complacency. A consequence of this is that management may pay lip-service to the quality system.
- The question 'Does the quality system reflect the needs of the customer?' should for ever circulate in the minds of senior management.

  Only if there is strong leadership and a written commitment to improvement in the management review of the system will an improvement cycle be triggered. Some organizations have done this by building on and widening their quality systems management review meetings – which deal with issues such as quality audit; corrective and preventative action; production rejections, concessions and corrective actions; waste levels; supplier performance/concessions; customer complaints; and market trends and requirements – into monthly steering meetings for quality improvement. In this way the quality system is integrated into the quality improvement process; it is not uncommon to find they are operated in parallel.
- Having an ISO 9001 certificate of registration does not as a matter of course imply that non-conformities at all stages of the process will not occur, and there is no consensus to suggest that companies working to the same management system generate the same standard of quality. The standard is not prescriptive as to the means of prevention. Detection methods which rely very heavily on inspection techniques, human or mechanical, would appear to satisfy the standard in many aspects. This may be an acknowledgment of the fact that there are many processes where, given the state-of-the-art technology, it is not possible to achieve 'zero defects'. The standard does clearly indicate that corrective and preventative actions and procedures should be established, documented and maintained to prevent recurrence of non-conforming product, and that the system should be maintained and developed through the internal audit and management review, but there is a lack of evidence to suggest that improvement is an explicit criterion by which ongoing registration is monitored. In general, ISO 9001 tends to measure the effectiveness of documentation, paperwork and procedures (the

requisite assessments are often termed a paper chase); this leads to the claim that it encourages bureaucracy and a complex process of documentation.

- Experience indicates that the ISO 9000 series has a limited impact on the total improvement operation of an organization simply because it does not get to the root cause of problems. Most problems are resolved at branch level, and this is a failure in a number of businesses.
- In some quarters there is confusion about the relationship between the ISO 9000 series and TQM. They are not alternatives; a quality system is an essential feature of TQM. However, some organizations see ISO 9001 registration as the pinnacle of their TQM achievements and no plans are laid for building on this registration; a small number of people even believe that improvements driven through internal audits of the ISO 9001 will lead their organization to TQM. As previously mentioned, registration often results in a sense of complacency, in particular after successful third-party assessment of the system.
- It should be obvious from the above discussion that ISO 9001 registration, or for that matter any other quality system registration or certification or approvals, will not prevent a supplier from producing and delivering nonconforming products and/or services to its customers. The standards are a specification for the management of quality; there is a clear distinction between registration and capability, and this fundamental fact needs to be recognized. Product and/or service quality is determined by the individual organization and its people and processes and not by a quality management system standard.
- Many organizations and executives have inflated views of the ISO 9000 series; these are often picked up from the hype generated by those selling advisory services. These views can lead to high expectations of what the standard can achieve which, in the long term, may do it a disservice. The following are typical of the comments (not referenced or attributed to individuals):
  - 'Quality recognition of the ISO 9000 series from a national accredited certification body is prized nationwide because it is known to be difficult to achieve the high standards required by their impartial testing procedures.'
  - 'It will give the car-buying public a guarantee of complete satisfaction or their money back. What it aims to achieve is the world's coveted benchmark of quality: BS 5750. it is a standard that is recognized as being truly superb and is a move that no other rival car maker can afford to ignore.'
  - 'How can it be coveted and difficult to achieve when many thousands of companies in the UK have already met this requirement?'
  - 'Such and such a company is the first in its industrial sector to obtain the prestigious ISO 9001 registration – tremendous achievement, very proud to have achieved to the registration, the most significant event in the company's history, breaking new ground for quality, etc., etc.' (write-up and picture in the local paper).

To the informed what these statements and platitudes are saying is that the organization has taken the first step on the TQM journey.

Summary

A quality management system is one of the key building-blocks for an organization's TQM activities. ISO 9001 and ISO 9004 define and set out a definitive list of features and characteristics which should be present in an organization's quality management system through documented policies, manual and procedures, whatever the product manufactured or offered, or the service provided, or the technology used. In this way sound advice is provided on how an organization may develop a quality system.

In addition to incorporating the clauses of ISO 9001 a quality system design must maximize ownership, allow flexibility without loss of control, and be able to be developed to cope with changes in the business and capture improvements; above all it must be 'user-friendly'.

Seeking registration for the wrong reasons and a system which is too inflexible and bureaucratic are some of the major pitfalls. Assessment to ISO 9001 may improve an organization's systems, procedures and processes but on its own will not deliver continuous and company-wide improvement. To make best use of the ISO 9000 series it is important that the implementation is carried out in the right spirit and for the right reasons. This is an area in which management commitment is vital. The solution to many of the reported difficulties, shortcomings and criticisms of the standard lies in the hands of an organization's senior management team. The saying 'You only get out what you put in' is so relevant to the ISO 9000 series and it is so important that the system is seen as being alive. All too often the ISO 9001 system is left solely in the hands of the quality department, often just one individual.

Registration to ISO 9001 is not the only way to achieve quality assurance, neither is it a prerequisite for TQM. It is, however, sometimes necessary to have the appropriate registration in order to do business at both a national and an international level, and in this respect it is a key marketing tool. It is the fear of loss of business and substitution in the marketplace that has caused many organizations to obtain ISO 9001 registration. The ISO 9000 series provides a common benchmark for good-quality management system practice which is recognized throughout the world. An organization which is registered to ISO 9001:2000 should be working in an organized, structured and procedural way with defined methods of operating. It is important that organizations do not view ISO 9001 registration as their pinnacle of success in relation to quality assurance and quality management. It only provides the basic foundation blocks, and they must have strategies and business plans in place to move on and cater for

areas which are not addressed by the standard and develop to TQM. This is particularly important in smaller businesses which, in a number of cases, attain ISO 9001 registration and have no interest in or vision of developing further their quality management activities.

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Chapter Fourteen

Integrated Management Systems

G. Wilkinson and B. G. Dale

Introduction

The need to assure customers that products and services satisfy requirements for quality has led to the introduction of quality management systems (QMS), and registration to QMS standards, such as ISO 9001 (1994 and 2000), has become the norm for many organizations. However, responsible organizations have also to be concerned about the well-being of their employees, their working environment, the impact of operations on the local community, and the long-term effects of their products while in use and after they have been discarded. They cannot ignore legislation such as the Environmental Protection Act 1990, the Health and Safety at Work Act 1974 and the Control of Substances Hazardous to Health Regulations 1988, where failure to have effective management systems in place can lead to heavy fines, a prison sentence, loss of operating license or even plant closure. Customers, employees, shareholders and the community are also concerned about these matters. In addition to benefits, such as less waste, lower energy costs and reduced absence and employee turnover levels, creating an 'image' that meets customer expectations can help an organization improve market share. This has led to the introduction of EMAS, the European Commission's Eco-Management and Audit Scheme (European Commission 1993); ISO 14001 (1996) – the specification for environmental management systems (EMS); and BS 8800 (1996) and BSI-OHSAS18001 (1999) – guides/specifications for occupational health and safety management systems (OH&SMS). Dealing with separate management systems covering quality, environmental, and health and safety issues, and ensuring that they align with the organization's strategy, has not proved easy, however, and from the mid-1990s, an integrated management system (IMS) addressing these three areas of management has come to be of interest to business. Research studies by Riemann and Sharratt (1995), Hillary (1997) and Wilkinson and Dale (1998, 1999), and survey results examined by Daniel (2001), show increasing interest by companies in integration, and an IMS is now seen as part of the organization's management portfolio. Although the

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Systèmes de management de la qualité — Exigences

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 176, *Quality management and quality assurance*, Subcommittee SC 2, *Quality systems*.

This fifth edition cancels and replaces the fourth edition (ISO 9001:2008), which has been technically revised, through the adoption of a revised clause sequence and the adaptation of the revised quality management principles and of new concepts. It also cancels and replaces the Technical Corrigendum ISO 9001:2008/Cor.1:2009.

a thing to be corrected, typically an error in a printed book.

https://asq.org/quality-resources/quality-management-system#Benefits

Each element of a quality management system helps achieve the overall goals of meeting the customers' and organization's requirements. Quality management systems should address an organization's unique needs; however, the elements all systems have in common include:

The organization's quality policy and quality objectives
Quality manual
Procedures, instructions, and records
Data management
Internal processes
Customer satisfaction from product quality
Improvement opportunities
Quality analysis

A quality management system (QMS) is defined as a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. A QMS helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis.

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A quality management system (QMS) is a collection of business processes and procedures which aims to ensure that the quality of products or services meets - or exceeds - customer expectations.

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Introduction

0.1 General

The adoption of a quality management system is a strategic decision for an organization that can help to improve its overall performance and provide a sound basis for sustainable development initiatives.

The potential benefits to an organization of implementing a quality management system based on this International Standard are:

a) the ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements;

b) facilitating opportunities to enhance customer satisfaction;

c) addressing risks and opportunities associated with its context and objectives;

d) the ability to demonstrate conformity to specified quality management system requirements.

This International Standard can be used by internal and external parties.

It is not the intent of this International Standard to imply the need for:

— uniformity in the structure of different quality management systems;

— alignment of documentation to the clause structure of this International Standard;

— the use of the specific terminology of this International Standard within the organization.

The quality management system requirements specified in this International Standard are complementary to requirements for products and services.

This International Standard employs the process approach, which incorporates the Plan-Do-Check-Act (PDCA) cycle and risk-based thinking.

The process approach enables an organization to plan its processes and their interactions.

The PDCA cycle enables an organization to ensure that its processes are adequately resourced and managed, and that opportunities for improvement are determined and acted on.

Risk-based thinking enables an organization to determine the factors that could cause its processes and its quality management system to deviate from the planned results, to put in place preventive controls to minimize negative effects and to make maximum use of opportunities as they arise (see Clause A.4).

Consistently meeting requirements and addressing future needs and expectations poses a challenge for organizations in an increasingly dynamic and complex environment. To achieve this objective, the organization might find it necessary to adopt various forms of improvement in addition to correction and continual improvement, such as breakthrough change, innovation and re-organization.

In this International Standard, the following verbal forms are used:

— "shall" indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

— "can" indicates a possibility or a capability.

Information marked as "NOTE" is for guidance in understanding or clarifying the associated requirement.

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The iPhone
One of the best cited examples of breakthrough innovation on the tech front is the first iPhone. By harnessing new technology, Apple was able to bring a fundamentally new product to market, creating new demand in the process.

Blippar
Another great example of breakthrough innovation on the technology front is Blippar, a ground-breaking visual search app that recognises objects in the real world and then uses augmented reality to bring them to life through fresh content. The app uses machine learning to recognise its environment and has been named one of Business Insider's most innovative companies in tech. And did we mention that this innovation is the brainchild of an ex-FreshMinder, the wonderful Jessica Butcher?

Dyson
No list of breakthrough innovations would be complete without including Dyson. The world's first bag-less vacuum cleaner is based on an existing business model but the company harnessed new technology to substantially improve the market offering. This same approach is what's behind Dyson Cool, the company's bladeless fan.

Breakthrough innovations harnessing a new business model
Dollar Shave Club
One of my favourite examples of breakthrough innovation which harnesses a new business model comes from Dollar Shave Club, a subscription based business which delivers fresh razors to its members every four weeks for as little as – you guessed it – a dollar a month. Rethinking the business model surrounding shaving has

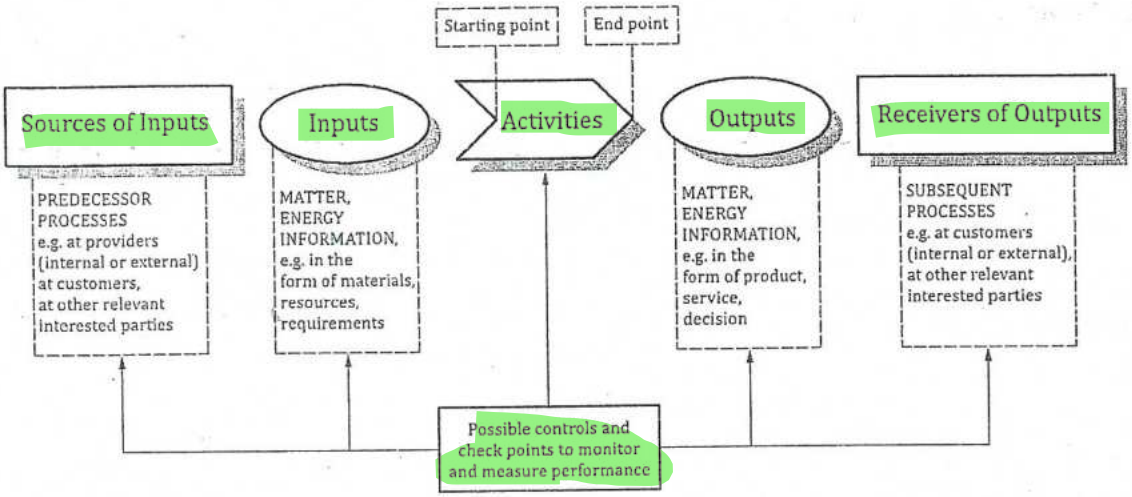
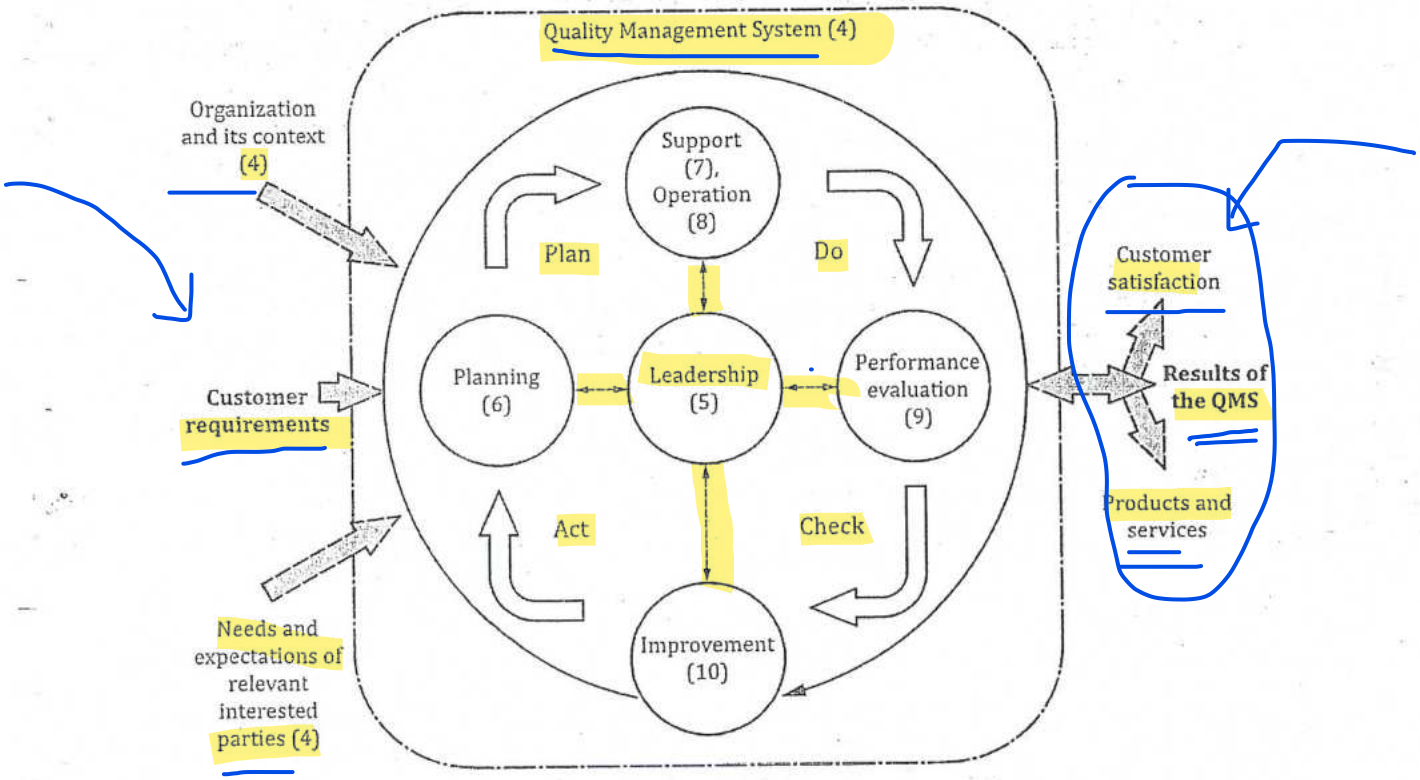


Figure 1 — Schematic representation of the elements of a single process

0.3.2 Plan-Do-Check-Act cycle

The PDCA cycle can be applied to all processes and to the quality management system as a whole. Figure 2 illustrates how Clauses 4 to 10 can be grouped in relation to the PDCA cycle.



NOTE Numbers in brackets refer to the clauses in this International Standard.

Figure 2 — Representation of the structure of this International Standard in the PDCA cycle

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0.2 Quality management principles

This International Standard is based on the quality management principles described in ISO 9000. The descriptions include a statement of each principle, a rationale of why the principle is important for the organization, some examples of benefits associated with the principle and examples of typical actions to improve the organization's performance when applying the principle.

The quality management principles are:

https://asq.org/quality-resources/iso-9000

ISO 9001:2015: Quality Management Systems - Requirements
ISO 9000:2015: Quality Management Systems - Fundamentals and Vocabulary (definitions)
ISO 9004:2018: Quality Management - Quality of an Organization - Guidance to Achieve Sustained Success (continuous improvement)
ISO 19011:2018: Guidelines for Auditing Management Systems

Particular focus on CS and CRM

- customer focus;
- leadership;
- engagement of people;
- process approach;
- improvement;
- evidence-based decision making;
- relationship management.

0.3 Process approach

0.3.1 General

This International Standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements. Specific requirements considered essential to the adoption of a process approach are included in 4.4.

Understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its intended results. This approach enables the organization to control the interrelationships and interdependencies among the processes of the system, so that the overall performance of the organization can be enhanced.

The process approach involves the systematic definition and management of processes, and their interactions, so as to achieve the intended results in accordance with the quality policy and strategic direction of the organization. Management of the processes and the system as a whole can be achieved using the PDCA cycle (see 0.3.2) with an overall focus on risk-based thinking (see 0.3.3) aimed at taking advantage of opportunities and preventing undesirable results.

The application of the process approach in a quality management system enables:

a) understanding and consistency in meeting requirements;
b) the consideration of processes in terms of added value;
c) the achievement of effective process performance;
d) improvement of processes based on evaluation of data and information.

Figure 1 gives a schematic representation of any process and shows the interaction of its elements. The monitoring and measuring check points, which are necessary for control, are specific to each process and will vary depending on the related risks.

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A risk is something unplanned that might happen that could have a negative impact on your project;
An issue is something that is currently happening and is having a negative impact on your project;
An opportunity is something unplanned that might happen that you could exploit to have a positive impact on your project.

The PDCA cycle can be briefly described as follows:

— **Plan**: establish the objectives of the system and its processes, and the resources needed to deliver results in accordance with customers' requirements and the organization's policies, and identify and address risks and opportunities;

— **Do**: implement what was planned;

— **Check**: monitor and (where applicable) measure processes and the resulting products and services against policies, objectives, requirements and planned activities, and report the results;

— **Act**: take actions to improve performance, as necessary.

0.3.3 Risk-based thinking

Risk-based thinking (see Clause A.4) is essential for achieving an effective quality management system. The concept of risk-based thinking has been implicit in previous editions of this International Standard including, for example, carrying out preventive action to eliminate potential nonconformities, analysing any nonconformities that do occur, and taking action to prevent recurrence that is appropriate for the effects of the nonconformity.

To conform to the requirements of this International Standard, an organization needs to plan and implement actions to address risks and opportunities. Addressing both risks and opportunities establishes a basis for increasing the effectiveness of the quality management system, achieving improved results and preventing negative effects.

Opportunities can arise as a result of a situation favourable to achieving an intended result, for example, a set of circumstances that allow the organization to attract customers, develop new products and services, reduce waste or improve productivity. Actions to address opportunities can also include consideration of associated risks. Risk is the effect of uncertainty and any such uncertainty can have positive or negative effects. A positive deviation arising from a risk can provide an opportunity, but not all positive effects of risk result in opportunities.

0.4 Relationship with other management system standards

This International Standard applies the framework developed by ISO to improve alignment among its International Standards for management systems (see Clause A.1).

This International Standard enables an organization to use the process approach, coupled with the PDCA cycle and risk-based thinking, to align or integrate its quality management system with the requirements of other management system standards.

This International Standard relates to ISO 9000 and ISO 9004 as follows:

— ISO 9000 *Quality management systems — Fundamentals and vocabulary* provides essential background for the proper understanding and implementation of this International Standard;

— ISO 9004 *Managing for the sustained success of an organization — A quality management approach* provides guidance for organizations that choose to progress beyond the requirements of this International Standard.

Annex B provides details of other International Standards on quality management and quality management systems that have been developed by ISO/TC 176.

This International Standard does not include requirements specific to other management systems, such as those for environmental management, occupational health and safety management, or financial management.

Sector-specific quality management system standards based on the requirements of this International Standard have been developed for a number of sectors. Some of these standards specify additional quality management system requirements, while others are limited to providing guidance to the application of this International Standard within the particular sector.

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A matrix showing the correlation between the clauses of this edition of this International Standard and the previous edition (ISO 9001:2008) can be found on the ISO/TC 176/SC 2 open access web site at: www.iso.org/tc176/sc02/public.

Definition of Strategy
Strategy is a game plan, chosen to achieve the organizational objectives, gain customer's trust, attain competitive advantage and to acquire a market position. It is a combination of well thought intent and actions which lead to the organization towards its desired position or destination. It is a unified and integrated plan made to achieve the basic objectives of the enterprise like:

Effectiveness
Handling events and problems
Taking advantage of opportunities
Full resource utilization
Coping with threats
Strategy is a combination of flexibly designed corporate moves, through which an organization can compete with its rivals successfully. The following are the features of the Strategy:

It should be formulated from the top level management, however, sub-strategies can be made by middle level management.
It should have a long range perspective.
It should be dynamic in nature.
The main purpose is to overcome from uncertain situations.
It should be made in such a way, to make the best possible use of scarce resources.
Definition of Policy
The policy is also regarded as a mini – mission statement, is a set of principles and rules which directs the decisions of the organization. Policies are framed by the top level management of the organization to serve as a guideline for operational decision making. It is helpful in highlighting the rules, value and beliefs of the organization. In addition to this, it acts as a basis for guiding the actions.

Policies are designed, by taking opinion and general view of a number of people in the organization regarding any situation. They are made from the past experience and basic understanding. In this way, the people who comes under the range of such policy will completely agree upon its implementation.

Policies helps the management of an organization to determine what is to be done, in a particular situation. These have to be consistently applied over a long period of time to avoid discrepancies and overlapping.

Key Differences Between Strategy and Policy

The following are the major differences between strategy and policy

Strategy is the best plan opted from a number of plans, in order to achieve the organizational goals and objectives. Policy is a set of common rules and regulations, which forms as a base to take day to day decisions.
Strategy is a plan of action while the policy is a principle of action.
Strategies can be modified as per the situation, so they are dynamic in nature. Conversely, Policies are uniform in nature, however relaxations can be made for unexpected situations.
Strategies are concentrated toward actions, whereas Policies are decision oriented.
Strategies are always framed by the top management but sub strategies are formulated at the middle level. In contrast to Policy, they are, in general made by the top management.
Strategies deals with external environmental factors. On the other hand, Policies are made for internal environment of business.

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Quality management systems — Requirements

1 Scope

This International Standard specifies requirements for a quality management system when an organization:

a) needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and

b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

All the requirements of this International Standard are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides.

NOTE 1 In this International Standard, the terms "product" or "service" only apply to products and services intended for, or required by, a customer.

NOTE 2 Statutory and regulatory requirements can be expressed as legal requirements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000:2015, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000:2015 apply.

4 Context of the organization

4.1 Understanding the organization and its context

The organization shall determine external and internal issues that are relevant to its purpose and its strategic direction and that affect its ability to achieve the intended result(s) of its quality management system.

The organization shall monitor and review information about these external and internal issues.

NOTE 1 Issues can include positive and negative factors or conditions for consideration.

NOTE 2 Understanding the external context can be facilitated by considering issues arising from legal, technological, competitive, market, cultural, social and economic environments, whether international, national, regional or local.

NOTE 3 Understanding the internal context can be facilitated by considering issues related to values, culture, knowledge and performance of the organization.

At the strategic level, tools such as Strengths, Weaknesses, Opportunities and Threats analysis (SWOT) and Political, Economic, Social, Technological, Legal, Environmental analysis (PESTLE) can be used.

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4.2 Understanding the needs and expectations of interested parties

Due to their effect or potential effect on the organization's ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, the organization shall determine:

a) the interested parties that are relevant to the quality management system;

b) the requirements of these interested parties that are relevant to the quality management system.

The organization shall monitor and review information about these interested parties and their relevant requirements.

4.3 Determining the scope of the quality management system

The organization shall determine the boundaries and applicability of the quality management system to establish its scope.

When determining this scope, the organization shall consider:

a) the external and internal issues referred to in 4.1;

b) the requirements of relevant interested parties referred to in 4.2;

c) the products and services of the organization.

The organization shall apply all the requirements of this International Standard if they are applicable within the determined scope of its quality management system.

The scope of the organization's quality management system shall be available and be maintained as documented information. The scope shall state the types of products and services covered, and provide justification for any requirement of this International Standard that the organization determines is not applicable to the scope of its quality management system.

Conformity to this International Standard may only be claimed if the requirements determined as not being applicable do not affect the organization's ability or responsibility to ensure the conformity of its products and services and the enhancement of customer satisfaction.

4.4 Quality management system and its processes

4.4.1 The organization shall establish, implement, maintain and continually improve a quality management system, including the processes needed and their interactions, in accordance with the requirements of this International Standard.

The organization shall determine the processes needed for the quality management system and their application throughout the organization, and shall:

a) determine the inputs required and the outputs expected from these processes;

b) determine the sequence and interaction of these processes;

c) determine and apply the criteria and methods (including monitoring, measurements and related performance indicators) needed to ensure the effective operation and control of these processes;

d) determine the resources needed for these processes and ensure their availability;

e) assign the responsibilities and authorities for these processes;

f) address the risks and opportunities as determined in accordance with the requirements of 6.1;

g) evaluate these processes and implement any changes needed to ensure that these processes achieve their intended results;

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h) improve the processes and the quality management system.

4.4.2 To the extent necessary, the organization shall:

a) maintain documented information to support the operation of its processes;

b) retain documented information to have confidence that the processes are being carried out as planned.

5 Leadership

5.1 Leadership and commitment

5.1.1 General

Top management shall demonstrate leadership and commitment with respect to the quality management system by:

a) taking accountability for the effectiveness of the quality management system;

b) ensuring that the quality policy and quality objectives are established for the quality management system and are compatible with the context and strategic direction of the organization;

c) ensuring the integration of the quality management system requirements into the organization's business processes;

d) promoting the use of the process approach and risk-based thinking;

e) ensuring that the resources needed for the quality management system are available;

f) communicating the importance of effective quality management and of conforming to the quality management system requirements;

g) ensuring that the quality management system achieves its intended results;

h) engaging, directing and supporting persons to contribute to the effectiveness of the quality management system;

i) promoting improvement;

j) supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

NOTE Reference to "business" in this International Standard can be interpreted broadly to mean those activities that are core to the purposes of the organization's existence, whether the organization is public, private, for profit or not for profit.

5.1.2 Customer focus

Top management shall demonstrate leadership and commitment with respect to customer focus by ensuring that:

a) customer and applicable statutory and regulatory requirements are determined, understood and consistently met;

b) the risks and opportunities that can affect conformity of products and services and the ability to enhance customer satisfaction are determined and addressed;

c) the focus on enhancing customer satisfaction is maintained.

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5.2 Policy

5.2.1 Establishing the quality policy

Top management shall establish, implement and maintain a quality policy that:

a) is appropriate to the purpose and context of the organization and supports its strategic direction;

b) provides a framework for setting quality objectives;

c) includes a commitment to satisfy applicable requirements;

d) includes a commitment to continual improvement of the quality management system.

5.2.2 Communicating the quality policy

The quality policy shall:

a) be available and be maintained as documented information;

b) be communicated, understood and applied within the organization;

c) be available to relevant interested parties, as appropriate.

5.3 Organizational roles, responsibilities and authorities

Top management shall ensure that the responsibilities and authorities for relevant roles are assigned, communicated and understood within the organization.

Top management shall assign the responsibility and authority for:

a) ensuring that the quality management system conforms to the requirements of this International Standard;

b) ensuring that the processes are delivering their intended outputs;

c) reporting on the performance of the quality management system and on opportunities for improvement (see 10.1), in particular to top management;

d) ensuring the promotion of customer focus throughout the organization;

e) ensuring that the integrity of the quality management system is maintained when changes to the quality management system are planned and implemented.

6 Planning

6.1 Actions to address risks and opportunities

6.1.1 When planning for the quality management system, the organization shall consider the issues referred to in 4.1 and the requirements referred to in 4.2 and determine the risks and opportunities that need to be addressed to:

a) give assurance that the quality management system can achieve its intended result(s);

b) enhance desirable effects;

c) prevent, or reduce, undesired effects;

d) achieve improvement.

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6.1.2 The organization shall plan:

a) actions to address these risks and opportunities;

b) how to:

1) integrate and implement the actions into its quality management system processes (see 4.4);

2) evaluate the effectiveness of these actions.

Actions taken to address risks and opportunities shall be proportionate to the potential impact on the conformity of products and services.

NOTE 1 Options to address risks can include avoiding risk, taking risk in order to pursue an opportunity, eliminating the risk source, changing the likelihood or consequences, sharing the risk, or retaining risk by informed decision.

Risk is usually expressed in terms of risk sources (3.4), potential events (3.5), their consequences (3.6) and their likelihood (3.7).

NOTE 2 Opportunities can lead to the adoption of new practices, launching new products, opening new markets, addressing new customers, building partnerships, using new technology and other desirable and viable possibilities to address the organization's or its customers' needs.

6.2 Quality objectives and planning to achieve them

6.2.1 The organization shall establish quality objectives at relevant functions, levels and processes needed for the quality management system.

Unlike "Risk Avoidance", the process or activity is not eliminated. Rather, the risk of an incident or adverse event associated to a process is removed by getting rid of a hazard or hazardous condition.

The quality objectives shall:

a) be consistent with the quality policy;

b) be measurable;

c) take into account applicable requirements;

d) be relevant to conformity of products and services and to enhancement of customer satisfaction;

e) be monitored;

f) be communicated;

g) be updated as appropriate.

The organization shall maintain documented information on the quality objectives.

6.2.2 When planning how to achieve its quality objectives, the organization shall determine:

a) what will be done;

b) what resources will be required;

c) who will be responsible;

d) when it will be completed;

e) how the results will be evaluated.

6.3 Planning of changes

When the organization determines the need for changes to the quality management system, the changes shall be carried out in a planned manner (see 4.4).

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The organization shall consider:

a) the purpose of the changes and their potential consequences;

b) the integrity of the quality management system;

c) the availability of resources;

d) the allocation or reallocation of responsibilities and authorities.

7 Support

7.1 Resources

7.1.1 General

The organization shall determine and provide the resources needed for the establishment, implementation, maintenance and continual improvement of the quality management system.

The organization shall consider:

a) the capabilities of, and constraints on, existing internal resources;

b) what needs to be obtained from external providers.

7.1.2 People

The organization shall determine and provide the persons necessary for the effective implementation of its quality management system and for the operation and control of its processes.

7.1.3 Infrastructure

The organization shall determine, provide and maintain the infrastructure necessary for the operation of its processes and to achieve conformity of products and services.

NOTE Infrastructure can include:

a) buildings and associated utilities;

b) equipment, including hardware and software;

c) transportation resources;

d) information and communication technology.

7.1.4 Environment for the operation of processes

The organization shall determine, provide and maintain the environment necessary for the operation of its processes and to achieve conformity of products and services.

NOTE A suitable environment can be a combination of human and physical factors, such as:

a) social (e.g. non-discriminatory, calm, non-confrontational);

b) psychological (e.g. stress-reducing, burnout prevention, emotionally protective);

c) physical (e.g. temperature, heat, humidity, light, airflow, hygiene, noise).

These factors can differ substantially depending on the products and services provided.

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7.1.5 Monitoring and measuring resources

7.1.5.1 General

The organization shall determine and provide the resources needed to ensure valid and reliable results when monitoring or measuring is used to verify the conformity of products and services to requirements.

The organization shall ensure that the resources provided:

a) are suitable for the specific type of monitoring and measurement activities being undertaken;

b) are maintained to ensure their continuing fitness for their purpose.

The organization shall retain appropriate documented information as evidence of fitness for purpose of the monitoring and measurement resources.

7.1.5.2 Measurement traceability

When measurement traceability is a requirement, or is considered by the organization to be an essential part of providing confidence in the validity of measurement results, measuring equipment shall be:

a) calibrated or verified, or both, at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; when no such standards exist, the basis used for calibration or verification shall be retained as documented information;

b) identified in order to determine their status;

c) safeguarded from adjustments, damage or deterioration that would invalidate the calibration status and subsequent measurement results.

The organization shall determine if the validity of previous measurement results has been adversely affected when measuring equipment is found to be unfit for its intended purpose, and shall take appropriate action as necessary.

7.1.6 Organizational knowledge

The organization shall determine the knowledge necessary for the operation of its processes and to achieve conformity of products and services.

This knowledge shall be maintained and be made available to the extent necessary.

When addressing changing needs and trends, the organization shall consider its current knowledge and determine how to acquire or access any necessary additional knowledge and required updates.

NOTE 1 Organizational knowledge is knowledge specific to the organization; it is generally gained by experience. It is information that is used and shared to achieve the organization's objectives.

NOTE 2 Organizational knowledge can be based on:

a) internal sources (e.g. intellectual property; knowledge gained from experience; lessons learned from failures and successful projects; capturing and sharing undocumented knowledge and experience; the results of improvements in processes, products and services);

b) external sources (e.g. standards; academia; conferences; gathering knowledge from customers or external providers).

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7.2 Competence

The organization shall:

a) determine the necessary competence of person(s) doing work under its control that affects the performance and effectiveness of the quality management system;

b) ensure that these persons are competent on the basis of appropriate education, training, or experience;

c) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken;

d) retain appropriate documented information as evidence of competence.

NOTE Applicable actions can include, for example, the provision of training to, the mentoring of, or the re-assignment of currently employed persons; or the hiring or contracting of competent persons.

7.3 Awareness

The organization shall ensure that persons doing work under the organization's control are aware of:

a) the quality policy;

b) relevant quality objectives;

c) their contribution to the effectiveness of the quality management system, including the benefits of improved performance;

d) the implications of not conforming with the quality management system requirements.

7.4 Communication

The organization shall determine the internal and external communications relevant to the quality management system, including:

a) on what it will communicate;

b) when to communicate;

c) with whom to communicate;

d) how to communicate;

e) who communicates.

7.5 Documented information

7.5.1 General

The organization's quality management system shall include:

a) documented information required by this International Standard;

b) documented information determined by the organization as being necessary for the effectiveness of the quality management system.

NOTE The extent of documented information for a quality management system can differ from one organization to another due to:

— the size of organization and its type of activities, processes, products and services;

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Document : maintained

Records : retained

— the complexity of processes and their interactions;

— the competence of persons.

7.5.2 Creating and updating

When creating and updating documented information, the organization shall ensure appropriate:

a) identification and description (e.g. a title, date, author, or reference number);

b) format (e.g. language, software version, graphics) and media (e.g. paper, electronic);

c) review and approval for suitability and adequacy.

7.5.3 Control of documented information

7.5.3.1 Documented information required by the quality management system and by this International Standard shall be controlled to ensure:

a) it is available and suitable for use, where and when it is needed;

b) it is adequately protected (e.g. from loss of confidentiality, improper use, or loss of integrity).

7.5.3.2 For the control of documented information, the organization shall address the following activities, as applicable:

a) distribution, access, retrieval and use;

b) storage and preservation, including preservation of legibility;

c) control of changes (e.g. version control);

d) retention and disposition.

Documented information of external origin determined by the organization to be necessary for the planning and operation of the quality management system shall be identified as appropriate, and be controlled.

Documented information retained as evidence of conformity shall be protected from unintended alterations.

NOTE Access can imply a decision regarding the permission to view the documented information only, or the permission and authority to view and change the documented information.

8 Operation

8.1 Operational planning and control

The organization shall plan, implement and control the processes (see 4.4) needed to meet the requirements for the provision of products and services, and to implement the actions determined in Clause 6, by:

a) determining the requirements for the products and services;

b) establishing criteria for:

1) the processes;

2) the acceptance of products and services;

c) determining the resources needed to achieve conformity to the product and service requirements;

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d) implementing control of the processes in accordance with the criteria;

e) determining, maintaining and retaining documented information to the extent necessary:

1) to have confidence that the processes have been carried out as planned;

2) to demonstrate the conformity of products and services to their requirements.

The output of this planning shall be suitable for the organization's operations.

The organization shall control planned changes and review the consequences of unintended changes, taking action to mitigate any adverse effects, as necessary.

The organization shall ensure that outsourced processes are controlled (see 8.4).

8.2 Requirements for products and services

8.2.1 Customer communication

Communication with customers shall include:

a) providing information relating to products and services;

b) handling enquiries, contracts or orders, including changes;

c) obtaining customer feedback relating to products and services, including customer complaints;

d) handling or controlling customer property;

e) establishing specific requirements for contingency actions, when relevant.

8.2.2 Determining the requirements for products and services

When determining the requirements for the products and services to be offered to customers, the organization shall ensure that:

a) the requirements for the products and services are defined, including:

1) any applicable statutory and regulatory requirements;

2) those considered necessary by the organization;

b) the organization can meet the claims for the products and services it offers.

8.2.3 Review of the requirements for products and services

8.2.3.1 The organization shall ensure that it has the ability to meet the requirements for products and services to be offered to customers. The organization shall conduct a review before committing to supply products and services to a customer, to include:

a) requirements specified by the customer, including the requirements for delivery and post-delivery activities;

b) requirements not stated by the customer, but necessary for the specified or intended use, when known;

c) requirements specified by the organization;

d) statutory and regulatory requirements applicable to the products and services;

e) contract or order requirements differing from those previously expressed.

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The organization shall ensure that contract or order requirements differing from those previously defined are resolved.

The customer's requirements shall be confirmed by the organization before acceptance, when the customer does not provide a documented statement of their requirements.

NOTE In some situations, such as internet sales, a formal review is impractical for each order. Instead, the review can cover relevant product information, such as catalogues.

8.2.3.2 The organization shall retain documented information, as applicable:

a) on the results of the review;

b) on any new requirements for the products and services.

8.2.4 Changes to requirements for products and services

The organization shall ensure that relevant documented information is amended, and that relevant persons are made aware of the changed requirements, when the requirements for products and services are changed.

8.3 Design and development of products and services

8.3.1 General

The organization shall establish, implement and maintain a design and development process that is appropriate to ensure the subsequent provision of products and services.

8.3.2 Design and development planning

In determining the stages and controls for design and development, the organization shall consider:

a) the nature, duration and complexity of the design and development activities;

b) the required process stages, including applicable design and development reviews;

c) the required design and development verification and validation activities;

d) the responsibilities and authorities involved in the design and development process;

e) the internal and external resource needs for the design and development of products and services;

f) the need to control interfaces between persons involved in the design and development process;

g) the need for involvement of customers and users in the design and development process;

h) the requirements for subsequent provision of products and services;

i) the level of control expected for the design and development process by customers and other relevant interested parties;

j) the documented information needed to demonstrate that design and development requirements have been met.

8.3.3 Design and development inputs

The organization shall determine the requirements essential for the specific types of products and services to be designed and developed. The organization shall consider:

a) functional and performance requirements;

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b) information derived from previous similar design and development activities;

c) statutory and regulatory requirements;

d) standards or codes of practice that the organization has committed to implement;

e) potential consequences of failure due to the nature of the products and services.

Inputs shall be adequate for design and development purposes, complete and unambiguous.

Conflicting design and development inputs shall be resolved.

The organization shall retain documented information on design and development inputs.

8.3.4 Design and development controls

The organization shall apply controls to the design and development process to ensure that:

a) the results to be achieved are defined;

b) reviews are conducted to evaluate the ability of the results of design and development to meet requirements;

c) verification activities are conducted to ensure that the design and development outputs meet the input requirements;

d) validation activities are conducted to ensure that the resulting products and services meet the requirements for the specified application or intended use;

e) any necessary actions are taken on problems determined during the reviews, or verification and validation activities;

f) documented information of these activities is retained.

NOTE Design and development reviews, verification and validation have distinct purposes. They can be conducted separately or in any combination, as is suitable for the products and services of the organization.

8.3.5 Design and development outputs

The organization shall ensure that design and development outputs:

a) meet the input requirements;

b) are adequate for the subsequent processes for the provision of products and services;

c) include or reference monitoring and measuring requirements, as appropriate, and acceptance criteria;

d) specify the characteristics of the products and services that are essential for their intended purpose and their safe and proper provision.

The organization shall retain documented information on design and development outputs.

8.3.6 Design and development changes

The organization shall identify, review and control changes made during, or subsequent to, the design and development of products and services, to the extent necessary to ensure that there is no adverse impact on conformity to requirements.

The organization shall retain documented information on:

a) design and development changes;

b) the results of reviews;

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c) the authorization of the changes;

d) the actions taken to prevent adverse impacts.

8.4 Control of externally provided processes, products and services

8.4.1 General

The organization shall ensure that externally provided processes, products and services conform to requirements.

The organization shall determine the controls to be applied to externally provided processes, products and services when:

a) products and services from external providers are intended for incorporation into the organization's own products and services;

b) products and services are provided directly to the customer(s) by external providers on behalf of the organization;

c) a process, or part of a process, is provided by an external provider as a result of a decision by the organization.

The organization shall determine and apply criteria for the evaluation, selection, monitoring of performance, and re-evaluation of external providers, based on their ability to provide processes or products and services in accordance with requirements. The organization shall retain documented information of these activities and any necessary actions arising from the evaluations.

8.4.2 Type and extent of control

The organization shall ensure that externally provided processes, products and services do not adversely affect the organization's ability to consistently deliver conforming products and services to its customers.

The organization shall:

a) ensure that externally provided processes remain within the control of its quality management system;

b) define both the controls that it intends to apply to an external provider and those it intends to apply to the resulting output;

c) take into consideration:

   1) the potential impact of the externally provided processes, products and services on the organization's ability to consistently meet customer and applicable statutory and regulatory requirements;

   2) the effectiveness of the controls applied by the external provider;

d) determine the verification, or other activities, necessary to ensure that the externally provided processes, products and services meet requirements.

8.4.3 Information for external providers

The organization shall ensure the adequacy of requirements prior to their communication to the external provider.

The organization shall communicate to external providers its requirements for:

a) the processes, products and services to be provided;

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b) the approval of:

   1) products and services;

   2) methods, processes and equipment;

   3) the release of products and services;

c) competence, including any required qualification of persons;

d) the external providers' interactions with the organization;

e) control and monitoring of the external providers' performance to be applied by the organization;

f) verification or validation activities that the organization, or its customer, intends to perform at the external providers' premises.

8.5 Production and service provision

8.5.1 Control of production and service provision

The organization shall implement production and service provision under controlled conditions.

Controlled conditions shall include, as applicable:

a) the availability of documented information that defines:

   1) the characteristics of the products to be produced, the services to be provided, or the activities to be performed;

   2) the results to be achieved;

b) the availability and use of suitable monitoring and measuring resources;

c) the implementation of monitoring and measurement activities at appropriate stages to verify that criteria for control of processes or outputs, and acceptance criteria for products and services, have been met;

d) the use of suitable infrastructure and environment for the operation of processes;

e) the appointment of competent persons, including any required qualification;

f) the validation, and periodic revalidation, of the ability to achieve planned results of the processes for production and service provision, where the resulting output cannot be verified by subsequent monitoring or measurement;

g) the implementation of actions to prevent human error;

h) the implementation of release, delivery and post-delivery activities.

8.5.2 Identification and traceability

The organization shall use suitable means to identify outputs when it is necessary to ensure the conformity of products and services.

The organization shall identify the status of outputs with respect to monitoring and measurement requirements throughout production and service provision.

The organization shall control the unique identification of the outputs when traceability is a requirement, and shall retain the documented information necessary to enable traceability.

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8.5.3 Property belonging to customers or external providers

The organization shall exercise care with property belonging to customers or external providers while it is under the organization's control or being used by the organization.

The organization shall identify, verify, protect and safeguard customers' or external providers' property provided for use or incorporation into the products and services.

When the property of a customer or external provider is lost, damaged or otherwise found to be unsuitable for use, the organization shall report this to the customer or external provider and retain documented information on what has occurred.

NOTE A customer's or external provider's property can include materials, components, tools and equipment, premises, intellectual property and personal data.

8.5.4 Preservation

The organization shall preserve the outputs during production and service provision, to the extent necessary to ensure conformity to requirements.

NOTE Preservation can include identification, handling, contamination control, packaging, storage, transmission or transportation, and protection.

8.5.5 Post-delivery activities

The organization shall meet requirements for post-delivery activities associated with the products and services.

In determining the extent of post-delivery activities that are required, the organization shall consider:

a) statutory and regulatory requirements;

b) the potential undesired consequences associated with its products and services;

c) the nature, use and intended lifetime of its products and services;

d) customer requirements;

e) customer feedback.

NOTE Post-delivery activities can include actions under warranty provisions, contractual obligations such as maintenance services, and supplementary services such as recycling or final disposal.

8.5.6 Control of changes

The organization shall review and control changes for production or service provision, to the extent necessary to ensure continuing conformity with requirements.

The organization shall retain documented information describing the results of the review of changes, the person(s) authorizing the change, and any necessary actions arising from the review.

8.6 Release of products and services

The organization shall implement planned arrangements, at appropriate stages, to verify that the product and service requirements have been met.

The release of products and services to the customer shall not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and, as applicable, by the customer.

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f) retain documented information as evidence of the implementation of the audit programme and the audit results.

NOTE See ISO 19011 for guidance.

9.3 Management review

9.3.1 General

Top management shall review the organization's quality management system, at planned intervals, to ensure its continuing suitability, adequacy, effectiveness and alignment with the strategic direction of the organization.

9.3.2 Management review inputs

The management review shall be planned and carried out taking into consideration:

a) the status of actions from previous management reviews;

b) changes in external and internal issues that are relevant to the quality management system;

c) information on the performance and effectiveness of the quality management system, including trends in:

1) customer satisfaction and feedback from relevant interested parties;

2) the extent to which quality objectives have been met;

3) process performance and conformity of products and services;

4) nonconformities and corrective actions;

5) monitoring and measurement results;

6) audit results;

7) the performance of external providers;

d) the adequacy of resources;

e) the effectiveness of actions taken to address risks and opportunities (see 6.1);

f) opportunities for improvement.

9.3.3 Management review outputs

The outputs of the management review shall include decisions and actions related to:

a) opportunities for improvement;

b) any need for changes to the quality management system;

c) resource needs.

The organization shall retain documented information as evidence of the results of management reviews.

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10 Improvement

10.1 General

The organization shall determine and select opportunities for improvement and implement any necessary actions to meet customer requirements and enhance customer satisfaction.

These shall include:

a) improving products and services to meet requirements as well as to address future needs and expectations;

b) correcting, preventing or reducing undesired effects;

c) improving the performance and effectiveness of the quality management system.

NOTE Examples of improvement can include correction, corrective action, continual improvement, breakthrough change, innovation and re-organization.

10.2 Nonconformity and corrective action

10.2.1 When a nonconformity occurs, including any arising from complaints, the organization shall:

a) react to the nonconformity and, as applicable:

   1) take action to control and correct it;

   2) deal with the consequences;

b) evaluate the need for action to eliminate the cause(s) of the nonconformity, in order that it does not recur or occur elsewhere, by:

   1) reviewing and analysing the nonconformity;

   2) determining the causes of the nonconformity;

   3) determining if similar nonconformities exist, or could potentially occur;

c) implement any action needed;

d) review the effectiveness of any corrective action taken;

e) update risks and opportunities determined during planning, if necessary;

f) make changes to the quality management system, if necessary.

Corrective actions shall be appropriate to the effects of the nonconformities encountered.

10.2.2 The organization shall retain documented information as evidence of:

a) the nature of the nonconformities and any subsequent actions taken;

b) the results of any corrective action.

10.3 Continual improvement

The organization shall continually improve the suitability, adequacy and effectiveness of the quality management system.

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The organization shall consider the results of analysis and evaluation, and the outputs from management review, to determine if there are needs or opportunities that shall be addressed as part of continual improvement.

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Annex A
(informative)

Clarification of new structure, terminology and concepts

A.1 Structure and terminology

The clause structure (i.e. clause sequence) and some of the terminology of this edition of this International Standard, in comparison with the previous edition (ISO 9001:2008), have been changed to improve alignment with other management systems standards.

There is no requirement in this International Standard for its structure and terminology to be applied to the documented information of an organization's quality management system.

The structure of clauses is intended to provide a coherent presentation of requirements, rather than a model for documenting an organization's policies, objectives and processes. The structure and content of documented information related to a quality management system can often be more relevant to its users if it relates to both the processes operated by the organization and information maintained for other purposes.

There is no requirement for the terms used by an organization to be replaced by the terms used in this International Standard to specify quality management system requirements. Organizations can choose to use terms which suit their operations (e.g. using "records", "documentation" or "protocols" rather than "documented information"; or "supplier", "partner" or "vendor" rather than "external provider"). Table A.1 shows the major differences in terminology between this edition of this International Standard and the previous edition.

Table A.1 — Major differences in terminology between ISO 9001:2008 and ISO 9001:2015

ISO 9001:2008	ISO 9001:2015
Products	Products and services
Exclusions	Not used (See Clause A.5 for clarification of applicability)
Management representative	Not used (Similar responsibilities and authorities are assigned but no requirement for a single management representative)
Documentation, quality manual, documented procedures, records	Documented information
Work environment	Environment for the operation of processes
Monitoring and measuring equipment	Monitoring and measuring resources
Purchased product	Externally provided products and services
Supplier	External provider

A.2 Products and services

ISO 9001:2008 used the term "product" to include all output categories. This edition of this International Standard uses "products and services". "Products and services" include all output categories (hardware, services, software and processed materials).

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The specific inclusion of "services" is intended to highlight the differences between products and services in the application of some requirements. The characteristic of services is that at least part of the output is realized at the interface with the customer. This means, for example, that conformity to requirements cannot necessarily be confirmed before service delivery.

In most cases, products and services are used together. Most outputs that organizations provide to customers, or are supplied to them by external providers, include both products and services. For example, a tangible or intangible product can have some associated service or a service can have some associated tangible or intangible product.

A.3 Understanding the needs and expectations of interested parties

Subclause 4.2 specifies requirements for the organization to determine the interested parties that are relevant to the quality management system and the requirements of those interested parties. However, 4.2 does not imply extension of quality management system requirements beyond the scope of this International Standard. As stated in the scope, this International Standard is applicable where an organization needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and aims to enhance customer satisfaction.

There is no requirement in this International Standard for the organization to consider interested parties where it has decided that those parties are not relevant to its quality management system. It is for the organization to decide if a particular requirement of a relevant interested party is relevant to its quality management system.

A.4 Risk-based thinking

The concept of risk-based thinking has been implicit in previous editions of this International Standard, e.g. through requirements for planning, review and improvement. This International Standard specifies requirements for the organization to understand its context (see 4.1) and determine risks as a basis for planning (see 6.1). This represents the application of risk-based thinking to planning and implementing quality management system processes (see 4.4) and will assist in determining the extent of documented information.

One of the key purposes of a quality management system is to act as a preventive tool. Consequently, this International Standard does not have a separate clause or subclause on preventive action. The concept of preventive action is expressed through the use of risk-based thinking in formulating quality management system requirements.

The risk-based thinking applied in this International Standard has enabled some reduction in prescriptive requirements and their replacement by performance-based requirements. There is greater flexibility than in ISO 9001:2008 in the requirements for processes, documented information and organizational responsibilities.

Although 6.1 specifies that the organization shall plan actions to address risks, there is no requirement for formal methods for risk management or a documented risk management process. Organizations can decide whether or not to develop a more extensive risk management methodology than is required by this International Standard, e.g. through the application of other guidance or standards.

Not all the processes of a quality management system represent the same level of risk in terms of the organization's ability to meet its objectives, and the effects of uncertainty are not the same for all organizations. Under the requirements of 6.1, the organization is responsible for its application of risk-based thinking and the actions it takes to address risk, including whether or not to retain documented information as evidence of its determination of risks.

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A.5 Applicability

This International Standard does not refer to "exclusions" in relation to the applicability of its requirements to the organization's quality management system. However, an organization can review the applicability of requirements due to the size or complexity of the organization, the management model it adopts, the range of the organization's activities and the nature of the risks and opportunities it encounters.

The requirements for applicability are addressed in 4.3, which defines conditions under which an organization can decide that a requirement cannot be applied to any of the processes within the scope of its quality management system. The organization can only decide that a requirement is not applicable if its decision will not result in failure to achieve conformity of products and services.

A.6 Documented information

As part of the alignment with other management system standards, a common clause on "documented information" has been adopted without significant change or addition (see 7.5). Where appropriate, text elsewhere in this International Standard has been aligned with its requirements. Consequently, "documented information" is used for all document requirements.

Where ISO 9001:2008 used specific terminology such as "document" or "documented procedures", "quality manual" or "quality plan", this edition of this International Standard defines requirements to "maintain documented information".

Where ISO 9001:2008 used the term "records" to denote documents needed to provide evidence of conformity with requirements, this is now expressed as a requirement to "retain documented information". The organization is responsible for determining what documented information needs to be retained, the period of time for which it is to be retained and the media to be used for its retention.

A requirement to "maintain" documented information does not exclude the possibility that the organization might also need to "retain" that same documented information for a particular purpose, e.g. to retain previous versions of it.

Where this International Standard refers to "information" rather than "documented information" (e.g. in 4.1: "The organization shall monitor and review the information about these external and internal issues"), there is no requirement that this information is to be documented. In such situations, the organization can decide whether or not it is necessary or appropriate to maintain documented information.

A.7 Organizational knowledge

In 7.1.6, this International Standard addresses the need to determine and manage the knowledge maintained by the organization, to ensure the operation of its processes and that it can achieve conformity of products and services.

Requirements regarding organizational knowledge were introduced for the purpose of:

a) safeguarding the organization from loss of knowledge, e.g.
   - through staff turnover;
   - failure to capture and share information;

b) encouraging the organization to acquire knowledge, e.g.
   - learning from experience;
   - mentoring;
   - benchmarking.

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A.8 Control of externally provided processes, products and services

All forms of externally provided processes, products and services are addressed in 8.4, e.g. whether through:

a) purchasing from a supplier;

b) an arrangement with an associate company;

c) outsourcing processes to an external provider.

Outsourcing always has the essential characteristic of a service, since it will have at least one activity necessarily performed at the interface between the provider and the organization.

The controls required for external provision can vary widely depending on the nature of the processes, products and services. The organization can apply risk-based thinking to determine the type and extent of controls appropriate to particular external providers and externally provided processes, products and services.

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Annex B
(informative)

Other International Standards on quality management and quality management systems developed by ISO/TC 176

The International Standards described in this annex have been developed by ISO/TC 176 to provide supporting information for organizations that apply this International Standard, and to provide guidance for organizations that choose to progress beyond its requirements. Guidance or requirements contained in the documents listed in this annex do not add to, or modify, the requirements of this International Standard.

Table B.1 shows the relationship between these standards and the relevant clauses of this International Standard.

This annex does not include reference to the sector-specific quality management system standards developed by ISO/TC 176.

This International Standard is one of the three core standards developed by ISO/TC 176.

— ISO 9000 *Quality management systems — Fundamentals and vocabulary* provides an essential background for the proper understanding and implementation of this International Standard. The quality management principles are described in detail in ISO 9000 and have been taken into consideration during the development of this International Standard. These principles are not requirements in themselves, but they form the foundation of the requirements specified by this International Standard. ISO 9000 also defines the terms, definitions and concepts used in this International Standard.

— ISO 9001 (this International Standard) specifies requirements aimed primarily at giving confidence in the products and services provided by an organization and thereby enhancing customer satisfaction. Its proper implementation can also be expected to bring other organizational benefits, such as improved internal communication, better understanding and control of the organization's processes.

— ISO 9004 *Managing for the sustained success of an organization — A quality management approach* provides guidance for organizations that choose to progress beyond the requirements of this International Standard, to address a broader range of topics that can lead to improvement of the organization's overall performance. ISO 9004 includes guidance on a self-assessment methodology for an organization to be able to evaluate the level of maturity of its quality management system.

ISO 9002: 2016: Quality management systems — Guidelines for the application of ISO 9001: 2015

The International Standards outlined below can provide assistance to organizations when they are establishing or seeking to improve their quality management systems, their processes or their activities.

— ISO 10001 *Quality management — Customer satisfaction — Guidelines for codes of conduct for organizations* provides guidance to an organization in determining that its customer satisfaction provisions meet customer needs and expectations. Its use can enhance customer confidence in an organization and improve customer understanding of what to expect from an organization, thereby reducing the likelihood of misunderstandings and complaints.

— ISO 10002 *Quality management — Customer satisfaction — Guidelines for complaints handling in organizations* provides guidance on the process of handling complaints by recognizing and addressing the needs and expectations of complainants and resolving any complaints received. ISO 10002 provides an open, effective and easy-to-use complaints process, including training of people. It also provides guidance for small businesses.

— ISO 10003 *Quality management — Customer satisfaction — Guidelines for dispute resolution external to organizations* provides guidance for effective and efficient external dispute resolution for

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product-related complaints. Dispute resolution gives an avenue of redress when organizations do not remedy a complaint internally. Most complaints can be resolved successfully within the organization, without adversarial procedures.

— ISO 10004 *Quality management — Customer satisfaction — Guidelines for monitoring and measuring* provides guidelines for actions to enhance customer satisfaction and to determine opportunities for improvement of products, processes and attributes that are valued by customers. Such actions can strengthen customer loyalty and help retain customers.

— ISO 10005 *Quality management systems — Guidelines for quality plans* provides guidance on establishing and using quality plans as a means of relating requirements of the process, product, project or contract, to work methods and practices that support product realization. Benefits of establishing a quality plan are increased confidence that requirements will be met, that processes are in control and the motivation that this can give to those involved.

— ISO 10006 *Quality management systems — Guidelines for quality management in projects* is applicable to projects from the small to large, from simple to complex, from an individual project to being part of a portfolio of projects. ISO 10006 is to be used by personnel managing projects and who need to ensure that their organization is applying the practices contained in the ISO quality management system standards.

— ISO 10007 *Quality management systems — Guidelines for configuration management* is to assist organizations applying configuration management for the technical and administrative direction over the life cycle of a product. Configuration management can be used to meet the product identification and traceability requirements specified in this International Standard.

— ISO 10008 *Quality management — Customer satisfaction — Guidelines for business-to-consumer electronic commerce transactions* gives guidance on how organizations can implement an effective and efficient business-to-consumer electronic commerce transaction (B2C ECT) system, and thereby provide a basis for consumers to have increased confidence in B2C ECTs, enhance the ability of organizations to satisfy consumers and help reduce complaints and disputes.

— ISO 10012 *Measurement management systems — Requirements for measurement processes and measuring equipment* provides guidance for the management of measurement processes and metrological confirmation of measuring equipment used to support and demonstrate compliance with metrological requirements. ISO 10012 provides quality management criteria for a measurement management system to ensure metrological requirements are met.

— ISO/TR 10013 *Guidelines for quality management system documentation* provides guidelines for the development and maintenance of the documentation necessary for a quality management system. ISO/TR 10013 can be used to document management systems other than those of the ISO quality management system standards, e.g. environmental management systems and safety management systems.

— ISO 10014 *Quality management — Guidelines for realizing financial and economic benefits* is addressed to top management. It provides guidelines for realizing financial and economic benefits through the application of quality management principles. It facilitates application of management principles and selection of methods and tools that enable the sustainable success of an organization.

— ISO 10015 *Quality management — Guidelines for training* provides guidelines to assist organizations in addressing issues related to training. ISO 10015 can be applied whenever guidance is required to interpret references to "education" and "training" within the ISO quality management system standards. Any reference to "training" includes all types of education and training.

— ISO/TR 10017 *Guidance on statistical techniques for ISO 9001:2000* explains statistical techniques which follow from the variability that can be observed in the behaviour and results of processes, even under conditions of apparent stability. Statistical techniques allow better use of available data to assist in decision making, and thereby help to continually improve the quality of products and processes to achieve customer satisfaction.

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— ISO 10018 *Quality management — Guidelines on people involvement and competence* provides guidelines which influence people involvement and competence. A quality management system depends on the involvement of competent people and the way that they are introduced and integrated into the organization. It is critical to determine, develop and evaluate the knowledge, skills, behaviour and work environment required.

— ISO 10019 *Guidelines for the selection of quality management system consultants and use of their services* provides guidance for the selection of quality management system consultants and the use of their services. It gives guidance on the process for evaluating the competence of a quality management system consultant and provides confidence that the organization's needs and expectations for the consultant's services will be met.

— ISO 19011 *Guidelines for auditing management systems* provides guidance on the management of an audit programme, on the planning and conducting of an audit of a management system, as well as on the competence and evaluation of an auditor and an audit team. ISO 19011 is intended to apply to auditors, organizations implementing management systems, and organizations needing to conduct audits of management systems.

Table B.1 — Relationship between other International Standards on quality management and quality management systems and the clauses of this International Standard

Other International Standard	Clause in this International Standard						
	4	5	6	7	8	9	10
ISO 9000	All	All	All	All	All	All	All
ISO 9004	All	All	All	All	All	All	All
ISO 10001					8.2.2, 8.5.1	9.1.2	
ISO 10002					8.2.1,	9.1.2	10.2.1
ISO 10003						9.1.2	
ISO 10004						9.1.2, 9.1.3	
ISO 10005		5.3	6.1, 6.2	All	All	9.1	10.2
ISO 10006	All	All	All	All	All	All	All
ISO 10007					8.5.2		
ISO 10008	All	All	All	All	All	All	All
ISO 10012				7.1.5			
ISO/TR 10013				7.5			
ISO 10014	All	All	All	All	All	All	All
ISO 10015				7.2			
ISO/TR 10017			6.1	7.1.5		9.1	
ISO 10018	All	All	All	All	All	All	All
ISO 10019					8.4		
ISO 19011						9.2	

NOTE "All" indicates that all the subclauses in the specific clause of this International Standard are related to the other International Standard.

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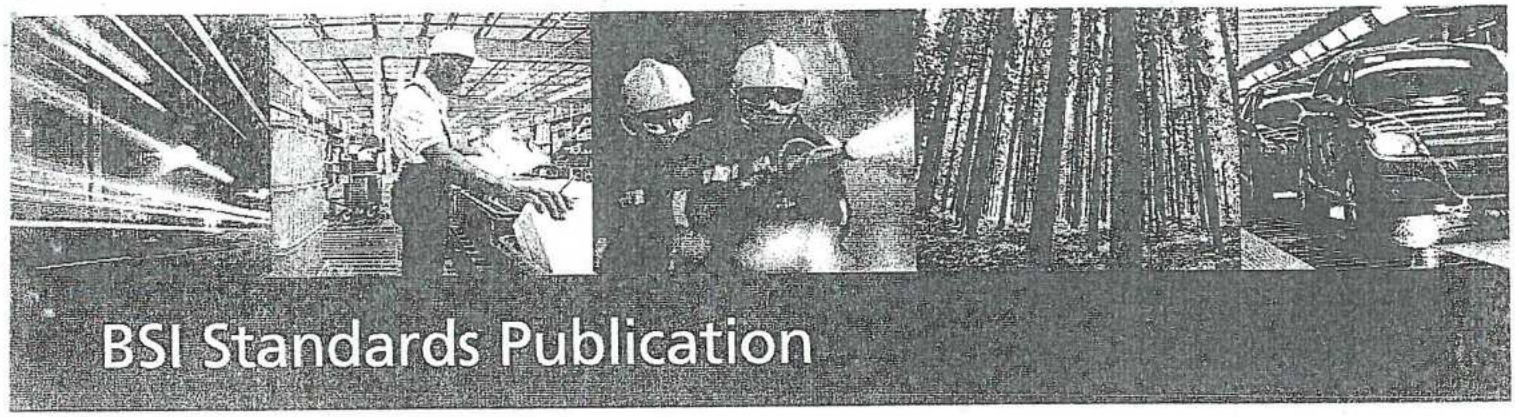
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National foreword

This British Standard is the UK implementation of EN ISO 14001:2015. It supersedes BS EN ISO 14001:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee SES/1/1, Environmental management systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 14001

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English Version

Environmental management systems - Requirements with guidance for use (ISO 14001:2015)

Systèmes de management environnemental - Exigences et lignes directrices pour son utilisation (ISO 14001:2015)

Umweltmanagementsysteme - Anforderungen mit Anleitung zur Anwendung (ISO 14001:2015)

This European Standard was approved by CEN on 14 September 2015.

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European foreword

This document (EN ISO 14001:2015) has been prepared by Technical Committee ISO/TC 207 "Environmental management".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2016, and conflicting national standards shall be withdrawn at the latest by March 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is Technical Committee ISO/TC 207, *Environmental management*, Subcommittee SC 1, *Environmental management systems*.

This third edition cancels and replaces the second edition (ISO 14001:2004), which has been technically revised. It also incorporates the Technical Corrigendum ISO 14001:2004/Cor.1:2009.

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Introduction

0.1 Background

Achieving a balance between the environment, society and the economy is considered essential to meet the needs of the present without compromising the ability of future generations to meet their needs. Sustainable development as a goal is achieved by balancing the three pillars of sustainability.

Societal expectations for sustainable development, transparency and accountability have evolved with increasingly stringent legislation, growing pressures on the environment from pollution, inefficient use of resources, improper waste management, climate change, degradation of ecosystems and loss of biodiversity.

This has led organizations to adopt a systematic approach to environmental management by implementing environmental management systems with the aim of contributing to the environmental pillar of sustainability.

0.2 Aim of an environmental management system

The purpose of this International Standard is to provide organizations with a framework to protect the environment and respond to changing environmental conditions in balance with socio-economic needs. It specifies requirements that enable an organization to achieve the intended outcomes it sets for its environmental management system.

A systematic approach to environmental management can provide top management with information to build success over the long term and create options for contributing to sustainable development by:

— protecting the environment by preventing or mitigating adverse environmental impacts;

— mitigating the potential adverse effect of environmental conditions on the organization;

— assisting the organization in the fulfilment of compliance obligations;

— enhancing environmental performance;

— controlling or influencing the way the organization's products and services are designed, manufactured, distributed, consumed and disposed by using a life cycle perspective that can prevent environmental impacts from being unintentionally shifted elsewhere within the life cycle;

— achieving financial and operational benefits that can result from implementing environmentally sound alternatives that strengthen the organization's market position;

— communicating environmental information to relevant interested parties.

This International Standard, like other International Standards, is not intended to increase or change an organization's legal requirements.

0.3 Success factors

The success of an environmental management system depends on commitment from all levels and functions of the organization, led by top management. Organizations can leverage opportunities to prevent or mitigate adverse environmental impacts and enhance beneficial environmental impacts, particularly those with strategic and competitive implications. Top management can effectively address its risks and opportunities by integrating environmental management into the organization's business processes, strategic direction and decision making, aligning them with other business priorities, and incorporating environmental governance into its overall management system. Demonstration of successful implementation of this International Standard can be used to assure interested parties that an effective environmental management system is in place.

Adoption of this International Standard, however, will not in itself guarantee optimal environmental outcomes. Application of this International Standard can differ from one organization to another

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due to the context of the organization. Two organizations can carry out similar activities but can have different compliance obligations, commitments in their environmental policy, environmental technologies and environmental performance goals, yet both can conform to the requirements of this International Standard.

The level of detail and complexity of the environmental management system will vary depending on the context of the organization, the scope of its environmental management system, its compliance obligations, and the nature of its activities, products and services, including its environmental aspects and associated environmental impacts.

0.4 Plan-Do-Check-Act model

The basis for the approach underlying an environmental management system is founded on the concept of Plan-Do-Check-Act (PDCA). The PDCA model provides an iterative process used by organizations to achieve continual improvement. It can be applied to an environmental management system and to each of its individual elements. It can be briefly described as follows.

— Plan: establish environmental objectives and processes necessary to deliver results in accordance with the organization's environmental policy.

— Do: implement the processes as planned.

— Check: monitor and measure processes against the environmental policy, including its commitments, environmental objectives and operating criteria, and report the results.

— Act: take actions to continually improve.

Figure 1 shows how the framework introduced in this International Standard could be integrated into a PDCA model, which can help new and existing users to understand the importance of a systems approach.

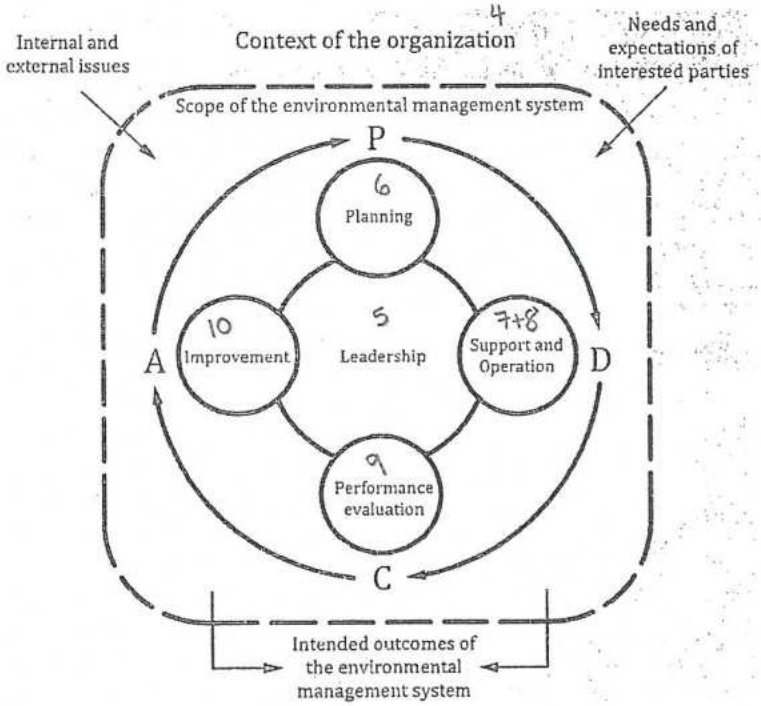


Figure 1 — Relationship between PDCA and the framework in this International Standard

0.5 Contents of this International Standard

This International Standard conforms to ISO's requirements for management system standards. These requirements include a high level structure, identical core text, and common terms with core definitions, designed to benefit users implementing multiple ISO management system standards.

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This International Standard does not include requirements specific to other management systems, such as those for quality, occupational health and safety, energy or financial management. However, this International Standard enables an organization to use a common approach and risk-based thinking to integrate its environmental management system with the requirements of other management systems.

This International Standard contains the requirements used to assess conformity. An organization that wishes to demonstrate conformity with this International Standard can do so by:

— making a self-determination and self-declaration, or

— seeking confirmation of its conformance by parties having an interest in the organization, such as customers, or

— seeking confirmation of its self-declaration by a party external to the organization, or

— seeking certification/registration of its environmental management system by an external organization.

Annex A provides explanatory information to prevent misinterpretation of the requirements of this International Standard. Annex B shows broad technical correspondence between the previous edition of this International Standard and this edition. Implementation guidance on environmental management systems is included in ISO 14004.

In this International Standard, the following verbal forms are used:

— "shall" indicates a requirement;

— "should" indicates a recommendation;

— "may" indicates a permission;

— "can" indicates a possibility or a capability.

Information marked as "NOTE" is intended to assist the understanding or use of the document. "Notes to entry" used in Clause 3 provide additional information that supplements the terminological data and can contain provisions relating to the use of a term.

The terms and definitions in Clause 3 are arranged in conceptual order, with an alphabetical index provided at the end of the document.

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Environmental management systems — Requirements with guidance for use

1 Scope

This International Standard specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance. This International Standard is intended for use by an organization seeking to manage its environmental responsibilities in a systematic manner that contributes to the environmental pillar of sustainability.

This International Standard helps an organization achieve the intended outcomes of its environmental management system, which provide value for the environment, the organization itself and interested parties. Consistent with the organization's environmental policy, the intended outcomes of an environmental management system include:

— enhancement of environmental performance;

— fulfilment of compliance obligations;

— achievement of environmental objectives.

This International Standard is applicable to any organization, regardless of size, type and nature, and applies to the environmental aspects of its activities, products and services that the organization determines it can either control or influence considering a life cycle perspective. This International Standard does not state specific environmental performance criteria.

This International Standard can be used in whole or in part to systematically improve environmental management. Claims of conformity to this International Standard, however, are not acceptable unless all its requirements are incorporated into an organization's environmental management system and fulfilled without exclusion.

2 Normative references

There are no normative references.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Terms related to organization and leadership

3.1.1
management system
set of interrelated or interacting elements of an *organization* (3.1.4) to establish policies and *objectives* (3.2.5) and *processes* (3.3.5) to achieve those objectives

Note 1 to entry: A management system can address a single discipline or several disciplines (e.g. quality, environment, occupational health and safety, energy, financial management).

Note 2 to entry: The system elements include the organization's structure, roles and responsibilities, planning and operation, performance evaluation and improvement.

Note 3 to entry: The scope of a management system can include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.

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3.1.2
environmental management system
part of the *management system* (3.1.1) used to manage *environmental aspects* (3.2.2), fulfil *compliance obligations* (3.2.9), and address *risks and opportunities* (3.2.11)

3.1.3
environmental policy
intentions and direction of an *organization* (3.1.4) related to *environmental performance* (3.4.11), as formally expressed by its *top management* (3.1.5)

3.1.4
organization
person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its *objectives* (3.2.5)

Note 1 to entry: The concept of organization includes, but is not limited to sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

3.1.5
top management
person or group of people who directs and controls an *organization* (3.1.4) at the highest level

Note 1 to entry: Top management has the power to delegate authority and provide resources within the organization.

Note 2 to entry: If the scope of the *management system* (3.1.1) covers only part of an organization, then top management refers to those who direct and control that part of the organization.

3.1.6
interested party
person or *organization* (3.1.4) that can affect, be affected by, or perceive itself to be affected by a decision or activity

EXAMPLE Customers, communities, suppliers, regulators, non-governmental organizations, investors and employees.

Note 1 to entry: To "perceive itself to be affected" means the perception has been made known to the organization.

3.2 Terms related to planning

3.2.1
environment
surroundings in which an *organization* (3.1.4) operates, including air, water, land, natural resources, flora, fauna, humans and their interrelationships

Note 1 to entry: Surroundings can extend from within an organization to the local, regional and global system.

Note 2 to entry: Surroundings can be described in terms of biodiversity, ecosystems, climate or other characteristics.

3.2.2
environmental aspect
element of an *organization's* (3.1.4) activities or products or services that interacts or can interact with the *environment* (3.2.1)

Note 1 to entry: An environmental aspect can cause (an) *environmental impact(s)* (3.2.4). A significant environmental aspect is one that has or can have one or more significant environmental impact(s).

Note 2 to entry: Significant environmental aspects are determined by the organization applying one or more criteria.

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3.2.3
environmental condition
state or characteristic of the *environment* (3.2.1) as determined at a certain point in time

3.2.4
environmental impact
change to the *environment* (3.2.1), whether adverse or beneficial, wholly or partially resulting from *organization's* (3.1.4) *environmental aspects* (3.2.2)

3.2.5
objective
result to be achieved

Note 1 to entry: An objective can be strategic, tactical, or operational.

Note 2 to entry: Objectives can relate to different disciplines (such as financial, health and safety, environmental goals) and can apply at different levels (such as strategic, organization-wide, project, proc service and *process* (3.3.5)).

Note 3 to entry: An objective can be expressed in other ways, e.g. as an intended outcome, a purpos operational criterion, as an *environmental objective* (3.2.6), or by the use of other words with similar mea (e.g. aim, goal, or target).

3.2.6
environmental objective
objective (3.2.5) set by the *organization* (3.1.4) consistent with its *environmental policy* (3.1.3)

3.2.7
prevention of pollution
use of *processes* (3.3.5), practices, techniques, materials, products, services or energy to avoid, re or control (separately or in combination) the creation, emission or discharge of any type of polluta waste, in order to reduce adverse *environmental impacts* (3.2.4)

Note 1 to entry: Prevention of pollution can include source reduction or elimination; process, product or se changes; efficient use of resources; material and energy substitution; reuse; recovery; recycling, reclam or treatment.

3.2.8
requirement
need or expectation that is stated, generally implied or obligatory

Note 1 to entry: "Generally implied" means that it is custom or common practice for the *organization* (3.1. *interested parties* (3.1.6) that the need or expectation under consideration is implied.

Note 2 to entry: A specified requirement is one that is stated, for example in *documented information* (3.3.2

Note 3 to entry: Requirements other than legal requirements become obligatory when the organization d to comply with them.

3.2.9
compliance obligations (preferred term)
legal requirements and other requirements (admitted term)
legal *requirements* (3.2.8) that an *organization* (3.1.4) has to comply with and other requirement an organization has to or chooses to comply with

Note 1 to entry: Compliance obligations are related to the *environmental management system* (3.1.2).

Note 2 to entry: Compliance obligations can arise from mandatory requirements, such as applicable la regulations, or voluntary commitments, such as organizational and industry standards, contractual relatio codes of practice and agreements with community groups or non-governmental organizations.

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3.2.10
risk
effect of uncertainty

Note 1 to entry: An effect is a deviation from the expected — positive or negative.

Note 2 to entry: Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

Note 3 to entry: Risk is often characterized by reference to potential *"events"* (as defined in ISO Guide 73:2009, 3.5.1.3) and *"consequences"* (as defined in ISO Guide 73:2009, 3.6.1.3), or a combination of these.

Note 4 to entry: Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated *"likelihood"* (as defined in ISO Guide 73:2009, 3.6.1.1) of occurrence.

3.2.11
risks and opportunities
potential adverse effects (threats) and potential beneficial effects (opportunities)

3.3 Terms related to support and operation

3.3.1
competence
ability to apply knowledge and skills to achieve intended results

3.3.2
documented information
information required to be controlled and maintained by an *organization* (3.1.4) and the medium on which it is contained

Note 1 to entry: Documented information can be in any format and media, and from any source.

Note 2 to entry: Documented information can refer to:

— the *environmental management system* (3.1.2), including related *processes* (3.3.5);

— information created in order for the organization to operate (can be referred to as documentation);

— evidence of results achieved (can be referred to as records).

3.3.3
life cycle
consecutive and interlinked stages of a product (or service) system, from raw material acquisition or generation from natural resources to final disposal

Note 1 to entry: The life cycle stages include acquisition of raw materials, design, production, transportation/delivery, use, end-of-life treatment and final disposal.

[SOURCE: ISO 14044:2006, 3.1, modified — The words "(or service)" have been added to the definition and Note 1 to entry has been added.]

3.3.4
outsource (verb)
make an arrangement where an external *organization* (3.1.4) performs part of an organization's function or *process* (3.3.5)

Note 1 to entry: An external organization is outside the scope of the *management system* (3.1.1), although the outsourced function or process is within the scope.

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3.3.5
process
set of interrelated or interacting activities which transforms inputs into outputs

Note 1 to entry: A process can be documented or not.

3.4 Terms related to performance evaluation and improvement

3.4.1
audit
systematic, independent and documented *process* (3.3.5) for obtaining audit evidence and evaluating it objectively to determine the extent to which the audit criteria are fulfilled

Note 1 to entry: An internal audit is conducted by the *organization* (3.1.4) itself, or by an external party on its behalf.

Note 2 to entry: An audit can be a combined audit (combining two or more disciplines).

Note 3 to entry: Independence can be demonstrated by the freedom from responsibility for the activity being audited or freedom from bias and conflict of interest.

Note 4 to entry: "Audit evidence" consists of records, statements of fact or other information which are relevant to the audit criteria and are verifiable; and "audit criteria" are the set of policies, procedures or *requirements* (3.2.8) used as a reference against which audit evidence is compared, as defined in ISO 19011:2011, 3.3 and 3.2 respectively.

3.4.2
conformity
fulfilment of a *requirement* (3.2.8)

3.4.3
nonconformity
non-fulfilment of a *requirement* (3.2.8)

Note 1 to entry: Nonconformity relates to requirements in this International Standard and additional *environmental management system* (3.1.2) requirements that an *organization* (3.1.4) establishes for itself.

3.4.4
corrective action
action to eliminate the cause of a *nonconformity* (3.4.3) and to prevent recurrence

Note 1 to entry: There can be more than one cause for a nonconformity.

3.4.5
continual improvement
recurring activity to enhance *performance* (3.4.10)

Note 1 to entry: Enhancing performance relates to the use of the *environmental management system* (3.1.2) to enhance *environmental performance* (3.4.11) consistent with the *organization's* (3.1.4) *environmental policy* (3.1.3).

Note 2 to entry: The activity need not take place in all areas simultaneously, or without interruption.

3.4.6
effectiveness
extent to which planned activities are realized and planned results achieved

3.4.7
indicator
measurable representation of the condition or status of operations, management or conditions

[SOURCE: ISO 14031:2013, 3.15]

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3.4.8
monitoring
determining the status of a system, a *process* (3.3.5) or an activity

Note 1 to entry: To determine the status, there might be a need to check, supervise or critically observe.

3.4.9
measurement
process (3.3.5) to determine a value

3.4.10
performance
measurable result

Note 1 to entry: Performance can relate either to quantitative or qualitative findings.

Note 2 to entry: Performance can relate to the management of activities, *processes* (3.3.5), products (including services), systems or *organizations* (3.1.4).

3.4.11
environmental performance
performance (3.4.10) related to the management of *environmental aspects* (3.2.2)

Note 1 to entry: For an *environmental management system* (3.1.2), results can be measured against the *organization's* (3.1.4) *environmental policy* (3.1.3), *environmental objectives* (3.2.6) or other criteria, using *indicators* (3.4.7).

4 Context of the organization

4.1 Understanding the organization and its context

The organization shall determine external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended outcomes of its environmental management system. Such issues shall include environmental conditions being affected by or capable of affecting the organization.

4.2 Understanding the needs and expectations of interested parties

The organization shall determine:

a) the interested parties that are relevant to the environmental management system;

b) the relevant needs and expectations (i.e. requirements) of these interested parties;

c) which of these needs and expectations become its compliance obligations.

4.3 Determining the scope of the environmental management system

The organization shall determine the boundaries and applicability of the environmental management system to establish its scope.

When determining this scope, the organization shall consider:

a) the external and internal issues referred to in 4.1;

b) the compliance obligations referred to in 4.2;

c) its organizational units, functions and physical boundaries;

d) its activities, products and services;

e) its authority and ability to exercise control and influence.

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Once the scope is defined, all activities, products and services of the organization within that scope need to be included in the environmental management system.

The scope shall be maintained as documented information and be available to interested parties.

4.4 Environmental management system

To achieve the intended outcomes, including enhancing its environmental performance, the organization shall establish, implement, maintain and continually improve an environmental management system, including the processes needed and their interactions, in accordance with the requirements of this International Standard.

The organization shall consider the knowledge gained in 4.1 and 4.2 when establishing and maintaining the environmental management system.

5 Leadership

5.1 Leadership and commitment

Top management shall demonstrate leadership and commitment with respect to the environmental management system by:

a) taking accountability for the effectiveness of the environmental management system;

b) ensuring that the environmental policy and environmental objectives are established and are compatible with the strategic direction and the context of the organization;

c) ensuring the integration of the environmental management system requirements into the organization's business processes;

d) ensuring that the resources needed for the environmental management system are available;

e) communicating the importance of effective environmental management and of conforming to the environmental management system requirements;

f) ensuring that the environmental management system achieves its intended outcomes;

g) directing and supporting persons to contribute to the effectiveness of the environmental management system;

h) promoting continual improvement;

i) supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

NOTE Reference to "business" in this International Standard can be interpreted broadly to mean those activities that are core to the purposes of the organization's existence.

5.2 Environmental policy

Top management shall establish, implement and maintain an environmental policy that, within the defined scope of its environmental management system:

a) is appropriate to the purpose and context of the organization, including the nature, scale and environmental impacts of its activities, products and services;

b) provides a framework for setting environmental objectives;

c) includes a commitment to the protection of the environment, including prevention of pollution and other specific commitment(s) relevant to the context of the organization;

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NOTE Other specific commitment(s) to protect the environment can include sustainable resource use, climate change mitigation and adaptation, and protection of biodiversity and ecosystems.

d) includes a commitment to fulfil its compliance obligations;

e) includes a commitment to continual improvement of the environmental management system to enhance environmental performance.

The environmental policy shall:

— be maintained as documented information;

— be communicated within the organization;

— be available to interested parties.

5.3 Organizational roles, responsibilities and authorities

Top management shall ensure that the responsibilities and authorities for relevant roles are assigned and communicated within the organization.

Top management shall assign the responsibility and authority for:

a) ensuring that the environmental management system conforms to the requirements of this International Standard;

b) reporting on the performance of the environmental management system, including environmental performance, to top management.

6 Planning

6.1 Actions to address risks and opportunities

6.1.1 General

The organization shall establish, implement and maintain the process(es) needed to meet the requirements in 6.1.1 to 6.1.4.

When planning for the environmental management system, the organization shall consider:

a) the issues referred to in 4.1;

b) the requirements referred to in 4.2;

c) the scope of its environmental management system;

and determine the risks and opportunities, related to its environmental aspects (see 6.1.2), compliance obligations (see 6.1.3) and other issues and requirements, identified in 4.1 and 4.2, that need to be addressed to:

— give assurance that the environmental management system can achieve its intended outcomes;

— prevent or reduce undesired effects, including the potential for external environmental conditions to affect the organization;

— achieve continual improvement.

Within the scope of the environmental management system, the organization shall determine potential emergency situations, including those that can have an environmental impact.

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The organization shall maintain documented information of its:

— risks and opportunities that need to be addressed;

— process(es) needed in 6.1.1 to 6.1.4, to the extent necessary to have confidence they are carried out as planned.

6.1.2 Environmental aspects

Within the defined scope of the environmental management system, the organization shall determine the environmental aspects of its activities, products and services that it can control and those that it can influence, and their associated environmental impacts, considering a life cycle perspective.

When determining environmental aspects, the organization shall take into account:

a) change, including planned or new developments, and new or modified activities, products and services;

b) abnormal conditions and reasonably foreseeable emergency situations.

The organization shall determine those aspects that have or can have a significant environmental impact, i.e. significant environmental aspects, by using established criteria.

The organization shall communicate its significant environmental aspects among the various levels and functions of the organization, as appropriate.

The organization shall maintain documented information of its:

— environmental aspects and associated environmental impacts;

— criteria used to determine its significant environmental aspects;

— significant environmental aspects.

NOTE Significant environmental aspects can result in risks and opportunities associated with either adverse environmental impacts (threats) or beneficial environmental impacts (opportunities).

6.1.3 Compliance obligations

The organization shall:

a) determine and have access to the compliance obligations related to its environmental aspects;

b) determine how these compliance obligations apply to the organization;

c) take these compliance obligations into account when establishing, implementing, maintaining and continually improving its environmental management system.

The organization shall maintain documented information of its compliance obligations.

NOTE Compliance obligations can result in risks and opportunities to the organization.

6.1.4 Planning action

The organization shall plan:

a) to take actions to address its:

1) significant environmental aspects;

2) compliance obligations;

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3) risks and opportunities identified in 6.1.1;

b) how to:

1) integrate and implement the actions into its environmental management system processes (see 6.2, Clause 7, Clause 8 and 9.1), or other business processes;

2) evaluate the effectiveness of these actions (see 9.1).

When planning these actions, the organization shall consider its technological options and its financial, operational and business requirements.

6.2 Environmental objectives and planning to achieve them

6.2.1 Environmental objectives

The organization shall establish environmental objectives at relevant functions and levels, taking into account the organization's significant environmental aspects and associated compliance obligations, and considering its risks and opportunities.

The environmental objectives shall be:

a) consistent with the environmental policy;

b) measurable (if practicable);

c) monitored;

d) communicated;

e) updated as appropriate.

The organization shall maintain documented information on the environmental objectives.

6.2.2 Planning actions to achieve environmental objectives

When planning how to achieve its environmental objectives, the organization shall determine:

a) what will be done;

b) what resources will be required;

c) who will be responsible;

d) when it will be completed;

e) how the results will be evaluated, including indicators for monitoring progress toward achievement of its measurable environmental objectives (see 9.1.1).

The organization shall consider how actions to achieve its environmental objectives can be integrated into the organization's business processes.

7 Support

7.1 Resources

The organization shall determine and provide the resources needed for the establishment, implementation, maintenance and continual improvement of the environmental management system.

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7.2 Competence

The organization shall:

a) determine the necessary competence of person(s) doing work under its control that affects its environmental performance and its ability to fulfil its compliance obligations;

b) ensure that these persons are competent on the basis of appropriate education, training or experience;

c) determine training needs associated with its environmental aspects and its environmental management system;

d) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken.

NOTE Applicable actions can include, for example, the provision of training to, the mentoring of, or the re-assignment of currently employed persons; or the hiring or contracting of competent persons.

The organization shall retain appropriate documented information as evidence of competence.

7.3 Awareness

The organization shall ensure that persons doing work under the organization's control are aware of:

a) the environmental policy;

b) the significant environmental aspects and related actual or potential environmental impacts associated with their work;

c) their contribution to the effectiveness of the environmental management system, including the benefits of enhanced environmental performance;

d) the implications of not conforming with the environmental management system requirements, including not fulfilling the organization's compliance obligations.

7.4 Communication

7.4.1 General

The organization shall establish, implement and maintain the process(es) needed for internal and external communications relevant to the environmental management system, including:

a) on what it will communicate;

b) when to communicate;

c) with whom to communicate;

d) how to communicate.

When establishing its communication process(es), the organization shall:

— take into account its compliance obligations;

— ensure that environmental information communicated is consistent with information generated within the environmental management system, and is reliable.

The organization shall respond to relevant communications on its environmental management system.

The organization shall retain documented information as evidence of its communications, as appropriate.

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7.4.2 Internal communication

The organization shall:

a) internally communicate information relevant to the environmental management system among the various levels and functions of the organization, including changes to the environmental management system, as appropriate;

b) ensure its communication process(es) enable(s) persons doing work under the organization's control to contribute to continual improvement.

7.4.3 External communication

The organization shall externally communicate information relevant to the environmental management system, as established by the organization's communication process(es) and as required by its compliance obligations.

7.5 Documented information

7.5.1 General

The organization's environmental management system shall include:

a) documented information required by this International Standard;

b) documented information determined by the organization as being necessary for the effectiveness of the environmental management system.

NOTE The extent of documented information for an environmental management system can differ from one organization to another due to:

— the size of organization and its type of activities, processes, products and services;

— the need to demonstrate fulfilment of its compliance obligations;

— the complexity of processes and their interactions;

— the competence of persons doing work under the organization's control.

7.5.2 Creating and updating

When creating and updating documented information, the organization shall ensure appropriate:

a) identification and description (e.g. a title, date, author, or reference number);

b) format (e.g. language, software version, graphics) and media (e.g. paper, electronic);

c) review and approval for suitability and adequacy.

7.5.3 Control of documented information

Documented information required by the environmental management system and by this International Standard shall be controlled to ensure:

a) it is available and suitable for use, where and when it is needed;

b) it is adequately protected (e.g. from loss of confidentiality, improper use, or loss of integrity).

For the control of documented information, the organization shall address the following activities as applicable:

— distribution, access, retrieval and use;

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— storage and preservation, including preservation of legibility;

— control of changes (e.g. version control);

— retention and disposition.

Documented information of external origin determined by the organization to be necessary for the planning and operation of the environmental management system shall be identified, as appropriate, and controlled.

NOTE Access can imply a decision regarding the permission to view the documented information only, or the permission and authority to view and change the documented information.

8 Operation

8.1 Operational planning and control

The organization shall establish, implement, control and maintain the processes needed to meet environmental management system requirements, and to implement the actions identified in 6.1 and 6.2, by:

— establishing operating criteria for the process(es);

— implementing control of the process(es), in accordance with the operating criteria.

NOTE Controls can include engineering controls and procedures. Controls can be implemented following a hierarchy (e.g. elimination, substitution, administrative) and can be used individually or in combination.

The organization shall control planned changes and review the consequences of unintended changes, taking action to mitigate any adverse effects, as necessary.

The organization shall ensure that outsourced processes are controlled or influenced. The type and extent of control or influence to be applied to the process(es) shall be defined within the environmental management system.

Consistent with a life cycle perspective, the organization shall:

a) establish controls, as appropriate, to ensure that its environmental requirement(s) is (are) addressed in the design and development process for the product or service, considering each life cycle stage;

b) determine its environmental requirement(s) for the procurement of products and services, as appropriate;

c) communicate its relevant environmental requirement(s) to external providers, including contractors;

d) consider the need to provide information about potential significant environmental impacts associated with the transportation or delivery, use, end-of-life treatment and final disposal of its products and services.

The organization shall maintain documented information to the extent necessary to have confidence that the processes have been carried out as planned.

8.2 Emergency preparedness and response

The organization shall establish, implement and maintain the process(es) needed to prepare for and respond to potential emergency situations identified in 6.1.1.

The organization shall:

a) prepare to respond by planning actions to prevent or mitigate adverse environmental impacts from emergency situations;

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b) respond to actual emergency situations;

c) take action to prevent or mitigate the consequences of emergency situations, appropriate to the magnitude of the emergency and the potential environmental impact;

d) periodically test the planned response actions, where practicable;

e) periodically review and revise the process(es) and planned response actions, in particular after the occurrence of emergency situations or tests;

f) provide relevant information and training related to emergency preparedness and response, as appropriate, to relevant interested parties, including persons working under its control.

The organization shall maintain documented information to the extent necessary to have confidence that the process(es) is (are) carried out as planned.

9 Performance evaluation

9.1 Monitoring, measurement, analysis and evaluation

9.1.1 General

The organization shall monitor, measure, analyse and evaluate its environmental performance.

The organization shall determine:

a) what needs to be monitored and measured;

b) the methods for monitoring, measurement, analysis and evaluation, as applicable, to ensure valid results;

c) the criteria against which the organization will evaluate its environmental performance, and appropriate indicators;

d) when the monitoring and measuring shall be performed;

e) when the results from monitoring and measurement shall be analysed and evaluated.

The organization shall ensure that calibrated or verified monitoring and measurement equipment is used and maintained, as appropriate.

The organization shall evaluate its environmental performance and the effectiveness of the environmental management system.

The organization shall communicate relevant environmental performance information both internally and externally, as identified in its communication process(es) and as required by its compliance obligations.

The organization shall retain appropriate documented information as evidence of the monitoring, measurement, analysis and evaluation results.

9.1.2 Evaluation of compliance

The organization shall establish, implement and maintain the process(es) needed to evaluate fulfilment of its compliance obligations.

The organization shall:

a) determine the frequency that compliance will be evaluated;

b) evaluate compliance and take action if needed;

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c) maintain knowledge and understanding of its compliance status.

The organization shall retain documented information as evidence of the compliance evaluation result(s).

9.2 Internal audit

9.2.1 General

The organization shall conduct internal audits at planned intervals to provide information on whether the environmental management system:

a) conforms to:

1) the organization's own requirements for its environmental management system;

2) the requirements of this International Standard;

b) is effectively implemented and maintained.

9.2.2 Internal audit programme

The organization shall establish, implement and maintain (an) internal audit programme(s), including the frequency, methods, responsibilities, planning requirements and reporting of its internal audits.

When establishing the internal audit programme, the organization shall take into consideration the environmental importance of the processes concerned, changes affecting the organization and the results of previous audits.

The organization shall:

a) define the audit criteria and scope for each audit;

b) select auditors and conduct audits to ensure objectivity and the impartiality of the audit process;

c) ensure that the results of the audits are reported to relevant management.

The organization shall retain documented information as evidence of the implementation of the audit programme and the audit results.

9.3 Management review

Top management shall review the organization's environmental management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness.

The management review shall include consideration of:

a) the status of actions from previous management reviews;

b) changes in:

1) external and internal issues that are relevant to the environmental management system;

2) the needs and expectations of interested parties, including compliance obligations;

3) its significant environmental aspects;

4) risks and opportunities;

c) the extent to which environmental objectives have been achieved;

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d) information on the organization's environmental performance, including trends in:

1) nonconformities and corrective actions;

2) monitoring and measurement results;

3) fulfilment of its compliance obligations;

4) audit results;

e) adequacy of resources;

f) relevant communication(s) from interested parties, including complaints;

g) opportunities for continual improvement.

The outputs of the management review shall include:

— conclusions on the continuing suitability, adequacy and effectiveness of the environmental management system;

— decisions related to continual improvement opportunities;

— decisions related to any need for changes to the environmental management system, including resources;

— actions, if needed, when environmental objectives have not been achieved;

— opportunities to improve integration of the environmental management system with other business processes, if needed;

— any implications for the strategic direction of the organization.

The organization shall retain documented information as evidence of the results of management reviews.

10 Improvement

10.1 General

The organization shall determine opportunities for improvement (see 9.1, 9.2 and 9.3) and implement necessary actions to achieve the intended outcomes of its environmental management system.

10.2 Nonconformity and corrective action

When a nonconformity occurs, the organization shall:

a) react to the nonconformity and, as applicable:

1) take action to control and correct it;

2) deal with the consequences, including mitigating adverse environmental impacts;

b) evaluate the need for action to eliminate the causes of the nonconformity, in order that it does not recur or occur elsewhere, by:

1) reviewing the nonconformity;

2) determining the causes of the nonconformity;

3) determining if similar nonconformities exist, or could potentially occur;

c) implement any action needed;

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d) review the effectiveness of any corrective action taken;

e) make changes to the environmental management system, if necessary.

Corrective actions shall be appropriate to the significance of the effects of the nonconformities encountered, including the environmental impact(s).

The organization shall retain documented information as evidence of:

— the nature of the nonconformities and any subsequent actions taken;

— the results of any corrective action.

10.3 Continual improvement

The organization shall continually improve the suitability, adequacy and effectiveness of the environmental management system to enhance environmental performance.

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Annex A
(informative)

Guidance on the use of this International Standard

A.1 General

The explanatory information given in this annex is intended to prevent misinterpretation of the requirements contained in this International Standard. While this information addresses and is consistent with these requirements, it is not intended to add to, subtract from, or in any way modify them.

The requirements in this International Standard need to be viewed from a systems or holistic perspective. The user should not read a particular sentence or clause of this International Standard in isolation from other clauses. There is an interrelationship between the requirements in some clauses and the requirements in other clauses. For example, the organization needs to understand the relationship between the commitments in its environmental policy and the requirements that are specified in other clauses.

Management of change is an important part of maintaining the environmental management system that ensures the organization can achieve the intended outcomes of its environmental management system on an ongoing basis. Management of change is addressed in various requirements of this International Standard, including

— maintaining the environmental management system (see 4.4),

— environmental aspects (see 6.1.2),

— internal communication (see 7.4.2),

— operational control (see 8.1),

— internal audit programme (see 9.2.2), and

— management review (see 9.3).

As part of managing change, the organization should address planned and unplanned changes to ensure that the unintended consequences of these changes do not have a negative effect on the intended outcomes of the environmental management system. Examples of change include:

— planned changes to products, processes, operations, equipment or facilities;

— changes in staff or external providers, including contractors;

— new information related to environmental aspects, environmental impacts and related technologies;

— changes in compliance obligations.

A.2 Clarification of structure and terminology

The clause structure and some of the terminology of this International Standard have been changed to improve alignment with other management systems standards. There is, however, no requirement in this International Standard for its clause structure or terminology to be applied to an organization's environmental management system documentation. There is no requirement to replace the terms used by an organization with the terms used in this International Standard. Organizations can choose to use terms that suit their business, e.g. "records", "documentation", or "protocols", rather than "documented information".

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A.3 Clarification of concepts

In addition to the terms and definitions given in Clause 3, clarification of selected concepts is provided below to prevent misunderstanding.

— In this International Standard, the use of the word "any" implies selection or choice.

— The words "appropriate" and "applicable" are not interchangeable. "Appropriate" means suitable (for, to) and implies some degree of freedom, while "applicable" means relevant or possible to apply and implies that if it can be done, it needs to be done.

— The word "consider" means it is necessary to think about the topic but it can be excluded; whereas "take into account" means it is necessary to think about the topic but it cannot be excluded.

— "Continual" indicates duration that occurs over a period of time, but with intervals of interruption (unlike "continuous" which indicates duration without interruption). "Continual" is therefore the appropriate word to use when referring to improvement.

— In this International Standard, the word "effect" is used to describe the result of a change to the organization. The phrase "environmental impact" refers specifically to the result of a change to the environment.

— The word "ensure" means the responsibility can be delegated, but not the accountability.

— This International Standard uses the term "interested party"; the term "stakeholder" is a synonym as it represents the same concept.

This International Standard uses some new terminology. A brief explanation is given below to aid both new users and those who have used previous editions of this International Standard.

— The phrase "compliance obligations" replaces the phrase "legal requirements and other requirements to which the organization subscribes" used in the previous edition of this International Standard. The intent of this new phrase does not differ from that of the previous edition.

— "Documented information" replaces the nouns "documentation", "documents" and "records" used in previous editions of this International Standard. To distinguish the intent of the generic term "documented information", this International Standard now uses the phrase "retain documented information as evidence of...." to mean records, and "maintain documented information" to mean documentation other than records. The phrase "as evidence of...." is not a requirement to meet legal evidentiary requirements; its intent is only to indicate objective evidence needs to be retained.

— The phrase "external provider" means an external supplier organization (including a contractor) that provides a product or a service.

— The change from "identify" to "determine" is intended to harmonize with the standardized management system terminology. The word "determine" implies a discovery process that results in knowledge. The intent does not differ from that of previous editions.

— The phrase "intended outcome" is what the organization intends to achieve by implementing its environmental management system. The minimal intended outcomes include enhancement of environmental performance, fulfilment of compliance obligations and achievement of environmental objectives. Organizations can set additional intended outcomes for their environmental management system. For example, consistent with their commitment to protection of the environment, an organization may establish an intended outcome to work towards sustainable development.

— The phrase "person(s) doing work under its control" includes persons working for the organization and those working on its behalf for which the organization has responsibility (e.g. contractors). It replaces the phrase "persons working for it or on its behalf" and "persons working for or on behalf of the organization" used in the previous edition of this International Standard. The intent of this new phrase does not differ from that of the previous edition.

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— The concept of "target" used in previous editions of this International Standard is captured within the term "environmental objective".

A.4 Context of the organization

A.4.1 Understanding the organization and its context

The intent of 4.1 is to provide a high-level, conceptual understanding of the important issues that can affect, either positively or negatively, the way the organization manages its environmental responsibilities. Issues are important topics for the organization, problems for debate and discussion or changing circumstances that affect the organization's ability to achieve the intended outcomes it sets for its environmental management system.

Examples of internal and external issues which can be relevant to the context of the organization include:

a) environmental conditions related to climate, air quality, water quality, land use, existing contamination, natural resource availability and biodiversity, that can either affect the organization's purpose, or be affected by its environmental aspects;

b) the external cultural, social, political, legal, regulatory, financial, technological, economic, natural and competitive circumstances, whether international, national, regional or local;

c) the internal characteristics or conditions of the organization, such as its activities, products and services, strategic direction, culture and capabilities (i.e. people, knowledge, processes, systems).

An understanding of the context of an organization is used to establish, implement, maintain and continually improve its environmental management system (see 4.4). The internal and external issues that are determined in 4.1 can result in risks and opportunities to the organization or to the environmental management system (see 6.1.1 to 6.1.3). The organization determines those that need to be addressed and managed (see 6.1.4, 6.2, Clause 7, Clause 8 and 9.1).

A.4.2 Understanding the needs and expectations of interested parties

An organization is expected to gain a general (i.e. high-level, not detailed) understanding of the expressed needs and expectations of those internal and external interested parties that have been determined by the organization to be relevant. The organization considers the knowledge gained when determining which of these needs and expectations it has to or it chooses to comply with, i.e. its compliance obligations (see 6.1.1).

In the case of an interested party perceiving itself to be affected by the organization's decisions or activities related to environmental performance, the organization considers the relevant needs and expectations that are made known or have been disclosed by the interested party to the organization.

Interested party requirements are not necessarily requirements of the organization. Some interested party requirements reflect needs and expectations that are mandatory because they have been incorporated into laws, regulations, permits and licences by governmental or even court decision. The organization may decide to voluntarily agree to or adopt other requirements of interested parties (e.g. entering into a contractual relationship, subscribing to a voluntary initiative). Once the organization adopts them, they become organizational requirements (i.e. compliance obligations) and are taken into account when planning the environmental management system (see 4.4). A more detailed-level analysis of its compliance obligations is performed in 6.1.3.

A.4.3 Determining the scope of the environmental management system

The scope of the environmental management system is intended to clarify the physical and organizational boundaries to which the environmental management system applies, especially if the organization is a part of a larger organization. An organization has the freedom and flexibility to define its boundaries. It may choose to implement this International Standard throughout the entire

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organization, or only in (a) specific part(s) of the organization, as long as the top management for that (those) part(s) has authority to establish an environmental management system.

In setting the scope, the credibility of the environmental management system depends upon the choice of organizational boundaries. The organization considers the extent of control or influence that it can exert over activities, products and services considering a life cycle perspective. Scoping should not be used to exclude activities, products, services, or facilities that have or can have significant environmental aspects, or to evade its compliance obligations. The scope is a factual and representative statement of the organization's operations included within its environmental management system boundaries that should not mislead interested parties.

Once the organization asserts it conforms to this International Standard, the requirement to make the scope statement available to interested parties applies.

A.4.4 Environmental management system

The organization retains authority and accountability to decide how it fulfils the requirements of this International Standard, including the level of detail and extent to which it:

a) establishes one or more processes to have confidence that it (they) is (are) controlled, carried out as planned and achieve the desired results;

b) integrates environmental management system requirements into its various business processes, such as design and development, procurement, human resources, sales and marketing;

c) incorporates issues associated with the context of the organization (see 4.1) and interested party requirements (see 4.2) within its environmental management system.

If this International Standard is implemented for (a) specific part(s) of an organization, policies, processes and documented information developed by other parts of the organization can be used to meet the requirements of this International Standard, provided they are applicable to that (those) specific part(s).

For information on maintaining the environmental management system as part of management of change, see Clause A.1.

A.5 Leadership

A.5.1 Leadership and commitment

To demonstrate leadership and commitment, there are specific responsibilities related to the environmental management system in which top management should be personally involved or which top management should direct. Top management may delegate responsibility for these actions to others, but it retains accountability for ensuring the actions are performed.

A.5.2 Environmental policy

An environmental policy is a set of principles stated as commitments in which top management outlines the intentions of the organization to support and enhance its environmental performance. The environmental policy enables the organization to set its environmental objectives (see 6.2), take actions to achieve the intended outcomes of the environmental management system, and achieve continual improvement (see Clause 10).

Three basic commitments for the environmental policy are specified in this International Standard to:

a) protect the environment;

b) fulfil the organization's compliance obligations;

c) continually improve the environmental management system to enhance environmental performance.

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These commitments are then reflected in the processes an organization establishes to address specific requirements in this International Standard, to ensure a robust, credible and reliable environmental management system.

The commitment to protect the environment is intended to not only prevent adverse environmental impacts through prevention of pollution, but to protect the natural environment from harm and degradation arising from the organization's activities, products and services. The specific commitment(s) an organization pursues should be relevant to the context of the organization, including the local or regional environmental conditions. These commitments can address, for example, water quality, recycling, or air quality, and can also include commitments related to climate change mitigation and adaptation, protection of biodiversity and ecosystems, and restoration.

While all the commitments are important, some interested parties are especially concerned with the organization's commitment to fulfil its compliance obligations, particularly applicable legal requirements. This International Standard specifies a number of interconnected requirements related to this commitment. These include the need to:

— determine compliance obligations;

— ensure operations are carried out in accordance with these compliance obligations;

— evaluate fulfilment of the compliance obligations;

— correct nonconformities.

A.5.3 Organizational roles, responsibilities and authorities

Those involved in the organization's environmental management system should have a clear understanding of their role, responsibility(ies) and authority(ies) for conforming to the requirements of this International Standard and achieving the intended outcomes.

The specific roles and responsibilities identified in 5.3 may be assigned to an individual, sometimes referred to as the "management representative", shared by several individuals, or assigned to a member of top management.

A.6 Planning

A.6.1 Actions to address risks and opportunities

A.6.1.1 General

The overall intent of the process(es) established in 6.1.1 is to ensure that the organization is able to achieve the intended outcomes of its environmental management system, to prevent or reduce undesired effects, and to achieve continual improvement. The organization can ensure this by determining its risks and opportunities that need to be addressed and planning action to address them. These risks and opportunities can be related to environmental aspects, compliance obligations, other issues or other needs and expectations of interested parties.

Environmental aspects (see 6.1.2) can create risks and opportunities associated with adverse environmental impacts, beneficial environmental impacts, and other effects on the organization. The risks and opportunities related to environmental aspects can be determined as part of the significance evaluation or determined separately.

Compliance obligations (see 6.1.3) can create risks and opportunities, such as failing to comply (which can damage the organization's reputation or result in legal action) or performing beyond its compliance obligations (which can enhance the organization's reputation).

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The organization can also have risks and opportunities related to other issues, including environmental conditions or needs and expectations of interested parties, which can affect the organization's ability to achieve the intended outcomes of its environmental management system, e.g.

a) environmental spillage due to literacy or language barriers among workers who cannot understand local work procedures;

b) increased flooding due to climate change that could affect the organizations premises;

c) lack of available resources to maintain an effective environmental management system due to economic constraints;

d) introducing new technology financed by governmental grants, which could improve air quality;

e) water scarcity during periods of drought that could affect the organization's ability to operate its emission control equipment.

Emergency situations are unplanned or unexpected events that need the urgent application of specific competencies, resources or processes to prevent or mitigate their actual or potential consequences. Emergency situations can result in adverse environmental impacts or other effects on the organization. When determining potential emergency situations (e.g. fire, chemical spill, severe weather), the organization should consider:

— the nature of onsite hazards (e.g. flammable liquids, storage tanks, compressed gasses);

— the most likely type and scale of an emergency situation;

— the potential for emergency situations at a nearby facility (e.g. plant, road, railway line).

Although risks and opportunities need to be determined and addressed, there is no requirement for formal risk management or a documented risk management process. It is up to the organization to select the method it will use to determine its risks and opportunities. The method may involve a simple qualitative process or a full quantitative assessment depending on the context in which the organization operates.

The risks and opportunities identified (see 6.1.1 to 6.1.3) are inputs for planning actions (see 6.1.4) and for establishing the environmental objectives (see 6.2).

A.6.1.2 Environmental aspects

An organization determines its environmental aspects and associated environmental impacts, and determines those that are significant and, therefore, need to be addressed by its environmental management system.

Changes to the environment, either adverse or beneficial, that result wholly or partially from environmental aspects are called environmental impacts. The environmental impact can occur at local, regional and global scales, and also can be direct, indirect or cumulative by nature. The relationship between environmental aspects and environmental impacts is one of cause and effect.

When determining environmental aspects, the organization considers a life cycle perspective. This does not require a detailed life cycle assessment; thinking carefully about the life cycle stages that can be controlled or influenced by the organization is sufficient. Typical stages of a product (or service) life cycle include raw material acquisition, design, production, transportation/delivery, use, end-of-life treatment and final disposal. The life cycle stages that are applicable will vary depending on the activity, product or service.

An organization needs to determine the environmental aspects within the scope of its environmental management system. It takes into account the inputs and outputs (both intended and unintended) that are associated with its current and relevant past activities, products and services; planned or new developments; and new or modified activities, products and services. The method used should consider normal and abnormal operating conditions, shut-down and start-up conditions, as well as the reasonably foreseeable emergency situations identified in 6.1.1. Attention should be paid to prior

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occurrences of emergency situations. For information on environmental aspects as part of managing change, see Clause A.1.

An organization does not have to consider each product, component or raw material individually to determine and evaluate their environmental aspects; it may group or categorize activities, products and services when they have common characteristics.

When determining its environmental aspects, the organization can consider:

a) emissions to air;

b) releases to water;

c) releases to land;

d) use of raw materials and natural resources;

e) use of energy;

f) energy emitted (e.g. heat, radiation, vibration (noise), light);

g) generation of waste and/or by-products;

h) use of space.

In addition to the environmental aspects that it can control directly, an organization determines whether there are environmental aspects that it can influence. These can be related to products and services used by the organization which are provided by others, as well as products and services that it provides to others, including those associated with (an) outsourced process(es). With respect to those an organization provides to others, it can have limited influence on the use and end-of-life treatment of the products and services. In all circumstances, however, it is the organization that determines the extent of control it is able to exercise, the environmental aspects it can influence, and the extent to which it chooses to exercise such influence.

Consideration should be given to environmental aspects related to the organization's activities, products and services, such as:

— design and development of its facilities, processes, products and services;

— acquisition of raw materials, including extraction;

— operational or manufacturing processes, including warehousing;

— operation and maintenance of facilities, organizational assets and infrastructure;

— environmental performance and practices of external providers;

— product transportation and service delivery, including packaging;

— storage, use and end-of-life treatment of products;

— waste management, including reuse, refurbishing, recycling and disposal.

There is no single method for determining significant environmental aspects, however, the method and criteria used should provide consistent results. The organization sets the criteria for determining its significant environmental aspects. Environmental criteria are the primary and minimum criteria for assessing environmental aspects. Criteria can relate to the environmental aspect (e.g. type, size, frequency) or the environmental impact (e.g. scale, severity, duration, exposure). Other criteria may also be used. An environmental aspect might not be significant when only considering environmental criteria. It can, however, reach or exceed the threshold for determining significance when other criteria are considered. These other criteria can include organizational issues, such as legal requirements or interested party concerns. These other criteria are not intended to be used to downgrade an aspect that is significant based on its environmental impact.

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A significant environmental aspect can result in one or more significant environmental impacts, and can therefore result in risks and opportunities that need to be addressed to ensure the organization can achieve the intended outcomes of its environmental management system.

A.6.1.3 Compliance obligations

The organization determines, at a sufficiently detailed level, the compliance obligations it identified in 4.2 that are applicable to its environmental aspects, and how they apply to the organization. Compliance obligations include legal requirements that an organization has to comply with and other requirements that the organization has to or chooses to comply with.

Mandatory legal requirements related to an organization's environmental aspects can include, if applicable:

a) requirements from governmental entities or other relevant authorities;

b) international, national and local laws and regulations;

c) requirements specified in permits, licenses or other forms of authorization;

d) orders, rules or guidance from regulatory agencies;

e) judgements of courts or administrative tribunals.

Compliance obligations also include other interested party requirements related to its environmental management system which the organization has to or chooses to adopt. These can include, if applicable:

— agreements with community groups or non-governmental organizations;

— agreements with public authorities or customers;

— organizational requirements;

— voluntary principles or codes of practice;

— voluntary labelling or environmental commitments;

— obligations arising under contractual arrangements with the organization;

— relevant organizational or industry standards.

A.6.1.4 Planning action

The organization plans, at a high level, the actions that have to be taken within the environmental management system to address its significant environmental aspects, its compliance obligations, and the risks and opportunities identified in 6.1.1 that are a priority for the organization to achieve the intended outcomes of its environmental management system.

The actions planned may include establishing environmental objectives (see 6.2) or may be incorporated into other environmental management system processes, either individually or in combination. Some actions may be addressed through other management systems, such as those related to occupational health and safety or business continuity, or through other business processes related to risk, financial or human resource management.

When considering its technological options, an organization should consider the use of best-available techniques, where economically viable, cost-effective and judged appropriate. This is not intended to imply that organizations are obliged to use environmental cost-accounting methodologies.

A.6.2 Environmental objectives and planning to achieve them

Top management may establish environmental objectives at the strategic level, the tactical level or the operational level. The strategic level includes the highest levels of the organization and the

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environmental objectives can be applicable to the whole organization. The tactical and operational levels can include environmental objectives for specific units or functions within the organization and should be compatible with its strategic direction.

Environmental objectives should be communicated to persons working under the organization's control who have the ability to influence the achievement of environmental objectives.

The requirement to "take into account significant environmental aspects" does not mean that an environmental objective has to be established for each significant environmental aspect, however, these have a high priority when establishing environmental objectives.

"Consistent with the environmental policy" means that the environmental objectives are broadly aligned and harmonized with the commitments made by top management in the environmental policy, including the commitment to continual improvement.

Indicators are selected to evaluate the achievement of measurable environmental objectives. "Measurable" means it is possible to use either quantitative or qualitative methods in relation to a specified scale to determine if the environmental objective has been achieved. By specifying "if practicable", it is acknowledged that there can be situations when it is not feasible to measure an environmental objective, however, it is important that the organization is able to determine whether or not an environmental objective has been achieved.

For additional information on environmental indicators, see ISO 14031.

A.7 Support

A.7.1 Resources

Resources are needed for the effective functioning and improvement of the environmental management system and to enhance environmental performance. Top management should ensure that those with environmental management system responsibilities are supported with the necessary resources. Internal resources may be supplemented by (an) external provider(s).

Resources can include human resources, natural resources, infrastructure, technology and financial resources. Examples of human resources include specialized skills and knowledge. Examples of infrastructure resources include the organization's buildings, equipment, underground tanks and drainage system.

A.7.2 Competence

The competency requirements of this International Standard apply to persons working under the organization's control who affect its environmental performance, including persons:

a) whose work has the potential to cause a significant environmental impact;

b) who are assigned responsibilities for the environmental management system, including those who:

   1) determine and evaluate environmental impacts or compliance obligations;

   2) contribute to the achievement of an environmental objective;

   3) respond to emergency situations;

   4) perform internal audits;

   5) perform evaluations of compliance.

A.7.3 Awareness

Awareness of the environmental policy should not be taken to mean that the commitments need to be memorized or that persons doing work under the organization's control have a copy of the documented

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environmental policy. Rather, these persons should be aware of its existence, its purpose and their role in achieving the commitments, including how their work can affect the organization's ability to fulfil its compliance obligations.

A.7.4 Communication

Communication allows the organization to provide and obtain information relevant to its environmental management system, including information related to its significant environmental aspects, environmental performance, compliance obligations and recommendations for continual improvement. Communication is a two-way process, in and out of the organization.

When establishing its communication process(es), the internal organizational structure should be considered to ensure communication with the most appropriate levels and functions. A single approach can be adequate to meet the needs of many different interested parties, or multiple approaches might be necessary to address specific needs of individual interested parties.

The information received by the organization can contain requests from interested parties for specific information related to the management of its environmental aspects, or can contain general impressions or views on the way the organization carries out that management. These impressions or views can be positive or negative. In the latter case (e.g. complaints), it is important that a prompt and clear answer is provided by the organization. A subsequent analysis of these complaints can provide valuable information for detecting improvement opportunities for the environmental management system.

Communication should:

a) be transparent, i.e. the organization is open in the way it derives what it has reported on;

b) be appropriate, so that information meets the needs of relevant interested parties, enabling them to participate;

c) be truthful and not misleading to those who rely on the information reported;

d) be factual, accurate and able to be trusted;

e) not exclude relevant information;

f) be understandable to interested parties.

For information on communication as part of managing change, see Clause A.1. For additional information on communication, see ISO 14063.

A.7.5 Documented information

An organization should create and maintain documented information in a manner sufficient to ensure a suitable, adequate and effective environmental management system. The primary focus should be on the implementation of the environmental management system and on environmental performance, not on a complex documented information control system.

In addition to the documented information required in specific clauses of this International Standard, an organization may choose to create additional documented information for purposes of transparency, accountability, continuity, consistency, training, or ease in auditing.

Documented information originally created for purposes other than the environmental management system may be used. The documented information associated with the environmental management system may be integrated with other information management systems implemented by the organization. It does not have to be in the form of a manual.

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A.8 Operation

A.8.1 Operational planning and control

The type and extent of operational control(s) depend on the nature of the operations, the risks and opportunities, significant environmental aspects and compliance obligations. An organization has the flexibility to select the type of operational control methods, individually or in combination, that are necessary to make sure the process(es) is (are) effective and achieve(s) the desired results. Such methods can include:

a) designing (a) process(es) in such a way as to prevent error and ensure consistent results;

b) using technology to control (a) process(es) and prevent adverse results (i.e. engineering controls);

c) using competent personnel to ensure the desired results;

d) performing (a) process(es) in a specified way;

e) monitoring or measuring (a) process(es) to check the results;

f) determining the use and amount of documented information necessary.

The organization decides the extent of control needed within its own business processes (e.g. procurement process) to control or influence (an) outsourced process(es) or (a) provider(s) of products and services. Its decision should be based upon factors such as:

— knowledge, competence and resources, including:

  — the competence of the external provider to meet the organization's environmental management system requirements;

  — the technical competence of the organization to define appropriate controls or assess the adequacy of controls;

— the importance and potential effect the product and service will have on the organization's ability to achieve the intended outcome of its environmental management system;

— the extent to which control of the process is shared;

— the capability of achieving the necessary control through the application of its general procurement process;

— improvement opportunities available.

When a process is outsourced, or when products and services are supplied by (an) external provider(s), the organization's ability to exert control or influence can vary from direct control to limited or no influence. In some cases, an outsourced process performed onsite might be under the direct control of an organization; in other cases, an organization's ability to influence an outsourced process or external supplier might be limited.

When determining the type and extent of operational controls related to external providers, including contractors, the organization may consider one or more factors such as:

— environmental aspects and associated environmental impacts;

— risks and opportunities associated with the manufacturing of its products or the provision of its services;

— the organization's compliance obligations.

For information on operational control as part of managing change, see Clause A.1. For information on life cycle perspective, see A.6.1.2.

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An outsourced process is one that fulfils all of the following:

— it is within the scope of the environmental management system;

— it is integral to the organization's functioning;

— it is needed for the environmental management system to achieve its intended outcome;

— liability for conforming to requirements is retained by the organization;

— the organization and the external provider have a relationship where the process is perceived by interested parties as being carried out by the organization.

Environmental requirements are the organization's environmentally-related needs and expectations that it establishes for, and communicates to, its interested parties (e.g. an internal function, such as procurement; a customer; an external provider).

Some of the organization's significant environmental impacts can occur during the transportation, delivery, use, end-of-life treatment or final disposal of its product or service. By providing information, an organization can potentially prevent or mitigate adverse environmental impacts during these life cycle stages.

A.8.2 Emergency preparedness and response

It is the responsibility of each organization to be prepared and to respond to emergency situations in a manner appropriate to its particular needs. For information on determining emergency situations, see A.6.1.1.

When planning its emergency preparedness and response process(es), the organization should consider:

a) the most appropriate method(s) for responding to an emergency situation;

b) internal and external communication process(es);

c) the action(s) required to prevent or mitigate environmental impacts;

d) mitigation and response action(s) to be taken for different types of emergency situations;

e) the need for post-emergency evaluation to determine and implement corrective actions;

f) periodic testing of planned emergency response actions;

g) training of emergency response personnel;

h) a list of key personnel and aid agencies, including contact details (e.g. fire department, spillage clean-up services);

i) evacuation routes and assembly points;

j) the possibility of mutual assistance from neighbouring organizations.

A.9 Performance evaluation

A.9.1 Monitoring, measurement, analysis and evaluation

A.9.1.1 General

When determining what should be monitored and measured, in addition to progress on environmental objectives, the organization should take into account its significant environmental aspects, compliance obligations and operational controls.

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The methods used by the organization to monitor and measure, analyse and evaluate should be defined in the environmental management system, in order to ensure that:

a) the timing of monitoring and measurement is coordinated with the need for analysis and evaluation results;

b) the results of monitoring and measurement are reliable, reproducible and traceable;

c) the analysis and evaluation are reliable and reproducible, and enable the organization to report trends.

The environmental performance analysis and evaluation results should be reported to those with responsibility and authority to initiate appropriate action.

For additional information on environmental performance evaluation, see ISO 14031.

A.9.1.2 Evaluation of compliance

The frequency and timing of compliance evaluations can vary depending on the importance of the requirement, variations in operating conditions, changes in compliance obligations and the organization's past performance. An organization can use a variety of methods to maintain its knowledge and understanding of its compliance status, however, all compliance obligations need to be evaluated periodically.

If compliance evaluation results indicate a failure to fulfil a legal requirement, the organization needs to determine and implement the actions necessary to achieve compliance. This might require communication with a regulatory agency and agreement on a course of action to fulfil its legal requirements. Where such an agreement is in place, it becomes a compliance obligation.

A non-compliance is not necessarily elevated to a nonconformity if, for example, it is identified and corrected by the environmental management system processes. Compliance-related nonconformities need to be corrected, even if those nonconformities have not resulted in actual non-compliance with legal requirements.

A.9.2 Internal audit

Auditors should be independent of the activity being audited, wherever practicable, and should in all cases act in a manner that is free from bias and conflict of interest.

Nonconformities identified during internal audits are subject to appropriate corrective action.

When considering the results of previous audits, the organization should include:

a) previously identified nonconformities and the effectiveness of the actions taken;

b) results of internal and external audits.

For additional information on establishing an internal audit programme, performing environmental management system audits and evaluating the competence of audit personnel, see ISO 19011. For information on internal audit programme as part of managing change, see Clause A.1.

A.9.3 Management review

The management review should be high-level; it does not need to be an exhaustive review of detailed information. The management review topics need not be addressed all at once. The review may take place over a period of time and can be part of regularly scheduled management activities, such as board or operational meetings; it does not need to be a separate activity.

Relevant complaints received from interested parties are reviewed by top management to determine opportunities for improvement.

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For information on management review as part of managing change, see Clause A.1.

"Suitability" refers to how the environmental management system fits the organization, its operations, culture and business systems. "Adequacy" refers to whether it meets the requirements of this International Standard and is implemented appropriately. "Effectiveness" refers to whether it is achieving the desired results.

A.10 Improvement

A.10.1 General

The organization should consider the results from analysis and evaluation of environmental performance, evaluation of compliance, internal audits and management review when taking action to improve.

Examples of improvement include corrective action, continual improvement, breakthrough change, innovation and re-organization.

A.10.2 Nonconformity and corrective action

One of the key purposes of an environmental management system is to act as a preventive tool. The concept of preventive action is now captured in 4.1 (i.e. understanding the organization and its context) and 6.1 (i.e. actions to address risks and opportunities).

A.10.3 Continual improvement

The rate, extent and timescale of actions that support continual improvement are determined by the organization. Environmental performance can be enhanced by applying the environmental management system as a whole or improving one or more of its elements.

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Annex B
(informative)

Correspondence between ISO 14001:2015 and ISO 14001:2004

Table B.1 shows the correspondence between this edition of this International Standard (ISO 14001:2015) and the previous edition (ISO 14001:2004).

Table B.1 — Correspondence between ISO 14001:2015 and ISO 14001:2004

ISO 14001:2015		ISO 14001:2004	
Clause title	Clause number	Clause number	Clause title
Introduction			Introduction
Scope	1	1	Scope
Normative references	2	2	Normative references
Terms and definitions	3	3	Terms and definitions
Context of the organization (title only)	4		
		4	Environmental management system requirements (title only)
Understanding the organization and its context	4.1		
Understanding the needs and expectations of interested parties	4.2		
Determining the scope of the environmental management system	4.3	4.1	General requirements
Environmental management system	4.4	4.1	General requirements
Leadership (title only)	5		
Leadership and commitment	5.1		
Environmental policy	5.2	4.2	Environmental policy
Organizational roles, responsibilities and authorities	5.3	4.4.1	Resources, roles, responsibility and authority
Planning (title only)	6	4.3	Planning (title only)
Actions to address risks and opportunities (title only)	6.1		
General	6.1.1		
Environmental aspects	6.1.2	4.3.1	Environmental aspects
Compliance obligations	6.1.3	4.3.2	Legal and other requirements
Planning action	6.1.4		
Environmental objectives and planning to achieve them (title only)	6.2	4.3.3	Objectives, targets and programme(s)
Environmental objectives	6.2.1		
Planning actions to achieve environmental objectives	6.2.2		
Support (title only)	7	4.4	Implementation and operation (title only)
Resources	7.1	4.4.1	Resources, roles, responsibility and authority
Competence	7.2	4.4.2	Competence, training and awareness
Awareness	7.3		
Communication (title only)	7.4	4.4.3	Communication
General	7.4.1		
Internal communication	7.4.2		
External communication	7.4.3		

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Table B.1 *(continued)*

ISO 14001:2015		ISO 14001:2004	
Clause title	**Clause number**	**Clause number**	**Clause title**
Documented information (title only)	7.5	4.4.4	Documentation
General	7.5.1		
Creating and updating	7.5.2	4.4.5	Control of documents
		4.5.4	Control of records
Control of documented information	7.5.3	4.4.5	Control of documents
		4.5.4	Control of records
Operation (title only)	8	4.4	Implementation and operation (title only)
Operational planning and control	8.1	4.4.6	Operational control
Emergency preparedness and response	8.2	4.4.7	Emergency preparedness and response
Performance evaluation (title only)	9	4.5	Checking (title only)
Monitoring, measurement, analysis and evaluation (title only)	9.1	4.5.1	Monitoring and measurement
General	9.1.1		
Evaluation of compliance	9.1.2	4.5.2	Evaluation of compliance
Internal audit (title only)	9.2	4.5.5	Internal audit
General	9.2.1		
Internal audit programme	9.2.2		
Management review	9.3	4.6	Management review
Improvement (title only)	10		
General	10.1		
Nonconformity and corrective action	10.2	4.5.3	Nonconformity, corrective action and preventive action
Continual improvement	10.3		
Guidance on the use of this International Standard	Annex A	Annex A	Guidance on the use of this International Standard
Correspondence between ISO 14001:2015 and ISO 14001:2004	Annex B		
		Annex B	Correspondence between ISO 14001:2004 and ISO 9001:2008
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[1] ISO 14004, *Environmental management systems — General guidelines on principles, systems and support techniques*

[2] ISO 14006, *Environmental management systems — Guidelines for incorporating ecodesign*

[3] ISO 14031, *Environmental management — Environmental performance evaluation — Guidelines*

[4] ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

[5] ISO 14063, *Environmental management — Environmental communication — Guidelines and examples*

[6] ISO 19011, *Guidelines for auditing management systems*

[7] ISO 31000, *Risk management — Principles and guidelines*

[8] ISO 50001, *Energy management systems — Requirements with guidance for use*

[9] ISO Guide 73, *Risk management — Vocabulary*

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may exist. The approach should always be tailored to the organization and 'off-the-shelf' packages avoided. Senior management have much to gain by networking with their counterparts in different businesses and this exchange of ideas and concerns and discussion of common issues can help to fine-tune the approach which is being used and to advance the development of TQM.

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Chapter Five

A Framework for the Introduction of TQM

B. G. Dale, A. van der Wiele and J. D. van Iwaarden

Introduction

This chapter presents a framework for the introduction of TQM. It is divided into four main sections, all of which need to be addressed once the motivation for TQM has been identified. The motivation will set the overall strategic direction of TQM and influence the relevant importance of each part of the framework. The foundation of the framework is 'organizing' and the two pillars which form its structure are the use of 'systems and techniques' and 'measurement and feedback'. 'Changing the culture' is something which must be considered at all stages, including the initial organizing activities, but primarily results from the other initiatives described, interacts with them throughout the process, and will evolve with the organization's operating experience of TQM. People, both as individuals and working in teams, are central to TQM and without their skills and endeavours continuous improvement will simply not occur. The framework integrates the various aspects of TQM, from 'soft' approaches such as teamwork, employee development and human relations, to the use of 'hard' techniques such as SPC and FMEA. A diagrammatic representation of the framework is given in figure 5.1 and a summary of its features in table 5.1.

The framework provides an indication of how the various aspects of TQM fit together and is particularly useful for those organizations who:

- Are taking their first steps on the TQM journey.
- Have got ISO 9000 series registration and require some guidance and advice on what to do next.

Barrie Dale acknowledges the contribution of Dr Ruth Boaden to the development of the framework described in this chapter. He also wishes to thank the directors and managers who have commented on earlier versions of this chapter, in particular, the past and current associates of the TQM Multi-Company Teaching Company Programme for their invaluable suggestions in the development of the framework.

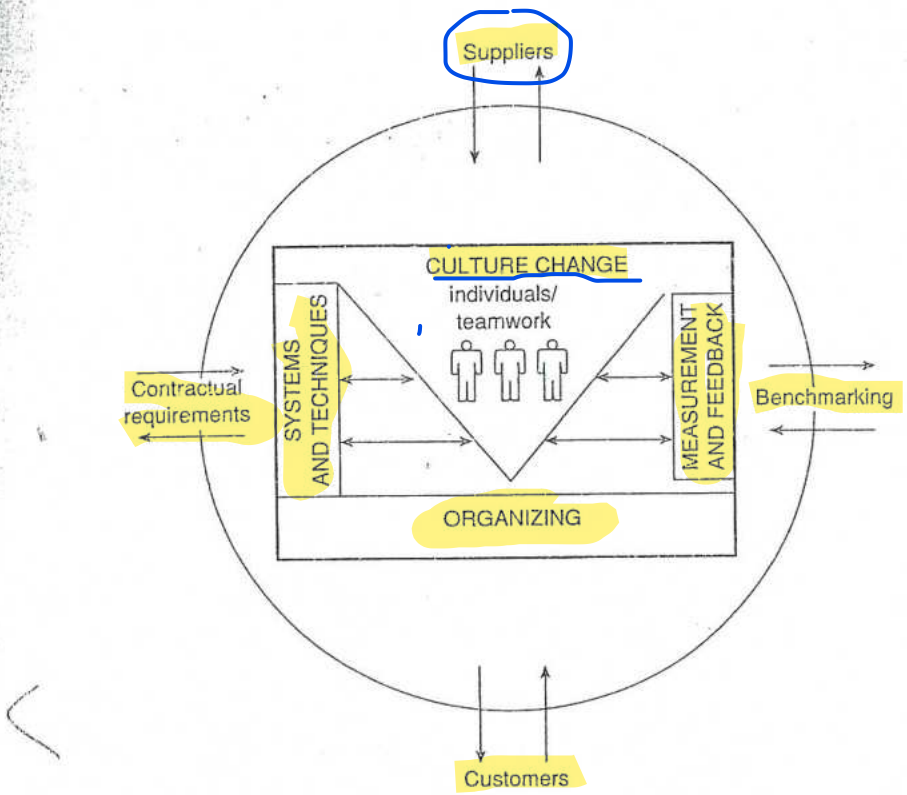


Figure 5.1 The TQM framework
Source: Dale and Boaden (1993)

- Are attempting to develop improvement plans and controls across a number of sites.
- Have less than three years' operating experience of TQM and continuous improvement.

The framework is not a 'how-to' guide for TQM; there are a considerable number of such guides outlining a step-by-step approach to TQM. These guides usually have a set starting point and follow a single route. The framework is a means of developing and presenting plans in a non-prescriptive manner; it is a guide to action and not to be followed slavishly. In this way it allows an organization to choose an appropriate starting point and course of action and develop TQM and the improvement process at a pace which suits its business situation and available resources. If used in the correct manner the framework ensures that there are adequate mechanisms in place to enable continuous improvements to occur. At this stage the organization can turn to the use of self-assessment methods against a recognized excellence model to identify

Table 5.1 TQM framework: a summary

Organizing	*Systems and techniques*	*Measurement and feedback*	*Changing the culture*
Long-term strategy for TQM formulated and integrated with other strategies; improvement plans developed	Identification of applicable tools and techniques at each stage of continuous improvement	Key internal and external performance measures identified, defined and developed	Assess the current status of organizational culture before developing plans for change
Definition of quality, TQM and continuous improvement developed and agreed	Training in the use of tools and techniques, for the right people at the right time	Ongoing discussion with customers about expected performance	Recognize the ongoing nature of culture change, and the need to outline specific changes
Choice of approach to TQM	Identification of other systems and standards that may be required by customers or legislation	Means for celebration and communication of success and teamwork developed	Recognize the role of people as an asset
Identification of sources of advice	Use of a formal quality system	Benchmarking, once improvement is under way	Plan change consistently and incrementally
Stages of improvement activity identified, taking the starting point into account	Identification of key business processes and improvement based on these processes	Consideration of the link between results from improvement and rewards	To minimize conflict, consider the inter-relationships of all activities within the organization
Executive leadership and commitment to TQM		Means of assessing the progress towards world-class performance considered, e.g. EFQM or MBNQA models	Identify factors which indicate that culture is changing
Vision and mission statements and values developed and communicated to all members of the organization			Consider the national and local culture
Decide the means by which TQM will be communicated			
Formal program of education and training for all members of the organization			
Organizational infrastructure established to facilitate local ownership of TQM			
Teamwork established as a way of working and part of the infrastructure			

strengths and weaknesses in its approach (for details of self-assessment, see chapter 24).

The framework was initially developed as a theoretical tool, from the author's research experience. The details of the framework as presented here have been based on its use by the senior management teams of a number of major manufacturing companies and a number of service organizations, in both private and public environments. In addition, the framework has also been used in syndicate exercises by some 300 people from a wide variety of manufacturing and service organizations, in America, Hong Kong, South Africa and the UK. With its solid research base and practical testing and application, it is a very robust framework.

Organizing

This foundation stage is concerned with the motivation for starting TQM and a process of continuous improvement (which will influence the TQM approach adopted) and the resultant strategies, plans, and means necessary to introduce and develop the process. The appropriate time to introduce TQM must also be considered, as should communication down and across the organization of what TQM is, why it is being adopted and what will be involved, including the cost and required resources.

It is also useful to consider the problems and obstacles likely to be encountered in the introduction of TQM and agree actions to avoid or minimize them: see chapter 7 for details of typical difficulties and obstacles. Similar examples are also provided by Bunney and Dale (1996), Crofton and Dale (1996), Dale (1991) and Dale and Lightburn (1992).

In planning this stage full use should be made of pilot schemes, whether they are in relation to the use of a technique such as SPC or the operation of improvement teams. In this way, problems can be resolved on a small scale and experiences fed back and reacted to before development and advancement of the issue under study.

The key actions in this stage can be described as follows:

1 *A clear long-term strategy for TQM should be formulated and integrated with other key business strategies, departmental policies and objectives. This also includes the development of a quality policy and quality strategy. The aim should be to integrate them with the long-term plans of the business.* Any short-term strategy which the organization needs to pursue (e.g. to cater for rapid turnover of staff, market downturns, exchange fluctuations and supply difficulties) should be consistent and integrated with the long-term strategy. The strategy must then be developed into a series of improvement plans and objectives

for each department and function and also for those areas and aspects of the business which have been identified as requiring improvement, and methods of monitoring and assessment developed. Such plans will also result from the other three sections of the framework and also from actions and initiatives which are independent of it. The methodology of policy deployment (e.g. Dale 1990; Akao 1991) is important in this respect; details are given in chapter 8.

2 *A common organizational definition for quality, TQM, and other terms used as part of the continuous improvement process, should be developed, agreed and communicated in simple and non-technical language, after discussion.* Consideration should also be given to the term (e.g. TQM, total quality performance, business excellence, world-class, customer first, business improvement or continuous improvement) used to describe the improvement initiative, or indeed to whether a term is required. The development of a glossary of quality-related terms should be considered; useful guidance is provided in BS EN ISO 9000 (2000). A lack of such definitions can hamper the progress of TQM; a glossary will also help to prevent misunderstandings, and competing views and different interpretations being expressed by the various functions and levels within the business and also with customers and suppliers, improving communication both inside and outside the business. Without clear definition it is difficult to deliver what is espoused as quality. In particular, many people have difficulty in understanding the difference between TQM and quality assurance.

3 *The approach to TQM should be decided.* This will depend on the existing culture of the organization as well as the preferences of senior management but is an important element in its success. Whichever TQM approach is adopted, it should be flexible and capable of fine-tuning to suit the business needs and objectives of the organization. Some of the available options were explored in chapter 1.

4 *The organizations and people (internal and external) who can be sources of advice on the approach to TQM, and its introduction and development, should be identified.* Such advice may also be required to develop the quality management system to meet the requirements of ISO 9001 and/or QS 9000 and the application of particular tools and techniques. Useful expertise is often available within the organization. Such people know the internal workings of the organization, its processes and the unique problems which exist. This expertise should not be overlooked. It is always beneficial to combine internal expertise with external consultants' knowledge and skills. In service organizations, which have large numbers of relatively small locations, or those manufacturing organizations which have a variety of operating sites spread across a country or throughout a number of countries, it is recommended that a 'directory of resources and experiences' is compiled to encourage co-operation and mutual assistance.

5 *Stages of improvement activity should be identified at the outset, taking into account the starting point of the organization, the motivation for TQM and the tools and techniques which may be applicable.* For example, Newall and Dale (1991) identified six stages of an improvement process – awareness, education and training, consolidation, problem identification and improvement planning, implementation of quality plans and assessment. A formal project-planning methodology, which requires the identification of milestones and their ongoing monitoring, is also a vital tool at this stage.

6 *Executive leadership, tangible commitment and support should be recognized as being crucial at all stages (see chapter 2).* Such commitment should be demonstrated in actions such as allocating time to understanding and involvement in TQM, being visible and accessible ('management by wandering about'), holding discussions with people at the operating level of the business, providing words of encouragement and advice, 'quality' placed at the top of every business meeting agenda, identification of key performance measurements, use of tools and techniques in their everyday work activities, developing personal action plans, seeking feedback on their style of management, acting as a mentor to improvement teams, attending training sessions, writing articles on TQM in the company newsletter, ensuring that any decisions made are consistent with the agreed plans and objectives, and exhibiting a passion for TQM. There is no magic formula for achieving such commitment, although the characteristics of good leaders are currently being researched with the aim of identifying appropriate management guidelines for the future. Useful guidance is provided by Bass (1985), Kotter (1990), Maxwell (1993, 1995), and Townsend and Gebhardt (1997a).

7 *Vision and mission statements which are concise and understandable to all employees should be developed, displayed and communicated in company-unique language.* It is also important to outline what needs to be done to make these statements and the associated company values become a reality, including the benefits that will accrue from TQM and how it will affect the way employees go about their jobs. The format and timing of education/awareness-raising events should also be outlined. The influence of the historical culture of the organization, its people, processes, technology, products/services and the views of its current senior executives must not be underestimated in this process.

8 *It is important that everyone in the organization can identify with the vision and mission statements* since this will help to unite and focus employees on where the organization is heading. Employees must feel that the vision statement is achievable. Regular assessments should also be carried out to see whether employees believe that the organization is getting closer to achieving the objectives outlined in these statements.

9 *Communication is a key component of TQM and management cannot communicate too much on issues relating to TQM and the improvements made.*

The communication should be based on common sense, be two-way, use jargon-free language and be consistent in the approach adopted. It must be good enough to win the 'hearts and minds' of all employees. The means of communication should include both written and verbal mediums in both group and individual mode (e.g. notice boards, whiteboards, news-sheets, booklets, team-meeting minutes, team briefings, senior management 'state-of-the-nation' briefings, breakfast and birthday meetings and electronic mail). Communication must be by example, with management doing what they say must be done, and they must assess, on a regular basis, to ensure that the messages they wish to convey are getting through. Managers must recognize the difference between the art of communication and its medium. It also means that management must listen and act upon the views of those they manage.

10 *A formal programme of education and training should be established.* This is important in order to build the skills of employees, and should involve basic job skills and process training, including induction, TQM awareness, customer care, and training in the use of tools, techniques and systems. It must provide a common message and encompass the whole organization starting with the senior management team and members of the TQM steering committee. The training should also aim to identify potential improvement projects.

11 *The development of a training matrix* (see figure 5.2) helps to ensure that needs and capabilities are identified, along with the current level of awareness of TQM, quality systems, tools and techniques, etc. Training records also need to be maintained. The training matrix should be reviewed whenever an appraisal is carried out. Consideration should also be given to the concept of a 'learning organization': this would require an internal library of information and the appropriate training aids to be set up.

12 *An organizational infrastructure should be established which will ultimately facilitate local ownership of TQM.* Direction should be provided by the TQM steering committee, but the time it sometimes takes for people to accept

Person and function	Type of course and duration		
	General awareness	Specific (e.g. FMEA)	Degree of difficulty
Senior management			
Clerical			
Operator			

Figure 5.2 TQM training matrix

such ownership for TQM and continuous improvement should not be underestimated. Actions include deciding the membership of the committee, role and meeting frequency, setting up, as appropriate, local steering groups, identification of improvement co-ordinator (full-time or part-time), facilitators and team leaders, along with clear definitions of their roles, ensuring the means by which the actions developed by improvement teams can be carried through and agreeing budgets. In some companies it may be more appropriate for TQM steering committee-type issues to be discussed as an agenda item as part of management/board of directors meetings. Research by Dale and Boaden (1993) has shown that full-time support is essential in order to get the process going and establish a central pool of expertise, particularly in service or multi-site manufacturing organizations. The structure must be appropriate for the business situation. However, it is important that the improvement structure does not duplicate the existing management structure. If it does then questions must be asked about the latter. It is also recommended that the current organizational structure is assessed in terms of its suitability for starting and sustaining TQM.

13 *Teamwork should be established and become part of the organization's method of working.* In the first place it is suggested that a review is undertaken of any teams which are already established, in conjunction with their previous and current projects. Following this, task forces/project teams and cross-functional improvement teams should be established to address the major problems facing the organization, followed by the setting up of departmental improvement teams.

Systems and Techniques

This pillar of the framework involves the development of a quality management system to provide the necessary controls and discipline, and the standardization of improvements. It also involves the use of quality management tools and techniques to, for example, aid quality planning, listen to the 'voices' of customers, capture data, control processes, make improvements, solve problems and involve people. Key actions at this stage include:

1 *The tools and techniques applicable at different stages of the improvement process should be identified.* The areas/projects for the application of these tools and the conditions (organizational and people) necessary for the successful application of each tool and technique have to be identified. In the first place consideration should be given to identifying which tools and techniques employees are familiar with and those which are in regular use. Tools and techniques should be classified as core and optional, depending on their nature

and impact and the environment (e.g. manufacturing or service) in which they are being applied.

2 *The right type of training targeted at the right people should be developed; it should emphasize the why and how of the tools and techniques and the benefits of their use.* Many studies (e.g. Payne and Dale 1990; Dale and McQuater 1998) have demonstrated that the right type of training helps to stop the misuse of tools and techniques (e.g. SPC being applied in the wrong areas; only part characteristics being measured, used only for control purposes; lack of reactive disciplines, etc.). When tools and techniques have been used incorrectly, an additional set of problems in the introduction of TQM is created. Suitable training packages on tools and techniques should be developed and customized for the organization – this is perceived to be very important in some situations (e.g. public services). There is no correct 'formula' for training, since each organization will be starting from a different position and will have different needs, audiences, topics and views on the delivery mechanisms, but the superior-performing companies have well-developed, cyclical formal training programmes for TQM and have mechanisms in place for determining the effectiveness of the training.

3 *The use of a formal quality management system should be considered, if one is not in place.* If such a system is already in use, then some evaluation of its contribution to TQM is vital; the objective should be to continually improve and strengthen the quality system and ensure that any improvements are built into the system. The requirements outlined in BS EN ISO 9001 (2000) are a good starting point.

4 *Any other systems and standards which may be required as part of future contractual or legislative requirements, or simply in order to compete in certain markets, should be identified and implemented.* If relevant systems and standards are integrated with the improvement initiative it is less likely that the organization will have conflicting priorities and policies and confusion will be reduced. Examples include: ISO 14001 (2004), OHSAS 18001 (1999), Investors in People, Charter Mark, the Management Charter Initiative, National Vocational Qualifications, Environmental and Responsible Care programmes, and hygiene requirements. Ethical, social and political issues will also have to be considered.

5 *Process analysis and improvement should be a continual part of the organization's improvement process.* There should be a focus on processes (e.g. business planning and control and order generation) rather than functions within the organization. Process analysis and innovation gives emphasis to the centrality of quality throughout the business process and also focuses attention on customer and supplier relationships. Once key business processes have been identified along with their process owners, rationalization, simplification and identification of key performance measures can occur. This forms the basis for improvement, and despite the difficulties of implementing

such improvements when significant organizational restructuring may be necessary, it can yield significant business results.

Measurement and Feedback

This pillar of the framework enables the 'voice of the customer' to be translated into measures of performance with which the organization can identify, and on which it can improve. It also deals with internal measures of performance, supplier assessment and development and rewards and recognition. Key actions at this stage include:

1 *Key internal and external performance measures should be identified and defined to assess the progress being made with TQM, and to ensure that customers are satisfied.* The measurement process involves a two-way flow of information between the organization and its customers and suppliers, and these parties should be consulted as part of the process of deciding what measurements to make. However, it should be accepted from the outset that measuring customer satisfaction can be difficult and painful. For example, reading and developing responses to negative comments is not easy. Two key questions which need to be addressed in relation to feedback are: To whom is it made? and What level of detail is provided? When traditional financial and accounting-type data measurement criteria are evaluated in terms of their relevance to TQM it is often found that many of the existing indicators are inaccurate, unfocused, unconnected and seen as an end in themselves and therefore obsolete. Care must be taken to ensure that appropriate measures are developed, defined clearly and used. The chosen performance measures should help to facilitate the integration of TQM into the business processes of the organization and encourage all employees to focus on the key business and quality issues. It is suggested that an organization should consider the use of the 'balanced scorecard' method. This employs performance measures that contain different viewpoints and perspectives, typically representing customers, internal processes, continuous improvement and finance.

The performance indicators must be monitored, displayed and communicated through debriefing sessions on a regular basis, thereby sharing the information with all employees. This also assists with renewing commitment when the improvement process starts to stagnate – 'If we cannot express what we know in numbers, we don't know much about it', and 'You cannot manage what you do not measure'. People are encouraged when they are able to see the results of their activities and efforts on key results areas and measures. This also applies to qualitative evidence such as photographs of shop

floor and office areas before and after a campaign to improve housekeeping. It is also useful to feed back data on typical mistakes and what long-term corrective action has been taken to avoid them being made again; any goals and targets established as part of this should be achievable. It is important to build results and corrective actions into improvement plans and standardize the improvements across the organization. Senior management must recognize that gathering data for external measures is time-consuming, and extra resources may well be needed.

Assessment of supplier performance and feedback of any measurements along with corrective actions is also a key feature of this pillar of the framework.

2 *Discussion with customers (internal as well as external) about the performance expected and their needs and expectations should be undertaken, using a variety of techniques.* This must be an ongoing exercise to ensure that gaps between actual performance and customer needs and expectations are identified and analysed, and actions put in place for closing the gap. In going about this exercise it is also important to assess the relationship between the sales and marketing functions and the strengths of each. The main objective of all this is to build a partnership with customers and to develop customer loyalty in order to build competitive advantage.

Issues that have to be considered in this marketplace research include:

- How well the organization is meeting customer expectations
- How well the organization responds to customers' comments
- How customers perceive they are treated
- The chief causes of concern to customers
- The main complaints from customers
- Suggestions the customer might have for improvements and what else may be required in terms of products, services and features
- How the organization rates against the competition
- Whether the data which have been collected are actually used to generate improvements which benefit the customer.

In some organizations it may be necessary to initiate suitable systems for identifying customer needs. Customers must also be encouraged and invited to challenge the organization which is delivering the product or service. The trend is for increasing the level of contact with customers (internal and external), and such 'moments of truth' occur far more frequently in commerce, public organizations and service-type situations than in manufacturing organizations (see chapter 11). Systems to identify customer needs include:

- Customer workshops
- Client service and call centres
- Panels and clinics
- Focus groups
- Customer interviews
- Market research

- Surveys: mail (including electronic), telephone, comment cards, point of purchase (survey designs should vary in length, contact and format)
- Trailing the service and/or product
- Field trials of new products
- Using 'test' consumers and mystery shoppers
- Feedback from professional and trade associations
- Product launches
- Field contacts

Often potential sources of information are customers lost and customers gained, the data which the finance and accounts department hold on customers, and field failure and warranty claims.

There must be a methodology and system for analysing and feeding back the data gathered from customers by such means (i.e. customer service measurement); the same applies to data on competitors.

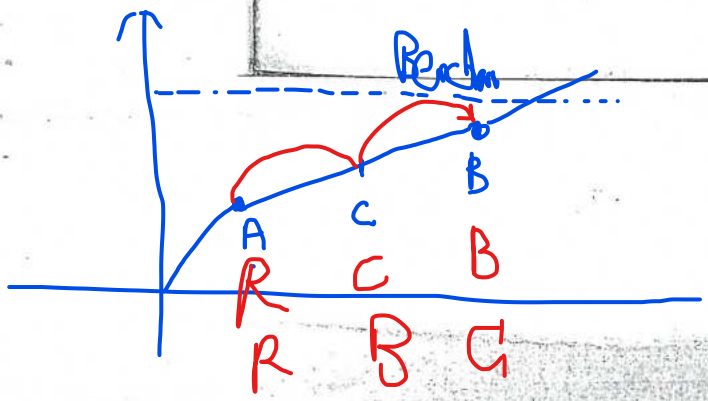
Goodman et al. (1996) report eight common pitfalls identified by Technical Assistance Research Programs Inc. (TARP) that undermine the integrity and value of customer feedback. These pitfalls are useful to keep in mind in tackling the issue of customer feedback data:

- Inefficient and costly data-collection
- Inconsistent classification schemes
- Old data
- Analysis in a vacuum
- Analysis without priorities
- Analysis that is not actionable
- Ineffective presentation of data and findings
- Failure to track the impact of corrective actions resulting from the voice of customer process

A considerable amount of useful guidance on understanding customer needs is provided by Gale (1994), McCarthy (1997), Vavra (1997) and BS EN 12973 (2000).

3 *Benchmarking should be considered once the organization has taken some steps to improve quality.* The benchmarking of a small number of strategic processes helps employees to see the need for change and thereby give impetus to the improvement process. The concept of benchmarking is a proven technique for assisting companies with a process of continuous improvement. It is a process whereby internal performance and practices are compared to those of other companies, including the superior-performing ones, in a bid to develop, improve and achieve the best practice that leads to superior performance (see Camp 1989, 1995, and chapter 21 below for details).

4 *Means of celebrating and communicating success with TQM should be considered, and methods developed for recognizing the efforts of teams and individuals.* The issue of ownership of TQM is linked to providing adequate recognition, rewards and incentives for quality efforts, and in this way the



message that quality is a strategic concern is reinforced. Two quotes worthy of mention are 'What gets measured gets done' (Anders Scharp, former CEO, Electrolux) and 'What gets rewarded gets repeated' (Anne Van't Haaff, former corporate quality manager, KLM).

Publishing successes is an effective means of communicating how people have tackled improvements. It helps to build up in people's minds that beneficial changes have started to take place, that things which at one time appeared impossible are now possible, and it helps convert the cynics: with published evidence of success they cannot say that TQM is not working – nothing succeeds like success.

Companies struggle in deciding how to recognize the efforts of teams and individuals for a job well done and often fail to think through the implications of their decisions in an adequate manner. Recognition and communication of success can be facilitated in a number of ways such as quality news-sheets, team briefs, quality action days, team competition/celebration days, quality conferences, presentations by the president and/or CEO, supplier award days, 'how are we doing?' boards, 'thank you' notes, small tokens of appreciation such as mugs, pens, meals, certificates and trophies, publicity in the company newsletter, personal thanks, applause, special functions (i.e. dinners, get-togethers, overseas trips, availability of company resources for personal use), and allocation of shares in the company; there is also recognition of performance by customers. Personal 'thank you' and 'praise' notes from senior management are often seen as a more genuine recognition than buying people through money. Townsend and Gebhardt (1997b) present some useful examples of successful recognition programmes which provide a range of thought-provoking ideas.

In some organizations people do not welcome individual recognition as they are made to feel uncomfortable by their peers, but in others tokens of recognition are desired and warmly appreciated. To help in deciding the most appropriate way to celebrate success it is recommended that views from employees are sought and the methods tailored to suit the needs of both the situation and employees.

5 *Linking rewards to improvement activities and results must be considered, although it is controversial.* Financial payment for participation in improvement activities, in particular, those schemes relating to individuals, should be discouraged but perhaps not overlooked. Continuous improvement should be a natural part of every person's job, but people at different levels of an organization have widely differing expectations of what improvement means to them personally and to the company. There is a view, however, that 'links to pay and promotion may still be the most tangible proof that top executives take total quality seriously' (see Troy 1991). An Income Data Services study (IDS 1991) concentrated on those incentive schemes in which quality or customer service are major determinants of bonus payments. It concluded

that few companies have sought 'to make a direct link between quality or customer service targets and then payment'. The study did go on to describe how Rank Xerox, Elida Gibbs, Scottish Widows, Companies House, British Steel and 3M have linked bonus payments in this way.

If there is pressure within an organization for financial payment perhaps it could be approached through a Japanese-style suggestion system, or along the lines of the Improvement Opportunity Scheme as described by Piddington et al. (1995). Organizations and individuals have different perceptions of the value of suggestion schemes. Among the common complaints are: 'We did not get any feedback so we are not going to make any more suggestions' and 'The response time to the suggestion was too long'.

6 *Means of assessing the progress of the business towards world-class performance should be used.* For example, the MBNQA criteria for performance and the EFQM excellence model should be considered (see chapter 24).

Changing the Culture

Organizations attempt to change culture for different reasons. Changing the culture is a key element in TQM and has wide-ranging implications for the whole organization; it requires the introduction and acceptance of individual, group, and organizational change. TQM provides the opportunity to make and influence behaviours and attitudes which have real effects on internal and external relationships and the way the organization conducts its business.

Culture change is not just relevant to TQM, although the increased emphasis on customers and their needs makes some form of culture change a must for most organizations. There is, however, a shortage of information and guidance for companies looking for ways to change, plan and facilitate culture change. The change of culture must be planned to avoid ambiguity and facilitate improvement; managers must learn to lead change and useful advice is provided on this issue by Adebanjo and Kehoe (1999), Atkinson (1990), Kanter et al. (1991), Schein (1985) and Tichy (1983). The current status from both management and employee perspectives should be established before firm plans for change are developed.

It is not possible to identify key actions for this stage, but there are a number of features which should be considered:

1 *An assessment, from both management and employee perspectives, of the current status of the organizational culture should be undertaken before firm plans for change are developed.* Senior management must be prepared to resolve conflicts, and resistance to change which is identified in the assessment; the personal values of staff and their expectations sometimes present a problem.

2 *Culture change must be recognized as ongoing, rather than as a prerequisite to the introduction of TQM.* Some degree of culture change in terms of senior management commitment and leadership and provision of adequate resources must, however, take place prior to and as part of the organizing stage. For example, the effective use of tools and techniques, developing the quality management system to meet the requirements of the ISO 9000 series, teamwork, the impact of successful improvement projects, presentations, recognition, effective channels of communication, etc. are all activities which can contribute to culture change. There are of course other activities which will contribute to the culture change process (e.g. improving the environment in terms of provision of uniforms and safety shoes, team meeting rooms and lockers) which may not connect directly with TQM and the improvement process. The crucial factor is a recognition of these activities and their contribution to culture change. In planning any changes it is useful to develop thinking along the lines of 'Where are we now?' and 'Where do we want to be?' Middle management must be involved in the planning process, since the burden of change falls on them. Management must create the culture which all employees believe in.

3 *Change should be planned and take place in a consistent and incremental manner.* Experience indicates that if the change is too great and unplanned the organization will revert back to the status quo. Clear and public displays of key indicators and 'how are we doing data' help to ensure that the changes which are made are real and that no slippage occurs. While there may also be some unexpected outcomes, they are no substitute for planned change.

The planned changes must be outlined in specific terms and, where possible, qualified against a time-scale. Employee attitude surveys, customer surveys and internal customer–supplier workshops are also useful for identifying culture change indicators. Examples of possible changes include:

- Create a single-status environment: harmonize conditions and eliminate other traditional status symbols, such as reserved car-parking spaces, different types of dining facilities, different terms and conditions of employment (i.e. move blue-collar sick pay towards that of staff) and other forms of demarcation (i.e. seasonal gifts being shared rather than going to individuals).
- Reduce the number of organizational levels.
- Delegate decision-making and the responsibility for taking actions down to the lowest possible level and spread the power base.
- Senior managers meet employees of all levels on a regular basis.
- Teach managers to adopt a listening, consulting and learning style of leadership.
- Enable every employee to visit a customer and other parts of the business.
- Operator exchange programmes.
- Operators to 'brief' customers during customer visits to the sites.

- Develop a requirement for senior management to spend a specified amount of time with people at the operating level of the business.
- Require the CEO to attend one meeting of each active quality team on an annual basis.
- Train managers to act as trainers.
- Change the payment system to one which recognizes issues such as the team, acquisition of skills, flexibility, etc.
- Replace supervision by leadership and give staff more freedom to get on with the job.
- Introduce the concept of associates rather than employees.
- Make it possible for operators to move between jobs within the business.
- Introduce cross-functional team activity.
- Provide opportunities for management to listen to the views of staff and customers and develop a listening and learning style of leadership.
- Get staff to tell management where they are going wrong. It is important to put into place a mechanism for ensuring that this happens, and providing guidance to staff in how to go about it, and to management on how to handle such feedback.
- Change to a cellular type of organization.
- Recognize and respect people's contribution to the business.
- Provide financial education for everyone.

The grid shown in figure 5.3 can be used to classify the degree of difficulty of each change and its effects.

4 *The role of people within the organization should be recognized.* The way that they are treated is vital, since they are an intellectual asset whose value to the organization can be increased by careful nurturing or decreased by poor management. It should also be recognized that most organizations are made up of people of differing ages, backgrounds, skills, abilities, levels of enthusiasm, levels of flexibility and ability to accept change (in some industries, tradition is very deep-rooted and this presents a specific set of resistance-to-change difficulties). If culture change is to be successful these people-based

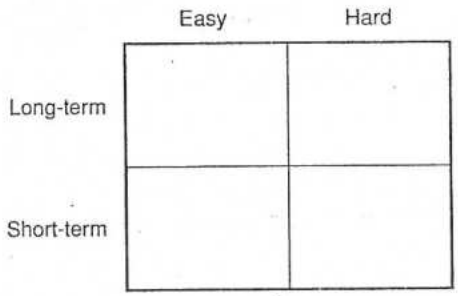


Figure 5.3 Culture change grid

factors must be taken into account. The means of developing and involving people must be identified; a skills audit is a useful starting point for this. The Investors in People programme provides useful advice on people development.

5 *Teamwork is an important facilitator in culture change, but organizations must ensure that the organizational infrastructure can adapt to the changes which teamwork will bring.* The operating characteristics of the teams to be employed in TQM should be defined and communicated (see chapter 23). It is also essential that participants in teams and other improvement activities are volunteers, not 'conscripts'.

6 *The interrelationship of all activities in the organization, and the way in which they contribute to the overall quality of service and product provided, should be identified, so that conflict is minimized and TQM becomes part of the way in which the business is run.* Such conflict typically arises at middle management level, where the impact of strategic initiatives meets the problems of day-to-day running of the organization. In any large organization there will be a variety of initiatives going on at one time, many of which will affect staff directly (e.g. installation of new computer systems, development of information technology, introduction of Manufacturing Resources Planning (MRP II), cost-cutting exercises, marketing promotions), and these may indirectly contribute to the quality of product and service provided. It is important that management and staff understand the relationship between these and formal improvement initiatives, otherwise they may be perceived as being in conflict, and thus not achieve the desired outcomes. A case in point is a strain on resources resulting in people not attending quality team meetings.

7 *Factors which indicate that TQM has started to change culture should be identified.* Without such factors it is difficult to know whether culture change is taking place, and the concept may be undermined by 'lack of results'. Factors that indicate that culture is changing include:

- People see for themselves the need for tools and techniques.
- Motivators and champions start to emerge from various parts of the organization.
- People talk processes and not functions.
- Changes to procedures and systems are easier to make.
- People are not afraid of expressing their views.
- People show a positive response to recognition.
- Employees are viewed by senior management as an asset and not a cost.
- People volunteer to take on tasks which would previously have involved considerable negotiation between management and unions.
- Shop stewards help management to explain new procedures.
- People asking for their setting-up activities to be videotaped in order to reduce the machine down time.
- Ideas and suggestions start to flow from the shop floor.
- Willingness to serve others.

- Team meetings scheduled outside of team shift, without pay.
- Improvement teams ask management to suggest project themes.
- The distinction between the 'manager' and the 'managed' becomes hazy.
- Senior management shift their attention from TQM to concentrate on other things and improvement activities continue.
- Continuous improvement goes on in the face of organizational instability.

8 *In planning for change thought needs to be given to the culture of a country and its people.* A national culture is a set of shared values, beliefs and behaviours which binds people into a relatively cohesive group. However, there may be subcultures (i.e. local cultures) within countries. Details of national culture are provided by Hofstede (1984) in terms of four dimensions – power distance, uncertainty avoidance, individualism and masculinity. For example:

- Companies in Hong Kong are characterized by paternalistic leadership, power distance and, to some degree, risk avoidance by employees. In Hong Kong there is also a tendency for Chinese people not to be open in reflecting opinions and ideas: they tend to look first for personal monetary reward and benefits. Such attitudes can be in conflict with culture change, which is a longer-term process.
- In South Africa there are a number of issues which have to be considered such as the political/union situation, the use of traditional leaders in an ethnic sense, the inherent suspicion of management by the workforce as a result of historical and political factors, the characteristics of both first and third world cultures and concepts, racial integration of personnel by means of positive assertive actions, and the eleven official languages.

In addition the cultures of different industry types, which are often quite strong, need to be taken into account.

Use of the Framework

The framework should be used as part of an eight-stage process:

1 *Review the organization's adoption of TQM to date.* This should include a presentation by senior management on the progress to date and future plans. The grid shown in figure 5.4 can be used for pinpointing the current position and the features of the four first four levels of the TQM adoption model (see chapter 6) – 'uncommitted', 'drifters', 'tool-pushers' and 'improvers' – are also of help in positioning an organization. This stage can take the form of a TQM awareness session if the business is relatively immature in its adoption of TQM.

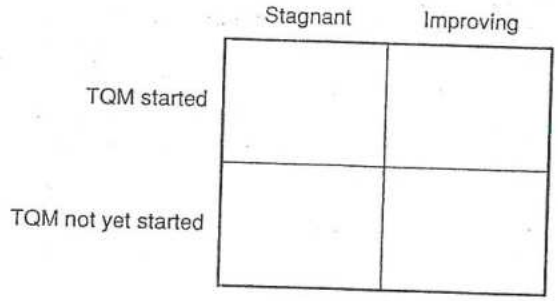


Figure 5.4 TQM grid

2 *Customize the framework to suit the individual organization.* In the first place, a full presentation of the framework is made to the participants. If the framework is being developed for a single organization, the senior and middle managers are divided into syndicate groups and tasked to consider the features of each section of the framework and customize it to suit the individual organization and its business. If the framework is being used in an open workshop session, and the participants are from manufacturing industry, the syndicate groups can be organized either by size of organization or type of industry. If they are from a mix of sectors they can be organized by sector (e.g. manufacturing, transport, financial, public sector, health care).

3 *Present and debate the customized framework.* A spokesperson from each syndicate group makes a presentation on the framework they have developed, with the features of each group's framework being debated in open forum. In the case of a single company a consolidated framework is developed, based on what has been agreed in the discussion arising from the open forum. If the syndicate group comprises a number of different companies, the participants can take the framework back to their own organization and either debate the framework with their management team and add or delete features as appropriate or repeat the syndicate exercise as a single management team.

4 *Assess which features of the framework are already in place.* Self-audit surveys and internal and external indicators can be employed. A number of methods of measurement can be used, for example, ranking each feature on a 1 to 6 scale or the use of a yes, no, in-part classification (figure 5.5 shows an example of this).

5 *Prioritize the features which are not already in place.* This should be done in accordance with the overall strategy and business plans of the organization. In some cases an organization may wish to accept this generic framework as it stands, thereby skipping steps 2 and 3. The way that this had been handled is to present the organizing section of the framework to the management team and get them to undertake steps 4 and 5 above. This is repeated for the other three sections.

Culture Change Section	*Yes*	*In part*	*No*
Commitment			
– Senior management	•		
– Visibility		•	
Current status			
– Questionnaire			•
Employee involvement	•		
Training and people Development			
– Customer appreciation	•		
– Appraisals/objectives	•		
– Skills audit		•	
Conditions of employment			•
People environment		•	

Figure 5.5 TQM framework: feature assessment

6 *Develop plans to introduce the prioritized features of the framework identified in the previous stage.* The plans should have a start and finish date, with detailed actions, milestones, resources and responsibilities.

7 *Communicate the details of the framework and the plans derived from it down through the organization.* This helps to gain acceptance. The framework should also be communicated to suppliers and customers.

8 *Identify any potential problems in putting the plans developed at stage 6 into place.* Some typical problems encountered are: lack of structure and how to formalize the existing organization in relation to current management roles and responsibilities, lack of trained personnel, definition of terms (e.g. customer response time), conflict of barriers, traditional attitudes, time conflicts/constraints and constructing a real and meaningful mission statement which can be owned.

The format shown in figure 5.6 can be used as part of this process.

Features Vision			*Plans*			
What will it look lile?	What does it involve?	What is the current situation?	What needs to be done?	Who is going to do it?	What is going to be done?	What are the obstacles/issues?
1						
2						

Figure 5.6 TQM framework: organizing section

Summary and Outcomes

The following are the outcomes derived by those organizations who have used the framework:

- Developing the framework provides a mechanism for debating TQM and continuous improvement strategies, plans, actions and initiatives and helps to generate a common level of understanding and reconcile views and opinions. It also assists management in identifying the factors which can slow down the process of improvement (e.g. inconsistent objectives, insufficient involvement and ownership, lack of data, lack of operator involvement, failure to complete projects, break-up of improvement teams, etc.) and helps to pinpoint and eradicate weaknesses in the current TQM approach of the organization.
- The framework, once developed and customized, becomes a reference point for current and future improvement initiatives. It builds on the quality initiatives already in place and guides the organization's development of TQM in a formal manner.
- Use of the framework requires all members of senior and middle management to be involved in the planning process, thereby developing ownership of the resultant plans. The prioritization of the framework features, in conjunction with business and commercial needs, against a time-scale helps to ensure that TQM is part of the business planning process and integrated with other strategies.
- The framework provides a means of communicating, in the organization's own language, what is involved in TQM and provides the essential logic of why the organization is adopting and progressing TQM and what is involved. It ensures that discussions on improvement are both structured and specific.
- In a multi-site operation the framework provides a common approach and language for all businesses, and those likely to be acquired in the future. In this way it avoids confusion with common suppliers and customers and presents a consistent approach and TQM image to both employees and the marketplace. It helps understanding of what each site has achieved in relation to TQM, assists in taking policy decisions (e.g. individual or common vision and mission statements, specific sites taking the lead role in piloting training programmes, quality management tools and techniques, etc.) shares common experiences, and highlights the availability of resources, mutual assistance, training, expertise, experiences, etc. It also helps those businesses which are less advanced in terms of TQM to discuss in a coherent manner common issues of interest with those that are more advanced (i.e. the common language and approach helps to facilitate 'technology' transfer).

- It provides the means for the local management committee and/or the TQM steering committee to assess the progress made by businesses against the plans developed, and ensures that issues are followed through. In undertaking this task problems can be identified and appropriate counter-measures developed.
- It can be used not only to assess the maturity of TQM but to audit whether or not certain features of the framework are firmly in place. In this way the next set of priorities can be identified.
- The correct use of the framework ensures that an organization puts in place the key features of TQM and a process of continuous improvement. Many of these fundamentals are encompassed in the 'TQM packages' offered by consultants. Thus an organization which feels it needs some 'outside' assistance can introduce and start a process of improvement without necessarily going to the expense of employing a management consultant. The use, if any, of a consultant could come later in the process when more specialized and detailed advice is required.

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Chapter Six

Levels of TQM Adoption

B. G. Dale and D. M. Lascelles

Introduction

From research work carried out world-wide on the subject of TQM by the Manchester School of Management at UMIST during the last 20 years or so, it is clear that the extent to which organizations have adopted and committed themselves to TQM as the ethos of the business is variable. Six different levels of TQM adoption (or lack of it) have been identified, which are termed:

1 Uncommitted
2 Drifters
3 Tool-pushers
4 Improvers
5 Award-winners
6 World-class (see figure 6.1)

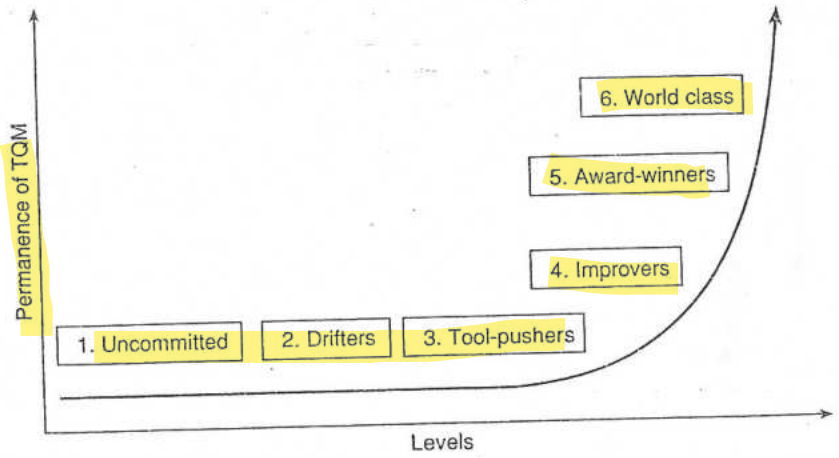


Figure 6.1 Levels of TQM adoption
Source: Lascelles and Dale (1993)

These levels of TQM adoptions were first derived by Dale and Lightburn (1992) from empirical observation, and were later refined by Lascelles and Dale (1993). The descriptions underlying each of the levels have since been tested by Dale in a number of workshop sessions for senior management in Europe, Hong Kong and South Africa. The initial descriptions of each level have been refined and added to from this testing and the current descriptions are reported in this chapter.

These levels are not necessarily the stages through which organizations pass on their TQM journey; rather, they are characteristics and behaviours which organizations display at one point in time in relation to TQM. While there are obviously exceptions to these generalized descriptions, with some organizations mid-way between two of the six levels, displaying hybrid characteristics and behaviour, it has been found that these six levels are a useful way of characterizing organizations and helping them to recognize symptoms and develop plans for the future. This positioning has also been found useful in helping to understand how people from a variety of hierarchical levels view the organization's TQM maturity. Some organizations, in using the levels as a TQM positioning model, have assigned a set of values (i.e. using a Likert-type scale) to each of the statements which highlight the characteristics and behaviour for each level, thereby quantifying the perceived level of their TQM adoption.

The six levels are now described.

Level 1 – Uncommitted غير ملتزم

Level 1 organizations are those who have not yet started a formal process of quality improvement and, in some cases, can be considered as being ignorant of TQM. Their quality initiatives are usually limited to gaining ISO 9001 quality management system registration and perhaps applying a few quality management tools and techniques as a reaction to customer pressure. The extent to which both systems and tools and techniques have been applied is often directly related to the amount of time spent by the client representatives on site, closely monitoring their use. The ISO 9001 quality management system will be seen by employees as a quality system and not a management tool. The quality department will be driving the quality management system and the keeping of ISO 9001 registration is totally dependent upon their efforts. The success of quality system audits by second- and third-party agencies will be viewed by senior management as an indication of the success of the company's quality initiative. The business will be operating in a detection mode (see chapter 1), but senior management believe a preventative approach is in place.

In this type of organization much talk is likely to be heard on topics such as productivity gains, financial indicators, and ISO 9001 and other customer

certificates of registration. Quality improvement is seen both as an externally imposed contractual requirement and as an added cost – a twin threat to be avoided whenever possible. Quality is not given priority in terms of either managerial time or resource allocation. The focus will be on the product not on the process, and corrective and preventative action will not be taken intuitively but only in response to client/customer complaints. The priority is given to fire-fighting situations.

(3) Problems are given support for their resolution subject to the level of impact which they may have on sales turnover. In this respect, failures and non-conformances encountered prior to shipment of product will receive the greatest attention, while those which have occurred after the product has been delivered and those problems which have arisen over a period of time will receive progressively less attention. It is also likely that the quality of design in terms of product, service and process will not receive the necessary and appropriate attention at the right time.

(4) Little investment in the education and training of management with respect to quality will have taken place, and managers consider themselves to be above this type of training. Consequently, senior managers in this type of organization are reluctant to take responsibility for or get involved in improvement activities. Evidence of this lack of commitment usually surfaces strongly in an ISO 9001 implementation programme. It is usual to find that management makes time available at the beginning of the programme, but as it progresses the attention given will diminish (e.g. non-attendance at meetings, failure to respond to requests for data, and not doing what they had agreed to do).

(5) It is likely that this type of organization will have had some bad experience of TQM or one of its elements, in the form of a programme (i.e. quality circles, ISO 9001 registration, empowerment) and consequently the concept will have acquired a less than favourable reputation amongst the senior management team. Some managers will associate TQM with unreasonable demands on them and their time and see it as a costly and bureaucratic system which will limit their autonomy.

Level 1 organizations are termed 'The Uncommitted' because they have no long-term plan for continuous improvement and are not convinced of its benefits. Managers, particularly at senior management level, are usually ignorant of the philosophy and values of TQM, and if they do have some knowledge of the concept they may be sceptical as to its relevance for them and their business. Any knowledge that has been acquired has come through informal sources. They are not necessarily small, immature, unsophisticated or owner-managed organizations. Some 'household name' organizations are at this level and are often characterized by a long and successful trading history with little effective competition and a lack of customer pressure (i.e. market-niche products, protected markets and contracts assured which are subject only to the budgetary constraints of the client).

Particular characteristics of Level 1 organizations include:

- An overwhelming emphasis and gearing of activity on return on sales and net assets employed, at the expense of other measures, both financial and non-financial.
- Meeting output and sales targets is the major objective of the business, whatever the cost.
- There will be a lack of quality assurance and behaviour-regulating systems, and as a consequence alternative methods will be employed to ensure that unrealistic production targets are met. These methods, more often than not, result in quality aspects of the job being discarded, resulting in a high incidence of internal and external failure.
- A pervading attitude of short-termism as evidenced by frequent changes of priority, lack of investment in people, technology, research and development, and infrastructure and cost-cutting.
- The company is inward-looking and its management style tends to be autocratic and 'lean and mean', with senior management having sole discretion and decision-making responsibility.
- The potential threat from the competition is not recognized.
- A number of negative elements are embedded in the organizational culture (e.g. 'them and us' attitudes, a limited view of 'on-the-job' expertise, inflexible working practices, job demarcation, little recognition of the potential of individuals, individuals are chastised in front of both their peers and subordinates and not given a chance to defend themselves, employees are required to wear identification tags to provide visual proof to management that they belong to a specific area, and managers enforce their ideas upon staff to a point where they are not allowed to think or deliver any input to decisions).
- The majority of employees have little concern for quality: it is seen as someone else's job. Employees are not held responsible for the quality of their output. A typical scenario is that inspectors find the defects and workers fix them.
- People hijack ideas and proposals from other employees to ingratiate themselves with management.
- When quality improvement proposals and suggestions for change are made they are either squashed, not understood or changed to suit management's needs, and there is an unwillingness to instigate any real changes.
- One hundred per cent inspection is carried out on incoming materials, at key points during the production process, and on the finished product. The main focus of the activity is to measure conformance to specification and a considerable amount of activity revolves around the acceptable quality level (AQL) concept.
- The data collected from tools such as check sheets and quality control checks tend to be left on file with no effort to identify trends and highlight major non-conformances.

- Ineffective and inaccurate corrective action control procedures.
- A piecework system is in operation for operatives and inspectors, with payment made for non-conforming work.
- Any quality improvement initiatives tend to be 'bottom-up' and are product-related.
- The same problems recur with no formal procedures for pursuing long-term corrective action.
- Processes are not fully understood, documented and/or accessible.
- Employees are encouraged, when things go wrong, to make all efforts to 'cover their backs', and if blame can be passed on to alleviate pressure then it is done without a thought for others. This type of action is condoned, if not encouraged, by management.
- Contact with customers is minimal.
- Suppliers are often blamed for quality problems, although the majority of the problems are of the company's own making.
- A lack of communication up and down the organization.
- Management and people are driven by fear and uncertainty. For example, in a plant of one of the UK's top-performing companies (in profit terms) a defective batch of product was hidden from the plant director by the works manager and a production supervisor so that they could dispose of it when the director was off-site. Another typical example of this characteristic is the unwillingness of all levels of personnel to express their opinions and ideas in the presence of their manager/director.

It could be argued that such companies, which are often very profitable, do not need TQM when they seem to be doing very well without it. But 'doing very well' is only for the time being and may not be a long-term phenomenon. Certainly, with rising costs due to inefficiency, they will in the future begin to suffer. Such uncommitted companies and their business philosophies are 'dinosaurs' belonging to another age; 'They are unlikely to survive the new economic age' (Deming 1982).

Level 2 – Drifters

Level 2 organizations will have been engaged in a process of continuous improvement for up to three years and have followed the available advice and 'received wisdom' on TQM. The management team will be taking stock of the progress made and it is also likely that initial enthusiasm will have worn off so that ways of reviving the process are under consideration. At this stage, those with a short-term view may be expressing disappointment that TQM has not lived up to their expectations, asking questions such as 'What comes after

TQM?' 'What do we need to concentrate on next?' 'What is the next fad?' 'Should we be using business process re-engineering?' 'Should we use the EFQM excellence model?' This type of organization is susceptible to the latest fad and this focus is detrimental to the development of an in-depth understanding of the fundamentals of key concepts. For example, in one utility some management believed that quality was being introduced into their processes by re-engineering them and therefore considered that there was no need for an ISO 9001 quality management system.

Senior management perceive that the motivation of employees can be improved but think that this is being suffocated by their supervisors and managers. To facilitate this motivation a form of empowerment programme is put into place, and some senior managers express the belief that this will replace TQM. It will also be assumed by senior management that – in spite of their lack of visible involvement in TQM, recognition for the improvements which have taken place and failure to prioritize improvement activities – continuous improvement will be naturally self-occurring and self-perpetuating.

This type of organization may have followed a programme along the lines of Crosby's 14 steps (1979; see chapter 3 above). Having reached Step 14 – 'Do it all again' – they do not know what to do next and are wary of 'doing it again' because the initiative taken to date has not been perceived as universally successful throughout the organization. In the case of a service, commercial, or public-sector organization they may have started with a customer-care programme, perhaps in a blaze of publicity. It is not unusual to find organizations at this level seeking to employ the philosophy of one of the other quality management experts – a typical comment being 'We started with Crosby and are now viewing the Juran videotapes to see if his philosophy is suitable for our next step forward' – or be considering the use of the EFQM model, taking the line 'This is evidence of our commitment to TQM.'

There is a danger that this type of organization enters a cycle of programme renewal and decline, moving in ever-decreasing circles of false starts, waning enthusiasm, frustration and disappointment.

The characteristics of Level 2 organizations include:

- Continuous improvement is still perceived as a programme, not a strategy or a process, and will have a low profile within the organization. It will not be integrated with business and departmental objectives.
- There is no plan for deployment of the TQM philosophy throughout the organization. Communication is limited and TQM does not penetrate to shop-floor and office levels.
- Management are overly susceptible to outside interventions and easily get distracted by the latest 'fads' which are put to them under various guises (i.e. they are quality fashion victims).
- Management have unduly high expectations of ISO 9001 and fail to distinguish between meeting this standard and TQM. It is also likely that the

procedures of such a system will be cumbersome; control and disciplines engendered by it will have been allowed to slide and documents will have become obsolete, resulting in a superficial application. While there is a belief that staff should work within the system, management cannot accept that they themselves need to accept the same disciplines. Consequently, at first-line supervision and operator levels they tend to be driven by day-to-day actions and quotes rather than compliance with quality management system requirements.

- The quality department has low status within the organization.
- Continuous improvement activities are little more than cosmetic 'off-line' motivation programmes, with little impression on the company's organizational structure, internal relationships, and overall business direction.
- There is inadequate reporting of defects and inaccurate and/or inappropriate feedback, and there is a lack of clarity on what the real non-conformances and defects are.
- The softer aspects of TQM will have been promoted without the underpinning and mastering of the quality assurance basics.
- Any team working is superficial and departments only tend to co-operate in order to lay the blame on another department. Considerable in-fighting, rivalry and 'politics' exist between departments.
- A programme of quality circles will have been attempted as a means of developing employees, and middle management told that they are judged by the number of quality circles they have in operation. The initial circles will have flourished, after which they will have floundered and then virtually died.
- No real changes in corporate culture have been made since the start of the TQM initiative. The activities associated with TQM are not given time to come to fruition before they are discarded and replaced by others.
- There is a reasonably high degree of suspicion and scepticism about TQM by management and staff, with a number of senior and middle managers not accepting the concept of TQM. Those at an operating level see TQM as another short-term tool to squeeze more productivity out of them.
- There are gaps in people's understanding of TQM and what it is, and, in addition, some key elements of the improvement process will have been treated superficially. This will not have been helped by an unco-ordinated training programme. A typical scenario is that awareness of TQM exists at the lower levels of the organization, and understanding of the benefits is turned into frustration because they do not get the support of senior management, because they lack of knowledge of the concept and do not understand the seriousness of the situation facing the organization.
- There is a wide gulf between levels of the organizational hierarchy in perceptions of TQM, benefits achieved and progress to date.
- Self-assessment has been performed against one of the recognized award models, but the areas for improvement identified have not been addressed by developing a time-scaled plan of action. The focus of the self-assessment

exercise is likely to have been on scoring mechanisms, 'scoring points' and impressing customers and suppliers, and not on how to facilitate improvement, and is perceived by many in the organization as being of little practical value. There is an overwhelming desire to win a quality award, mainly for PR and marketing reasons.

- A fear of failure and uncertainty pervades the organization and there is the view that TQM will be sidelined in the medium term.

- Level 2 organizations are termed 'The Drifters' because they drift, without a clearly defined baseline, from one programme to another in a stop-start fashion, with concepts, ideas and initiatives being reborn and relaunched under different guises. Management teams try a variety of approaches, often in response to the latest trend, consultancy input, what they perceive will impress customers and what has been gained from conference presentations and discussions with other companies. A change of approach may be sparked off when a senior manager who has been a protagonist of the TQM philosophy and a particular line of thinking leaves the organization. Individual initiatives may be very creative because the managers are intelligent and articulate people, and some will be genuinely committed to and enthusiastic about TQM. However, while they are unable or unwilling to place quality improvement within a strategic business framework, it will not yield the desired long-term results.

Level 3 – Tool-Pushers

A Level 3 organization has more operating experience of quality improvement than a drifter, usually between three and five years. They will typically have ISO 9001 registration and/or have met the requirements of the quality system standard of one or more of the major purchasers. They employ a selection of quality management tools and techniques such as SPC, the seven basic quality control tools, quality circles, FMEA and mistake-proofing, use a variety of quality improvement groups, and may be in the process of extending their knowledge of some of the more advanced techniques such as design of experiments, QFD and the seven management tools.

It is not uncommon to find that the training on tools and techniques has been aimed at individuals who cannot propagate their further use and application, hence the knowledge is contained. The system certification and use of tools and techniques will usually have been prompted and forced by a customer-driven initiative or based on the initiatives of individual employees. In some cases the tools and techniques will not have been implemented in a strategic and systematic way, but reactively and when necessary. An increasing number of organizations at Level 3 are also looking to the criteria of the TQM and performance and excellence

models of MBNQA (US Department of Commerce 2005) or the EFQM (2006) to provide an indication to senior management of what is involved in TQM and give some direction and structure to their improvement process, the quantitative assessment of progress being perceived as of particular benefit.

A detailed examination of the quality assurance procedures, quality planning systems and the use of quality management tools and techniques reveals that, in the main, they are being employed with an almost militaristic mindset (i.e. exacting and stringent quality requirements have been set by the customer and as a result a regulative approach has been built around fulfilling them).

If the organization is owned by an offshore parent company, it is likely it will have made an attempt to address the annual themes in its officially submitted business plans and will have responded to the improvement initiatives put out by regional and corporate headquarters. However, there will be no master plan to integrate and sustain the various initiatives which have been downloaded by headquarters to the various operating businesses.

There are a number of Level 3 organizations which have purchased a particular quality improvement tool (e.g. the Juran training videotapes) and then followed the recommended advice – i.e. training by module, establishment of problem-solving teams, project-by-project improvement, etc. However, even though some of these teams have been highly successful, after a period of up to two years the impetus of this type of training has been lost and the Juran training methodology has fallen into disuse. Such companies buy tools, training packages, programmes, etc. and disregard them once the novelty has worn off, thereby failing to realize the potential afforded by the tool by neglecting to link it into a continuous improvement strategy. It is often the case that the tool itself is then blamed as 'ineffective' when in reality it was its incorrect application which caused it to fail.

The characteristics of this type of organization are:

- They are for ever looking for the latest panacea, for a 'quick fix'. This has happened with quality circles, SPC, FMEA, design of experiments, QFD and benchmarking. The excellence models and BPR are now being used in this way by many organizations.
- Not all members of the senior management team are committed to TQM and those that are will probably not understand its full implications, with considerable variability in their knowledge of the subject. The different interpretations placed on the concept are sometimes wanted and built upon by management to disguise their lack of commitment to TQM. Some of these senior managers do not see it as their responsibility to facilitate improvement, but have a 'What's in it for me?' attitude. This surfaces in the form of autocratic and negative behaviour, particularly in the sales/marketing and finance functions. They have a tendency to delegate TQM responsibilities to the quality department (e.g. customer complaints, issues revolving around administration errors such as pricing, invoicing, duplication of orders,

over- and under-supply, and chairing ISO 9001 review meetings). Middle managers may say all the right things, but they remain unconvinced in their own minds of the value and strategic importance of TQM, and demonstrate this in their day-to-day actions. In their area of responsibility they give priority to systems and techniques which they consider will have more short-term impact than TQM. These apparently conflicting priorities are communicated through their actions and comments to first-line supervisors and operators, where the understanding of TQM and continuous improvement is usually patchy.

- The continuous improvement effort is concentrated in the manufacturing/operations departments, with other departments remaining less involved in improvement efforts. The tools and techniques will be in a reasonable state of health in those areas most affected by customer audits. The quality department is usually the main driving force of the improvement process, and company employees perceive the department as owning quality assurance and quality improvement. There will also be a perception within the quality department staff that they themselves own the continuous improvement process.
- A certain amount of inter-departmental/functional friction and lack of communication is likely to be evident.
- Detailed quality procedures are in place and the focus is on control of what exists now. The emphasis is on solving current rather than future problems.
- A quality management information system will exist, but the data provided by the system will not be used to its full potential.
- Meeting output targets is the key priority of the majority of managers, with conflict between the manufacturing/operations and quality assurance departments.
- Short-term results regarding product output and quality are expected, resulting in reactive problem-solving and a neglect of long-term, root-cause, process-improvement actions.
- The management style is reactionary.
- Organizations have acquired a reputation for their products and services but their processes have considerable potential for improvement.
- There are repeated claims from some parts of the organization that TQM is not working, with a tendency to dwell on old practices as being more effective.

This type of organization finds it very difficult to sustain the momentum of its improvement initiatives and is continually on the look-out for new ideas and quick fixes to deploy. The practice followed is often to replace those quality management tools and techniques which have been found to require considerable effort and disciplined application to make them work. The fire-fighting culture tends to suppress those techniques which need more effort to use and apply them successfully. A Level 3 organization gives the right kind of signals and presents the requisite image to its customers and suppliers, but under the surface a 'fire-fighting' culture remains, which is not really committed to TQM.

There are a number of similarities between Level 2 and Level 3 organizations, in that TQM has not affected the pervading organizational culture or achieved significant business results. The difference lies in the way in which organizations react to this, with Level 2 organizations trying a new overall approach, while Level 3 organizations merely turn to another tool or technique within the context of the same overall approach. Level 3 organizations more commonly have well-developed quality management systems, and tend to be concentrated in the manufacturing sector.

Level 4 – Improvers

Level 4 organizations will typically have been engaged in a process of continuous improvement for between three and eight years and during this time will have made important advances. They understand that TQM involves cultural change and have recognized the importance of customer-focused continuous improvement. The chief executive and members of the senior management team have committed themselves to total quality through leadership and their own personal actions. They will have formulated a strategy for TQM, in conjunction with the other business strategies, and have implemented a good deal of it. It is at this level that TQM begins to have a real impact on business performance.

Characteristics of this type of organization include:

- A policy deployment and problem-solving infrastructure is in place, together with a robust and proactive quality system.
- There is a high degree of closed-loop error prevention through the control of basic production/operation and/or service processes.
- A long-term and company-wide education and training programme is in place.
- Process-improvement activities exist throughout the organization with people looking to improve activities within their own sphere of influence, on their own initiative.
- The importance of employee involvement through a variety of departmental and cross-functional teams and other means is recognized, communicated and celebrated.
- Benchmarking studies have been initiated and the data are used to facilitate improvement activities.
- A 'leadership culture' is starting to emerge, with some strong quality improvement champions.
- Trust between all levels of the organizational hierarchy exists.
- The preoccupation with 'numbers' is less marked than with 'drifters' or 'tool-pushers'.

- The 'hype' which is usually associated with TQM is replaced by an acceptance of good management principles and practice.

In Level 4 organizations, TQM is still, however, dependent on a small number of key individuals to sustain the drive and direction of the improvement strategy. There is a danger of lost momentum and failure to 'hold the gains' if key managers or directors leave, if business mergers or organizational restructuring take place, or if the economic environment and trading conditions become difficult. This has been the case for a number of organizations during times of recession, where the long-term nature of TQM and its benefits have been discarded at the expense of short-term 'survival'.

Level 4 organizations are termed 'The Improvers'. They are moving in the right direction and have made real progress, but still have some way to go. TQM is not internalized throughout the organization and the process of improvement is not self-sustaining, with organizations still vulnerable to short-term pressures and unexpected difficulties. The results of improvement projects are not all effectively utilized for improvements and such initiatives are heavily dependent upon the individuals driving them. It is also likely that the change in culture is relatively slow and some contradictory signals are sent out (e.g. people empowerment versus control mechanisms). An overall strategy which pulls all the islands of improvement together is not fully in place, and concerns will also be expressed by management with respect to resources, in particular time. In 'improvers' the more complex quality management techniques must be implemented carefully. They should be handled by employees who are able to understand them, otherwise people will be overwhelmed and the technique rejected.

The next step forward involves the management and co-ordination of quality improvement across entire streams of processes – the point at which quality improvement starts to become total. Process-stream improvement and benchmarking activities of key processes may take between five and 10 years to mature sufficiently, so it is unlikely that the kind of cross-functional culture required to move up to Level 5 will emerge in less than five years; it is more likely to take around 10 years. At this stage of development, TQM will be a focal point but will not necessarily have attained prime strategic importance.

Level 5 – Award-Winners

To date there have been over 250 winners of the Deming Application Prize, the Japan Quality Award, the MBNQA and the EQA.

In their research on the long-term management issues of continuous improvement, Williams and Bertsch (1989) conclude that strong, world-class, quality-related competitiveness can only be achieved when an organization has reached

the stage of being able to compete for the top quality awards (i.e. Deming Application Prize, Japan Quality Award, MBNQA, and the EQA). Because the challenge is so formidable very few companies have been able to reach this level of quality.

Level 5 organizations are termed 'Award-Winners'. However, not all organizations reaching this level have actually won an internationally recognized or national quality award but they have reached a point in their TQM maturity where the kind of culture, values, trust, capabilities, relationship and employee involvement in their business required to win such an award have been developed; a point at which continuous improvement has become total in nature.

Such organizations have the following characteristics:

- A leadership 'culture' throughout the business that is not dependent on the commitment and drive of a limited number of individuals; all employees are involved in improvement.
- A number of successful organizational changes have been made.
- Business procedures and processes are efficient and responsive to customer needs.
- Effective cross-functional management processes and achieved process-stream improvements that are measurable.
- Strategic benchmarking is practised at all levels, in conjunction with an integrated system of internal and external performance measurement.
- A more participative organizational culture than before TQM was initiated.
- Powers of decision-making relinquished by management to people at lower levels of the organizational hierarchy in varying degrees.
- TQM is viewed sincerely by all employees as a way of managing the business to satisfy and delight customers, both internal and external.
- Perceptions of key stakeholders (i.e. people, customers and society) of organizational performance are surveyed and acted upon to drive improvement action.

However, although they may appear to form part of an elite, Level 5-type organizations have not necessarily achieved 'world-class' status. The attainment of Level 5 status marks the end of an organization's TQM apprenticeship and signifies that the organization has the capability and the potential to make an impact at the highest level, world-wide.

Level 6 – World-Class

This level is characterized by the total integration of continuous improvement and business strategy to delight the customer. Williams and Bertsch claimed in

1989 that fewer than 10 companies world-wide, all Japanese, had reached this stage. Smith (1994), in a chapter of his book entitled 'Becoming World Class', says that 'perhaps 50 organizations worldwide earn the world-class label'. However, in discussing numbers the points made by Williams and Bertsch under the discussion of award-winners should be noted.

An indication of world-class quality performance is that a company can apply for the Japan Quality Medal five years or more after it has received the Deming Application Prize. This, according to JUSE, is 'When it has been determined that an applicant company's implementation of CWQC has improved substantially beyond when it won the Deming Application Prize' (Deming Prize Committee 2000). They go on to say that 'By setting the goal of applying for the Japan Quality Medal when companies receive the Deming Application Prize, they can expect to prevent their CWQC from becoming stale and sluggish. In this way they can further develop their CWQC practices.' The Japan Quality Medal has currently been awarded on just 16 occasions (2000 data). While it is a clear indicator of TQM maturity, this award is not the sole qualification for Level 6 status.

Closer to home, the Royal Society for the Encouragement of Arts, Manufacturers and Commerce points out in *Inquiry: Tomorrow's Company* (RSA 1995) that there are too few world-class companies in the UK and an insufficient number of such companies are being created. In discussing the approach of 'tomorrow's company' the point is made that:

> The companies which will sustain competitive success in the future are those which focus less exclusively on shareholders and on financial measures of success – and instead include all their stakeholder relationships, and a broader range of measurements in the way they think and talk about their purpose and performance.

The characteristics of such a company, which it is claimed can compete at world-class levels, are examined in the inquiry and summarized as:

- Defining and communicating purpose and value
- Developing and applying a unique success model
- Placing a positive value on relationships
- Working in partnership with stakeholders
- Maintaining a strong license to operate

The relatively small number of organizations which have truly reached Level 6 epitomize the TQM concept. TQM is concerned with the search for opportunities to improve the ability of the organization to satisfy the customer. By this stage of TQM maturity (which will have probably taken more than 10 years after its initiation), the organization is continuously searching to identify more product and/or service factors or characteristics which will increase customer

satisfaction. The focus of its TQM strategy is on enhancing competitive advantage by improving the customer's perception of the company and the attractiveness of the product and/or service. This constant drive to enhance customer appeal through what the Japanese call 'miryokuteki hinshitsu' ('quality that fascinates') is integral to the concept of continuous improvement. Just like the concept of total quality itself miryokuteki hinshitsu is a vision, a paradigm and a value framework which will condition an entire organizational culture.

The never-ending pursuit of complete customer satisfaction to satisfy latent requirements is a personal goal of everyone in the organization and an integral part of their everyday working lives. TQM is no longer dependent on top-down drives to improve motivation and deploy the policy, but it is driven laterally throughout the organization. Kanter's terminology (1989) of 'PAL' – pooling, allying and linking across organizations – is useful here; she describes organizations who *pool* resources with others, *ally* to exploit opportunities and *link* systems in partnerships. Those organizations that PAL while seeking continuous improvement of processes and customer satisfaction are typical of Level 6.

Customer desires and business goals, growth and strategies are inseparable; total quality is the integrative and self-evident organizational truth. The vision of the entire organization is aligned to the voice of the customer in such organizations. Total quality is the single constant in a dynamic business environment – it is a way of life, a way of doing business – for all 'world-class' organizations. In summary the characteristics of world-class organizations are:

- Company values are fully understood and shared by employees, customers and suppliers.
- Each person in the organization is committed in an almost natural manner to seek opportunities for improvement to the mutual benefit of everyone and the business.
- Dependability is emphasized throughout the organization.
- The right things are got right first time and every time in every part of the company.
- Waste is not tolerated.
- The key processes of the organization are aligned to create common and shared objectives and to facilitate an environment conducive to improvement.
- There is total willingness and inherent capability to predict and respond to changing market conditions and customer needs and requirements.
- They constantly compete and win against the best world-wide.

Attaining Level 6 status is not the end, for none of the levels described here represents a 'steady state'. In particular, 'world-class' status is often attainable for only a few years, and it is dangerous for an organization to become complacent and blinkered to environmental changes. It is possible for such organizations to 'slip' to Level 5, or even lower.

Summary

Total quality management is a strategy for change in an environment where the accepted paradigms are subject to constant challenge. It is a strategy concerned with developing an organizational culture in which people are able to meet these challenges and realize the opportunities of change. The six levels described in this chapter are intended as a positioning model to aid organizations in identifying their weaknesses and addressing them, as part of the continual challenge of continuous improvement throughout the organization. The characteristics underpinning the six levels are also helpful in highlighting different perceptions of progress with continuous improvement at different levels of the organizational hierarchy of a firm. The characteristics of the more advanced adoptions should also provide the requisite inspiration to those less advanced to highlight the type of issues to which attention needs to be given.

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IMPLEMENTING TOTAL QUALITY MANAGEMENT

All glory comes from daring to begin. —***Anonymous***

MAJOR TOPICS

- Rationale for Change
- Requirements for Implementation
- Role of Top Management: Leadership
- Role of Middle Management
- Viewpoints of Those Involved
- Implementation Variation Among Organizations
- Implementation Approaches to Be Avoided
- An Implementation Approach That Works
- Getting On with It
- What to Do in the Absence of Commitment from the Top
- Implementation Strategies: ISO 9000 and Baldrige

This chapter is intended to serve three purposes:

1. To summarize in one chapter some of the salient points concerning the key elements and philosophy of total quality.
2. To develop a logical "road map," or structure for implementation, in order for the student of total quality to better understand the scope and magnitude of total quality implementation.
3. To provide a practical, hands-on, how-to guide for implementing total quality in any organization, in the sincere hope that this text will have inspired some who are in positions of leadership to take this next step.

Total quality management has been accurately described as a journey, not a destination. It is the fervent hope of the authors that many who study the material presented in this text will embark on that journey. This chapter is offered as your guide.

Six decades ago Japan was in a state of crisis. Japan's industry had been decimated by World War II, and its economy was in shambles. It was struggling to rebuild its economy and put people to work. This involved more than just getting the factories running again. Even if they could manage to get production flowing, who would buy the goods that were produced? The vast majority of Japanese people had all they could do to put clothes on their backs and food in their bellies. Japan had to look beyond its own shores for markets. The most obvious market was the United States, the economy of which had burgeoned during the war. However, the U.S. market posed two problems for the Japanese, which were as follows: convincing Americans that they should buy goods from the nation that attacked Pearl Harbor, and overcoming the American association of Japanese goods with inferior quality. Before World War II, Japan had been notably unsuccessful in American markets because of the perception of poor quality in its goods.

Enter Dr. W. Edwards Deming, an American statistician who had been in Japan in 1947 at the request of the Supreme Commander of Allied Powers to help prepare for a census to be taken in 1951. He had met some of the Japanese people who formed the Union of Japanese Scientists and Engineers (JUSE). As JUSE wrestled with the problems confronting Japanese industry and the economy, they were introduced to the 1931 McGraw-Hill book *The Economic Control of Manufactured Product* by Dr. Walter Shewhart of Bell Laboratories, the originator of the control chart. From their acquaintance with Deming, they thought he might help them apply Shewhart's techniques. JUSE wrote Deming in March 1950, asking him to give a series of lectures to plant managers, engineers, and research workers. Deming gave his first lecture on June 19, 1950. Some 500 people attended. Always unwilling to invest his time on a lost cause, Deming insisted that the top executives of Japanese industry get involved. JUSE arranged for that first high-level meeting on July 5, 1950. The top 21 Japanese company presidents attended. Deming told them that they could compete in the world's markets within 5 years if they followed his teachings. They did it in 4 years.

From Chapter 22 *of Quality Management for Organizational Excellence: Introduction to Total Quality,* 7th Edition. David L. Goetsch, Stanley B. Davis. Copyright © 2013 by Pearson Education, Inc. All rights reserved.

This chapter sets the stage for implementation of total quality in any organization. Had Japan not been in such dire straits after World War II—industry in shambles, people needing jobs, the nation with no money with which to import food—perhaps people there would not have listened to and acted on Deming's recommendations. They were *seeking a route to survival.* Your organization may or may not be in a similar fix. When an organization is truly facing the possibility of going out of business, there is a better chance that its management can be convinced to embrace the principles of total quality. On the other hand, when an organization is doing pretty well, then taking on the work that is involved in becoming a total quality organization is more difficult to sell—unless you are at the top of the organization chart.

Change is always difficult, and changing a culture that has been ingrained for many years is a monumental undertaking. When change is seen as the last hope for survival, it gets easier. People are more receptive to change when they realize that they will surely be out of jobs unless change is made. Is it worth the trouble? Unquestionably. Is survival ensured with change? No. But the other side of the coin is that going out of business is virtually ensured if you don't change. Every enterprise, no matter what the type, will be pressured more and more as total quality pervades industry, education, health care, government, merchandising, and services. Managers should consider whether they would prefer to be ahead of the quality groundswell or engulfed by it—out of control, fighting for survival with the odds against success much higher.

This chapter provides insights to help you implement total quality. No one best way fits the needs of all organizations. What you will find in this chapter are not prescriptions, but suggestions and examples of what has worked, with the idea that you may find the inspiration that will lead you to success in your own organization.

RATIONALE FOR CHANGE

What's wrong with the traditional way we do business?

1. ***We are bound to a short-term focus.*** If the organization of which you are a part is similar to most in the West, it is driven by short-term objectives. This is true whether you are in industry, education, health care, services, or government. For more than 60 years, we have been the victims of Keynesian economics. Everything we do has to have a measurable payback in the next quarter or the next year, or it cannot be justified. Whether Keynes had that in mind or not, it has become a reality of Western management and business. It is the sentiment "Don't tell me how good it will be in 5 years. What are you going to do for me today?"

2. ***The traditional approach tends to be arrogant rather than customer focused.*** Western organizations have tended to be arrogant. They think they know more about what their customers need than their customers do. Or worse yet, they don't care about their customers' needs. To illustrate this point, go into a typical government office and try to get something done—get new license plates for your car or have some legal papers executed. Often you will find that the employees, whose salaries come from your taxes, are rude, inefficient, and totally disinterested in you or your needs. The same thing has happened in industry.

3. ***We seriously underestimate the potential contribution of our employees, particularly those in hands-on functions.*** The person who knows the most about a job—and the one who is most likely to know how to solve problems—is the person who is doing that job and facing the job's problems day in and day out. This truth is proven over and over, yet the typical traditional manager does not believe it. This factor alone is responsible for much of the poor job performance and ill will that exists between management and labor, the folks who have to do the work. People generally want to do a good job; but faced with processes that are not capable and management that will not listen, they soon determine the only way to get ahead, or stay employed, is to "live with it and don't make waves." The result is that the brainpower we employ is largely wasted. Think about it: if you are in a 100-person organization and only two or three people can make changes to the procedures you work by and the processes you work with, 97% or 98% of the idea potential and creativity is silenced—but you still pay for it.

Let us bring home this point. Konosuke Matsushita, the head of Matsushita, the giant Japanese company that produces electronic equipment under the Panasonic brand name, writes:

> We are going to win and the industrial West is going to lose out; there's not much you can do about it because the reasons for failure are within yourselves.
>
> Your firms are built on the Taylor Model. Even worse, so are your heads. With your bosses doing the thinking while the workers wield the screwdrivers, you're convinced deep down that this is the right way to run a business. For you, the essence of management is getting the ideas out of the heads of the bosses and into the hands of labor.
>
> We [in Japan] are beyond the Taylor Model. Business, we know, is now so complex and difficult, the survival of firms so hazardous in an environment increasingly unpredictable, competitive and fraught with danger, that their continued existence depends on the day-to-day mobilization of every ounce of intelligence.[1]

Considering what Matsushita, Sony, Hitachi, and other Japanese consumer electronic firms did to the American

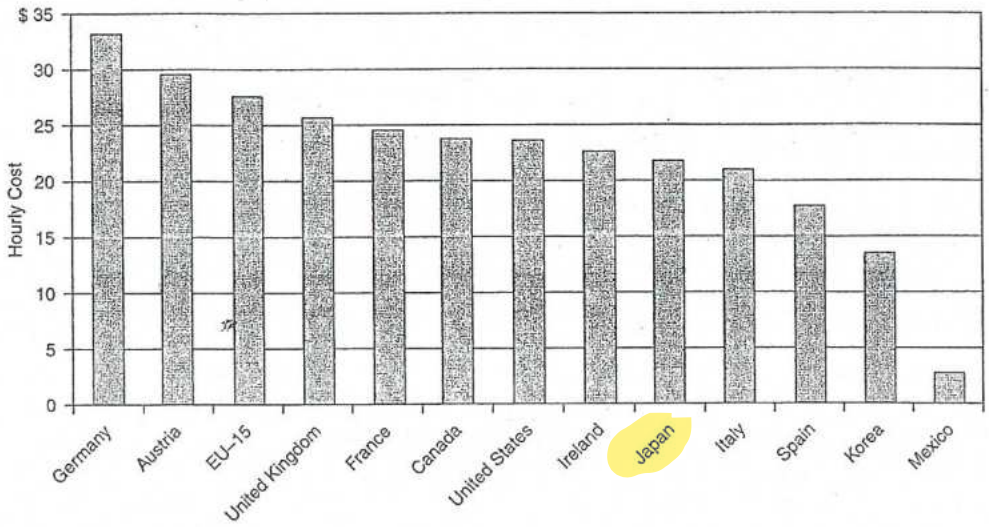


FIGURE 1 Hourly Production Labor Costs in U.S. Dollars, 2005

Source: U.S. Department of Labor, U.S. Bureau of Labor Statistics, December 2007.

Note: EU–15 is the average for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

competition, his remarks, while chilling, seem reasonable. The Japanese certainly won that battle, but the war is not over yet. Many Western organizations have also concluded (if belatedly) that our traditional management system (the Taylor Model) wastes brainpower in unthinkable amounts and is no longer appropriate; they have adopted the total quality model. If yours has not, now is the time.

4. ***The traditional approach equates better quality with higher cost.*** Philip Crosby wrote a book titled *Quality Is Free.*[2] The title was probably intended to catch the potential buyer's interest with its shock value. When the book was published in 1979, not many traditional managers would buy the idea that quality is free. In the ensuing years, however, that title has proven to be *understated.* Organizations that have successfully changed themselves into total quality enterprises have found not only that quality is free but also that it brings unforeseen benefits. Sadly, though, many traditional managers still believe that if you want better quality, you have to pay more for it. But the marketplace has found that if you want better quality, you simply pick the supplier that has demonstrated superior quality at the same price. That is why the Japanese cars have been so successful. Unfortunately, it is also the reason so many of our industries—radios, televisions, VCRs, and stereo equipment, just to name a few—have been lost. Better quality was to be had from other suppliers—for the same cost—and that is where the buyers went.

This issue of better quality from foreign competitors for the same cost is not a matter of lower wage scales in those countries. With few exceptions, wage scales in most of the developed nations do not differ widely. December 2007 data from the U.S. Department of Labor include hourly labor costs in U.S. dollars for production workers in several countries for the year 2005, the last year for which data are available (Figure 1). You will note that France, Canada, the United States, Ireland, Japan, and Italy all have hourly production labor costs between $20 and $25, with the United States and Japan separated by $1.89. For most of the past 15 years, Japan's hourly production labor costs have been higher than those of the United States. Figure 1 also shows that if any geographic entity was being adversely affected by high labor costs in 2005, it was Europe. Eight European countries and Australia and Canada (not all shown on Figure 1) had higher hourly labor costs than did the United States. Of course, there are a number of countries, including Korea, Taiwan, and Mexico, whose hourly production labor costs are significantly less than ours. But the point we want to make here is that whether in the United States or Japan, the cost of producing comparable quality products should be about the same. The same product would likely cost a little more if produced in Europe and a little less if produced in Korea, and that is borne out by product pricing with which we are all familiar. It is important to keep in mind that for manufactured goods like automobiles, televisions, washing machines, and so on, labor costs represent only 10 to 15% of the product's cost to the manufacturer and can be significantly less than that in factories with automation. That means that it takes a large difference in labor cost to yield a meaningful change in the ultimate cost of the product. The fact is that, when Japan is able to produce a $20,000 car that is of superior quality compared to an equivalent domestic offering, it is simply because that company has embraced total quality methods and honed them for 40 to 50 years.

5. ***The traditional approach is short on leadership and long on "bossmanship."*** Far too many Western managers see their jobs as simply telling subordinates what to do and when to do it. It is their station in life to make sure that the procedures are followed, that quotas are met, and that no one makes waves. It is easy to be critical of this kind of "leadership," but for 95 years, it is what we have been taught. It is a product of mass production, springing out of Henry Ford's Highland Park assembly line in 1913 and being adopted in one form or another by just about every kind of production activity. What exactly did Ford do? Prior to 1908, all automobiles were manufactured in craft shops. In North America, Europe, wherever, craft production was how things were made. All the people engaged in the making of an automobile were skilled craftsmen. All parts had to be hand-fitted by filing, cutting, or shaping. No two of anything coming out of a craft shop were the same. Ford realized that if he could make parts interchangeable, thereby eliminating the filing and bending, he could produce his cars a lot cheaper—and achieve unit-to-unit consistency in the bargain.

For example, in 1908 a Ford assembler/fitter (notice the latter designation) spent 514 minutes to complete his task before repeating the same steps on the next car. His work included getting the parts, filing or shaping them to fit, and bolting them on and adjusting and aligning as necessary. It also included maintaining his tools. These were multiple tasks—tasks requiring a craftsman's skills. At about that time, Ford finally achieved perfect part interchangeability. Ford assemblers then went to a single task, with the cycle time dropping to 2.3 minutes—the assembler's assigned task took only 2.3 minutes to complete before the assembler was ready to repeat it again on the next car. Productivity went up in a dramatic fashion. Having to do only one simple task over and over meant that the assembler (he was no longer a fitter) got to be an expert at it very quickly. Ford took it to the next step in 1913 with his introduction of the moving assembly line. Now the assembler no longer had to move. The work came to him. Assembler cycle time dropped to 1.19 minutes.

We cannot give Ford all the credit for part interchangeability because Cadillac apparently beat him to that goal by 2 years, achieving it in 1906. But Ford must be credited with the moving assembly line and what has been called the *interchangeable worker*.[3] Ford no longer needed skilled craftsmen. He could hire unskilled assemblers direct from the farm or immigrants who couldn't speak or read English. Within just a few minutes, they would be as expert as the assembly line demanded. This division of labor down to its simplest terms paid big dividends for Ford and for society in general. For the first time, the possibility of owning an automobile was not restricted to the wealthy. When the Model T was introduced in 1908 with its interchangeable parts, it cost far less than competing cars. In the early 1920s, Ford's interchangeable workers produced 2 million identical cars each year, and the cost was reduced by another two-thirds. Ford's production techniques soon found their way into virtually all manufacturing activities in North America and Europe.

Mass production had arrived—and with it the elimination of skills. Soon industry found ways to divide labor in other areas to minimize the need for worker skills and knowledge. We called it *specialization*. In this kind of environment, all you needed were simple work instructions, the right tool, and the requisite muscle to turn it. Follow the instructions—over and over and over again. Don't improvise; don't make waves; just follow orders. Supervisors and managers have been trained in this system for nearly a century. It worked, at least for a while. For the last half of that period the Japanese have demonstrated a better approach.

REQUIREMENTS FOR IMPLEMENTATION

Some parts of your organization are concerned that the future holds little promise of prosperity unless fundamental changes are brought about. Perhaps your competition is taking market share. You know that your product quality is not good enough. There is strife within your firm, bickering among departments, endless "brushfires." The total quality approach is working for others. Maybe total quality is what is needed. What has to happen for total quality to take place? What are the requirements for its implementation?

Commitment by Top Management

First and foremost, for total quality to become *the way we do business*, an unwavering and unquestioned commitment is required at the top. The CEO, general manager, or whatever title the top person has must commit not only resources but also a considerable amount of his or her own time. Top executives should plan on a third to half their time being used in the total quality effort. Certainly, less than a quarter of their time is not sufficient. Some say, "But the president is so busy. Why can't he delegate the implementation?" Neither in personal experience nor in the recorded experiences of the many companies of which we are aware is there a single success story of a delegated total quality implementation. People expect the boss to put his or her efforts on the most important issues. If they fail to see that effort as being total quality, the subliminal message is that total quality is not number one. Some departments will press on—for a while—until they get at cross purposes with other departments that are marching to the beat of a different drummer. Who has the authority to solve the impasse? Only the boss, and he or she is not involved in the process.

For an organization to completely embrace total quality from the mailroom to the executive office, a profound change is required in the corporate culture. Changing a culture is very difficult even when everyone is willing, and it is almost never the case that everyone will be willing. Some see danger in change, danger to their personal position, the threat of loss of power or prestige, perhaps even loss of employment. Some just like everything the way it is and see no reason to change. Some will be unwilling to put in the work required. Some

cannot believe that total quality makes sense. If the message from the top is not crystal clear and if the person at the top is not seen as being totally involved, that will be all the encouragement some will need to "toss wrenches into the gears."

But there is another reason the person at the top must be involved: the change to total quality is a learning experience. If the boss is not involved in it day to day, he or she will never know enough about what is happening to make rational decisions affecting the change. For example, suppose department heads have been meeting over the course of a month or two, wrestling with the issue of how the organizational structure needs to change to accommodate total quality. These people have aired the problem, have developed suggestions for change, and generally understand the issue. However, a change as far-reaching as creating a new organizational structure is beyond the scope of the department heads. Only the person at the top can do that. How do the department heads get that person to understand everything that has happened in these meetings? They have been at it for weeks. A 1-hour briefing is not going to get the boss up to speed. In this setting, the naysayer's impassioned plea for the status quo takes on a credibility that would have been impossible if the boss had been involved in the meetings from the start. The boss hears from one side that the proposed change must be put in place if total quality is ever going to provide the promised benefit. From the other side, he or she hears that the proposed change would be disruptive at best, and possibly disastrous. The span of control will be too wide, allowing things to drop through the cracks. Perhaps the system currently in place is not perfect, but at least it is familiar—and it works. What would you do? If you were the boss and heard these arguments, would you risk the company and make the change? The easy thing to do is do nothing: tell the department heads that you understand where they are coming from and that maybe sometime later it will be an appropriate thing to do, but in the meantime, they'll have to figure ways to work around the structure.

QUALITY TIP ▽

It Isn't Easy, but It's Worth Doing

In a review of an earlier edition of this text on the Amazon.com Web site, the reviewer chastised the authors for making TQM sound like it was difficult to achieve. We are quite sure the writer of the review had never been through a TQM implementation because if he had, he would more likely have agreed that it is not easy. The task is sometimes more than an organization is prepared to take on or to complete. Even so, it is shortsighted not to try, for it is certainly possible to accomplish with support from the top and a well-planned approach. The easy part will come after total quality is in place and performance and quality are improving, while simultaneously costs and time required are declining. Take our word for it—few TQM implementations take place without a lot of hard work and determination, none without a supporting commitment from the top. Yes, it is difficult, but the reward makes the endeavor sweet.

Source: David L. Goetsch and Stanley B. Davis.

What happened in this example goes on all the time. The boss is given a briefing from which he or she is expected to know as much as the briefer. It cannot be. The briefer has been directly involved in weeks of discussion and has the benefit of long and thoughtful consideration and deliberation. The boss got a few minutes of encapsulated data and has had no opportunity to consider them. Should he or she decide against the change, the decision will make an immediate and lasting impact on the proponents. They won't make that mistake again. Wasted weeks of effort, and for what? Only to be told that the boss thought the organization had better stay the way it is and make the best of it. Total quality will probably come to a screeching halt then and there. Does this happen in the real world? Yes, it does!

2 Commitment of Resources

The other part of the commitment is resources. Total quality implementation need not be expensive, but everything has a cost. In this case, the cost will certainly include some training. It may also include some consultant expense. The dollars must be there when they are needed. The difficulty is that it will not be easy to project a payback; so many factors can affect a company's performance that it may be impossible to know with certainty that *X* dollars invested in training yielded *Y* dollars in performance gains. This area conforms to Deming's truth that some things are not measurable. Accountants don't like to hear that.

The test for commitment of money should be one of reasonableness. Does it make sense to do this? Is the timing right? Is the money available? Can we afford it? Is it the right thing to do? If the answer to these questions is yes, you should not worry unduly about trying to capture the payback. Chances are good that it would cost more to figure out what the payback should be than the project itself will cost, and you can never be certain of the data.

3 Organization-wide Steering Committee

The third thing needed for company-wide implementation is a top-level steering committee. It may be called by a number of names, but it should be chaired by the person filling the top position in the organization's structure, and its membership should comprise that person's direct subordinates. In a typical corporate setting, this would be the president as chair, with all of the vice presidents filling the membership. The function of this group is to establish how total quality is to be implemented and then to see that it happens. As the conversion process starts, it will be necessary to set up cross-functional teams, to establish the teams' objectives, and to monitor results. Ultimately, this group will find itself operating as a team rather than just as the staff. It will set the vision and goals for the organization, establish teams to pursue the goals, monitor the teams' progress, and reward them for their achievements. The important point, from the outset, is that implementation requires management. Otherwise, it can easily set off in too many directions at once, some of

which may not even be in concert with the company's objectives. This cannot be allowed to happen. The energy that is going to be unleashed throughout the organization must be channeled. The steering committee does that.

Another important aspect of the steering committee is symbolic. If the employees observe the top-management group functioning like a team and doing things differently from the way things used to be done, they will get a strong message that this time something really is happening. If, on the other hand, they see the staff operating just as they always have, they will know that failure is simply a matter of time. Why bother to get involved? Do not minimize the difficulty of doing this. The typical staff is made up of stars, not team players. They have insulated their respective departments with walls that can defy all efforts to penetrate them. Their interests usually lie in their own departments rather than in the long-term vision and objectives of the company. What is worse, they don't have a common language—having backgrounds as diverse as engineering, finance, management information systems, human resources, quality assurance, manufacturing, purchasing, and so on. In many cases, they do not trust each other. Is it any wonder that we have problems? The person with the biggest challenge is the one who has to forge this crowd into a cohesive, mutually supportive team. But it must be done. The upside is that almost invariably, once they really start to function as a team, staff members will never want to go back to the old ways again.

Planning and Publicizing

So far, we have secured commitment from the top and established the steering committee. At this point, the real work has only begun. We've just said we're going to do it and determined who is going to manage it. Now we have to get down to the details. The steering committee must develop the vision statement and guiding principles, set the goals and objectives, put the TQ implementation plan in place, and then develop an award and recognition program and other publicity efforts. All these matters will be discussed next.

Vision Statement and Guiding Principles Where would the organization like to be 5 or even 10 years down the road, and what are the guiding principles for operating the business? The vision statement is a long-range strategic view. Total quality needs a long-range vision because total quality is achieved only over a relatively long period, although there will be visible improvements practically from the outset. We are really talking about fundamental changes in the way we do things and how people work together; about involving customers and suppliers in ways never before considered and putting values on matters that may never have been discussed. Not everything will come together overnight, so the vision must be of a distant target to provide a consistent course into the future. Without that, the company will find itself taking turns and detours with every new quarter or year. That will destroy the effort. Consistency is the watchword.

Toyota Motor Sales USA Inc.:
To be the most successful and respected car company in America.
Rollins College:
To be one of the nation's leading colleges, emphasizing academic excellence, responsible citizenship, personal growth, and ethical leadership.
Park Place Lexus:
To be the unparalleled retail automotive group in the United States.

FIGURE 2 Sample Vision Statements from a Manufacturer, a College, and a Car Dealership

Sources: Toyota, www.toyotamotors2alesus.com, retrieved September 23, 2011; Rollins College, www.rollins.edu, retrieved September 23, 2011; Park Place Lexus, www.quality.hist.gov/PDF_Files/Park_Place_Lexus_Profile.pdf, retrieved September 23, 2011.

The vision statement need not be lengthy—in fact, the shorter, the better. But it must represent the best collective thoughts of free and open discussion by the steering committee. If your organization is part of a larger entity (such as a division within a company) that has a vision, then you need only tailor yours to support that one. The total quality vision statement will usually include a recognition that only the customers make the final judgment of success or failure. If not stated in words, that idea must be implicit. Sample vision statements from a variety of businesses are found in Figure 2.

The guiding principles are the second element of the vision and usually accompany the vision statement in a single document. The guiding principles establish the rules of conduct for the organization and its members. These principles may be concerned with honesty, ethics, respect, fairness, quality, suppliers, customers, community, environment, roles of management and employees, and so on. This can sound very lofty indeed, and that is not a bad thing. People want to be associated with organizations with lofty ideals. They want to be proud not only of their own contribution but also of the company. Sample guiding principles are listed in Figure 3.

A well-written vision statement with its attending guiding principles has the following properties:

1. Is easily understood by all stakeholders (employees, customers, suppliers, and others)
2. Is briefly stated yet clear and comprehensive in meaning
3. Is challenging yet possible to accomplish, lofty yet tangible
4. Is capable of stirring excitement and unity of purpose among stakeholders
5. Sets the tone for how the organization and its employees conduct their business
6. Is not concerned with numbers

The vision statement must be crafted in such a way that all employees can relate to it and, in so doing, execute their work in a manner and direction that is consistent with its meaning and objectives.

Evonik Industries AG (Formerly Degussa)
Focus on our customers.
Operate according to Responsible Care principles that protect employees, environment and the community.
Respect diversity in culture, gender, nationality and race.
Treat people fairly, with consistency and respect different opinions.
Be open, honest, and share information.
Encourage learning, develop people, foster teamwork.
Set clear goals, empower employees and encourage open feedback.
Take responsibility, and lead by example.

Support innovation and initiative, learn from mistakes, strive for excellence.
Act with passion for our business.

PepsiCo Inc.
Care for customers, consumers and the world we live in.
Sell only products we can be proud of.
Speak with truth and candor.
Balance short term and long term.
Win with diversity and inclusion.
Respect others and succeed together.

FIGURE 3 Sample Guiding Principles

Sources: Evonik Industries, www.degussa-usa.com/north_america/en/company/visionmissionguidingprinciples, retrieved September 1, 2008; PepsiCo Inc., www.pepsico.com/PEP_Citizenship/pepsicovalues/index.cfm, retrieved September 1, 2008.

Goals and Objectives The broad strategic goals and objectives established by the steering committee must harmonize with the vision statement. These goals and objectives are for the total organization rather than necessarily aimed at the individual operating departments. They flow from the vision statement and are frequently part of the organization's strategic plan. To achieve the vision, these are the objectives that must be achieved. From these goals and objectives, supporting specific tactical objectives will be developed for departments, teams, and even individuals. The vision points the company in the desired direction and girds employees with the principles they must use in pursuit of the vision. The broad goals and objectives represent the strategic targets along the way to achieving the vision. Finally, a lower tier of specific tactical objectives describes what must be done as the company goes about achieving broad objectives and the vision. At both levels, objectives should be stated relative to total quality implementation. A word of caution: don't try to include every possibility and contingency. A few well-crafted goals are what you want. It may be that not all of your goals are measurable, but all should be defined such that you at least know when a goal has been achieved. See Figure 4 for the hierarchy and Figure 5 for sample objectives.

Total Quality Implementation Plan The plan is driven by the vision, goals, and objectives. It spells out as precisely as possible the route the implementation will take. No two total quality implementations will be the same. Your own organization—after considering your vision and objectives, studying the material, perhaps consulting with

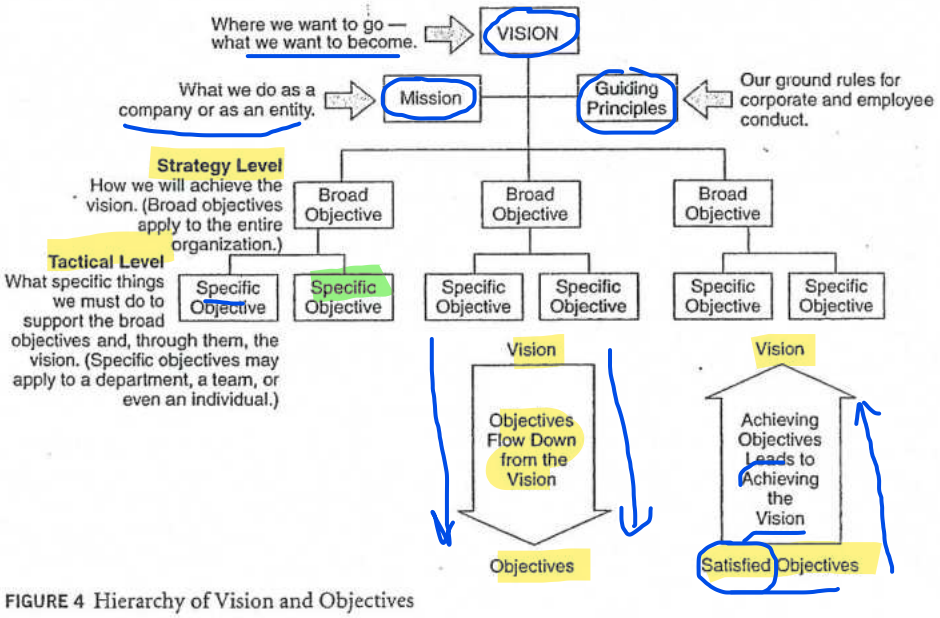


FIGURE 4 Hierarchy of Vision and Objectives

Maytag Corporation

- **Broad objective** (Strategy):
  Premium brand leadership
  Specific objective (Tactic):
  Extend the product offerings of our Maytag and Jenn-Air brands.
- **Broad objective** (Strategy):
  Continuous reinvestment in new product introductions and innovation
  Specific objectives (Tactic):
  A new Maytag dishwasher.
  A new Hoover deep carpet cleaner.
  A new Jenn-Air laundry line.

FIGURE 5 Sample Broad and Specific Objectives

Source: Maytag Corporation, *First Quarter Report*, 1995.

someone who has been there, and deliberating among the steering committee members—is best equipped to chart its own course. You may want to set up some pilot projects in two or three departments. Proceed slowly and monitor closely. Another organization may establish the total quality initiative by setting teams to work at understanding functional processes. A manufacturing organization may start by introducing just-in-time concepts on the assembly floor—probably in pilot programs at first. At this point, everyone is learning. Don't fret about the mistakes, but do learn from them. Soon a couple of successes will be achieved, and then things will tend to fall into place more readily.

One thing the implementation plan must provide for is training. Before the top executive and the steering committee can function as a total quality team, they will require training. This can be obtained through a variety of sources: seminar courses are available, a consultant could be brought in, or self-teaching is possible (but is probably the least desirable approach). After the steering committee has been trained, it will be ready to start its work. Before the first pilot program is initiated, however, the people who are to be involved must be trained. That degree of training is usually minimal—perhaps as little as a half day. Don't let them venture forth without some training.

A common mistake in U.S. industry has been to go into an across-the-board training program before total quality is introduced. This is wrong on several counts. First, it is a very expensive approach. Second, not everyone needs the training at one time. Third, most of those trained will have forgotten what they learned before getting a chance to apply it. It is better to train only as needed, a kind of just-in-time approach to training.

Many companies have successfully used the approach of cascading training. First the steering committee members are trained. They go off and do their planning to get ready for total quality. Then just prior to the first implementation, members of the steering committee train the total quality project leaders, who, in turn, train the team members.

Awards and Recognition Program How will you recognize team achievement? An awards and recognition program should be in hand before the implementation starts. The typical award/recognition program found in the United States is out of step with the total quality concept. Our society is oriented toward individuals. Our award programs recognize individual achievement. Even in team sports that is true. Consider the Heisman trophy. There may be a *best college football player* out there, but unless he is a member of a team that supports his efforts in superlative fashion, he will never win that trophy. Virtually all team sports, amateur or professional, have most valuable player awards. Many manufacturing plants have similar programs to recognize exceptional performance by individuals who are nominated by their peers. For a time, this approach was well-received, and perhaps it still has its place. But as total quality started to be a way of life, people began to view such systems as counterproductive. When trying to do things through teams, don't create superstars. We are not suggesting that exceptional individual accomplishment should go unrecognized, but the focus of the reward system should be on the teams.

These award and recognition programs usually operate on two levels. At one level, the employee review establishes pay raises, frequently associated with an annual or semiannual performance review. The other is like the one mentioned earlier: a kind of spot award for having achieved something special. Both now need to be oriented toward the team rather than the individual. It is very difficult to do that in the former case. This is an area of continuing study in many U.S. firms. The obstacle is that as individuals, we do not want to be penalized for the team's actions. Of course, we would not complain if the team carried us above our own limitations. The perceived problem is far smaller than it appears; it is not likely that any individual will be penalized because he or she happened to be assigned to a team of poor performers. Teams themselves tend to weed out the poor performers far more effectively than management ever could. Still, not many American or Canadian workers are paid on the basis of their teams' performance. Until that happens, we are sending the wrong message to them. This will be a good project for the human resources department.

Spot awards are easily set up to recognize team accomplishments. These need not be extravagant. Some companies provide a dinner for two to each of the winning team's members. Movie tickets are also popular. Some use cash awards. Some simply stress recognition, usually in a forum where all peers are present. Some companies have periodic awards banquets or similar affairs. The possibilities are endless, but employees must see the award process as being fair and equitable, and in tune with the organization's stated intentions.

Publicity Approach An approach for publicizing total quality activities and results is important. All the employees need to know what is going on—all the time. Every employee survey of which we are aware has placed communications at or very near the top of the problem list. It used to be that we tried to give employees *only as much information as they needed*. Now we know that if there is information, virtually all employees need it. They may not act on it directly in their

daily job function, but failing to provide sufficient information to employees with which to make life's decisions is an unconscionable lapse in caring about people. In addition, only when employees are fully informed can they understand many management decisions and consequently support management when they otherwise might be hostile. When it comes to total quality implementation, every employee will be affected in dramatic ways. It is absolutely essential that they understand what is going on and why. There should be no sugarcoating; tell it straight. Let employees know ahead of time what is planned and how they will be affected. When results come in, good or bad, let them know about it. It will be far better to admit a failure in a project than to let the employees find out about it through the underground communications that *always* fill an information void. The failure can be used to demonstrate that there will be no recriminations.

Almost limitless possibilities exist for communicating: a company newspaper or newsletter, all-employee meetings, videos playing in the lunchroom, special total quality bulletins, the intercom system, and so on. Some companies make a very big deal of it and hold picnics, fairs, or even circuses for the express purpose of communicating about total quality. Pick your methods, and use them vigorously.

5 Infrastructure That Supports Deployment and Continual Improvement

With commitment from the top, a high-level steering committee, a set of plans for at least the early phases of implementation, and the means of providing the required training, the only thing we may lack is the infrastructure that will support the deployment of total quality throughout the organization and continual improvement on a never-ending basis. Actually, most of what we talked about in the previous section—the vision and its harmonized objectives, the awards and recognition program, and certainly communication—can be considered a part of the supporting infrastructure. Three other infrastructure features—your operating procedures, organizational structure, and union situation—can offer support for your total quality implementation efforts, or they can get in your way. These considerations will be discussed next.

Procedures Virtually all organizations should operate in accordance with published procedures. You will undoubtedly find that many of your procedures, having been developed in another culture, do not support total quality and represent an opportunity for improvement. Be aware of this always, and never accept the old excuse "We've got to do it this way because that's what the procedures say." Don't buy it. If there is a better way, change the procedures.

Organization The typical Western organizational hierarchy does not fit with total quality (see Figure 6). Such organizations are arranged in departments that effectively raise all kinds of barriers to efficient operation. Communication among them is only the most notable of the problems. As total quality implementation progresses, you may find it necessary to alter your organization; it is an

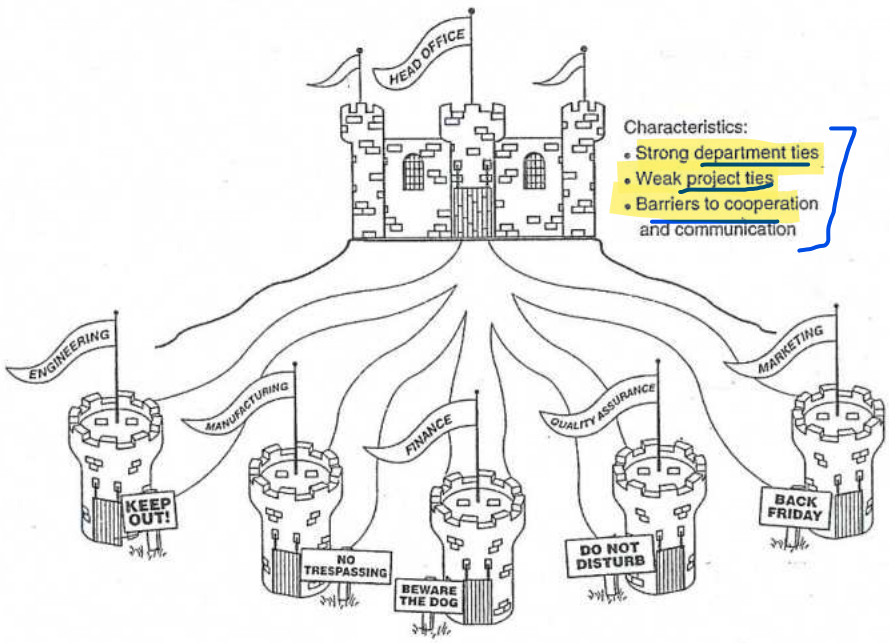


FIGURE 6 Typical Traditional Organization

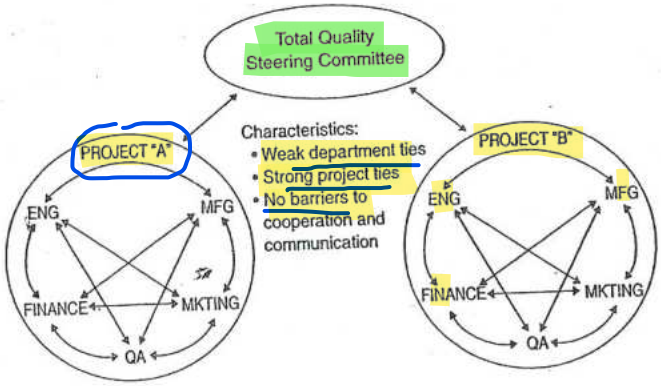


FIGURE 7 Total Quality Organization

absolute certainly that you will run into walls that have been built up around the departments over the years.

There are a number of ways to eliminate the walls. Some firms have simply designed new organizational structures. Others develop minicompanies oriented toward specific products or customers by drawing cross-functional talent from the functional "home" departments—the engineering department or the accounting department, for example (see Figure 7). Both approaches seem to work well. All members of the team (whether 6 or 600) must see their prospects as tied to the project team, not to the home department. This is what *organizational reengineering* is about.

Union Considerations In organizations with organized labor, the union is an inherent part of the infrastructure. The natural bent of the labor unions makes it difficult for them to accept the changes necessary for maximum benefit of total quality. Many unions as we know them today are another product of the mass production era. Just as much of U.S. and European management is out of step with the realities of today's worldwide business environment, so are these unions. Fundamentally, the traditional unions embrace the concept of division of labor to a fault. Henry Ford's assembler of 1913, tightening the same two bolts over and over again—never touching the third bolt—epitomizes their view of the worker. By making sure management could not require him to service bolt 3, the union guaranteed a job for another assembler. This is not confined to the assembly line. In an engineering laboratory of an electronics firm with organized labor, an engineer is forbidden to place a scope probe on a circuit test point. That is the job of the union's technician. So the engineer tells the technician where to probe and looks over the technician's shoulder to see the response on the oscilloscope screen. Does the engineer need the technician to do this probing? Not at all. Does the technician in this role add value to the process? No. Would they both prefer to work under different rules? Certainly, the engineer would. But the union assures the technician of a job where one might argue none would exist without the union.

These kinds of work rules are incompatible with total quality. Division of labor becomes a thing of the past. People are asked to do multiple tasks and to consider matters that would never have been brought up before—such as "Is this part perfect?" They are expected to stop the process when a problem occurs. Their ideas and suggestions are not only solicited but also expected. Work is done in teams, and people are shifted from function to function to pick up peak demands or to fill in for someone who is absent. These are very difficult concepts for some unions.

But over the past few years, unions have been coming around to the point of tolerance, at least. In shops where these techniques have been successfully applied, such as the Japanese automakers' transplants in the United States, their unions have become supporters of total quality. An illuminating example is the NUMMI plant in Fremont, California, which was jointly operated by Toyota and General Motors (GM) from 1984 to 2009. The Fremont plant had been operated earlier by GM, and when GM closed the plant in 1982, it had the worst record in the GM family—an unmanageable workforce, rampant absenteeism, and a quality record that was an embarrassment. When the plant reopened in 1984 under joint management by Toyota and GM, the same equipment was in place, and the workforce was composed of the same people who had been laid off a few years earlier. But everything else was different. The United Auto Workers (UAW) had signed a contract that permitted the plant to be run according to the Toyota model. Work was to be performed by teams. Employee participation was expected. Division of labor was a thing of the past. NUMMI had four job classifications in contrast to some GM plants with 183.[4] The UAW went along with the rules changes in return for a no-layoff policy. Everyone, it appears, turned out winners—the workers, the companies, the union, and, most important, the customers. In a very short time, the cars rolling off the NUMMI line, Toyota Corollas and Geo (later Chevy) Prizms, were receiving the top quality ratings in GM—virtually defect free. The Prizm had the best initial quality rating of all cars produced in the

United States or Europe in 1995, and it was only marginally led by five very expensive Japanese models. Lest you attribute this to a fluke, the Corolla has consistently been rated at or near the top of the J.D. Power and Associates studies. For 2007, J.D. Power and Associates ranked the MUMMI–produced Tacoma the best midsized pickup for initial quality.

The absence of a union shop might make total quality implementation easier, but the presence of a union is certainly no excuse for living with the status quo. Unions have found that the benefits outweigh the disadvantages and may even be able to help in the company's quest for total quality. The union must be a part of the team. In fact, many companies place the top union official on the total quality steering committee.

ROLE OF TOP MANAGEMENT: LEADERSHIP

Every organization must have a leader. That is what we pay our top managers to be. Yet, our expectations are infrequently met. For some inexplicable reason, Westerners have difficulty defining leadership. Leaders are described as people that command or guide a group or activity—not a very illuminating definition. In management circles, the debate goes on about who should be called a leader or whether so-and-so has leadership ability. Somehow the point has been missed: if a person is in charge of any group, that person must lead.

From this perspective, every supervisor, manager, director, vice president, president, and CEO must be a leader. The problem is that most of them have never been told what their job is, and few figure it out for themselves. Their job is to *lead*. You may be thinking that this is rather obvious. It is not. The way our society has traditionally organized its enterprises, the farther up the organizational structure you climb, the less leadership is demanded. When new floor supervisors in a factory have just been promoted from a position on the line, they intuitively know that they have to help the less experienced people, and usually they do so. That is a major role of leadership. On the other hand, when a company president becomes the CEO, he or she is likely to spend less time in a leadership role in the company, making it more competitive, than in lobbying Washington to do something about "unfair foreign competition."

Any person in charge of any group is a leader. That person may or may not be an *effective* leader. Too many times he or she is not. But someone put the person in a leadership position—it did not happen by self-proclamation. Who did it? Management, of course. Which brings us back to these questions: What is a leader? What skills, what natural abilities, what aura are prerequisites of leadership? While some individuals seem to possess qualities that are useful in leadership, we have all known excellent leaders who did not look the part. It helps to be attractive and to have charisma, but these traits are not necessary, nor are they a guarantee of leadership ability. So what is it that separates the good leaders from the ineffective?

1. ***Leaders pull rather than push.*** They are out in front leading the effort, not back in the office (foxhole) yelling, "Charge!" Wess Roberts says it well: "A Chieftain can never be in charge if he rides in the rear."[5] What this really means is that the leader is *visibly involved in the effort he or she is leading.* The antithesis of this is the general manager who gathers the people together and says, "We are going to be a total quality organization, and I'm putting Jim in charge of getting it done." That is abdication of leadership. A corollary to this definition of leadership is this: if you're not personally involved in an effort, you cannot be leading it.
2. ***Leaders know where they want to go.*** They set the vision for their organizations and chart the course to achieve the vision. Moreover, they make the choices of how to achieve the vision and *stick with it.* They provide the constancy of direction and purpose necessary for success in the long run. They keep their eyes on the prize and are not buffeted by the tempests that are often confronted. A second corollary is this: if you don't know where you're going, you cannot lead the expedition.
3. ***Leaders must be courageous and trustworthy.*** There are snares and obstacles along any new pathway. Leaders cannot turn back every time they encounter one. If the goal is worth going after, they must stay the course—even at the risk of enduring hardship along the way. Short-term objectives must be sacrificed if they become obstacles to achieving the vision—and in our society, that takes courage. In similar fashion, leaders can be trusted to come to your aid when one of those obstacles springs up in your area. You have to know beyond any doubt that if, when following their marching orders, something goes wrong, they will be there to protect you and won't "hang you out to dry." When people see courage flagging or subordinates taking the heat when things get tough, they will vote the leader out of the leadership office regardless of "rank." The third corollary is this: if you don't have faithful followers, you cannot be a leader.
4. ***A leader's most important role after forming the vision and setting the course is helping people to do their jobs with pride.*** This is about training and nurturing. It is about giving employees the necessary tools, both physical and intellectual. It is about encouraging when something is difficult and praising when something is accomplished. It is about, as the army commercial says, helping your people to be all that they can be. The role of the leader is not to dictate but to facilitate. It is not to know it all but to find out what others know and put it to use. It is not to "keep people in line" but to involve them to the fullest extent of their capabilities. The fourth corollary is this: a group that is not trained and equipped for a task cannot be led to accomplish it.

QUALITY TIP

The Aim of Leadership

"The aim of leadership should be to improve the performance of man and machine, to improve quality, to increase output, and simultaneously to bring pride of workmanship to people. Put in a negative way, the aim of leadership is not merely to find and record failures of men, but to remove the causes of failure: to help people to do a better job with less effort."

Source: Dr. W. Edwards Deming, cited in Mary Walton, *Deming Management at Work* (New York: Perigee, 1991), 237.

ROLE OF MIDDLE MANAGEMENT

The middle manager is not in a position to initiate the kind of cultural change required by total quality. The middle manager must deal with the facilities, equipment, and processes put in place by higher management. He or she must operate within budget constraints for training self and subordinates. The middle manager is to a greater or lesser extent stuck with the infrastructure established by higher management. The manager in the middle cannot commit company resources, establish the corporate vision, or set up recognition and publicity programs. Nor can the middle manager arbitrate interdepartmental friction. These are the very reasons that no successful total quality program can exist without the full backing and involvement of the top levels. This is not to say that the middle manager (and let's include all levels between the hands-on workers and the department heads) fails to play a role in total quality—far from it. These are the people who will carry the brunt of the work as the path to total quality unfolds.

From personal experience, and from the experience of others, it is clear that the middle-management levels present the greatest obstacles to success in total quality. It always seems easier to sell total quality to the top managers and the hands-on people than to the middle managers. There are several reasons for this:

- A good many people in these positions have been there a long time, recognize that they will progress no further, and see total quality's sweeping changes as threats to maintaining their status quo. Many times their insecurity is well-founded because Western hierarchies typically have far too many layers, and total quality makes that obvious.
- Many middle managers moved into those positions after long apprenticeships in the hands-on level. They feel that they know more about their subordinates' jobs than the subordinates themselves do. One of the basics of total quality is that the expert in any job is the person doing it day in and day out—not the one who did it 10 years ago.
- Most of the middle managers came up doing only what they were told to do, making no waves, playing the company game. That they were successful at it is demonstrated by their eventual promotions to their current stations. They may really believe that is the way it should be.
- Middle managers as a group tend to study less than managers at the top. Often the events that are reshaping the world's industry pass them by, and they simply do not know what total quality is about. People seldom support any concept they do not understand.

There are also many bright, forward-thinking people in the middle manager levels. These are the ones who will become total quality leaders, while the others fade away. The people in this category will take on a role similar to the top managers—the role centers on leadership. We can take the previous section, "Role of Top Management"; strip away functions that apply only to top managers, such as creating the vision and broad objectives and committing resources; and apply the rest directly to the middle manager. The middle manager must be a facilitator, enabling his or her people to do their jobs better, easier, and with increased satisfaction. He or she must help, teach, encourage, praise, and, most important of all, *listen* to these people. He or she must build trust and work for the success of the team.

Middle managers will often function as project team leaders, seeking to define and characterize processes and finding ways to improve them, or will take on a wide variety of special total quality projects. With their teams, they will find new ways to do things and new things to do. They will find themselves on the firing line, for it is at this level that products are produced and information is collected and analyzed. This is, in other words, where the action is, the *raison d'être* for the enterprise. How effective middle managers are in adapting to total quality, and how successful their leadership is, will have the greatest possible impact on the company's ultimate success.

VIEWPOINTS OF THOSE INVOLVED

The journey into total quality will be accompanied by fundamental changes in the culture of the organization. That being so, it is helpful to examine the perspectives of people at various levels and at various milestones along the way. This is presented not so much as a warning as an attempt to raise the sensitivity level of the manager of a total quality effort. Naturally, no two cultures will show identical reactions, but we believe these to be typical.

Factory or Office Worker

Initial reaction: Here we go again. Another company buzzword.

After some experience: Hey, maybe there's something to this total quality.

Six months later: I'd never go back. We're proud of what we do. We're a team.

Middle Management (Unenlightened)

Initial reaction: We've been through "zero defects" and "do it right the first time." This, too, shall pass.

After some experience: They are having lots of problems. They must be nuts to think involving lower levels will do anything but cost money.

Six months later (the still unenlightened): They're just trying to do away with our jobs.

Six months later (the newly enlightened): It's hard to deny success. I'm beginning to understand.

Middle Management (Enlightened)

Initial reaction: Time will tell whether top management is really behind this.

After some experience: We're finding problems we never knew we had. Our team is excited.

Six months later: We're operating better than ever, but we've just scratched the surface. Total quality is the way to go.

Top Management

Initial reaction: How much will this cost, how difficult will the cultural transition be, and will the employees buy in?

After some experience: Most of the staff (now steering committee) are on board. Lower levels seem to be developing enthusiasm, but there is some resistance in the middle levels. Overall, we're making progress, but it is sure taking a lot of attention.

Six months later: Definite progress in several areas. Almost everyone involved and excited. A few holdouts in the middle. Fewer crises to deal with. More time to put into total quality.

The Customer

After the first year: Far better delivery performance. Quality improved. If they can maintain this kind of improvement, they've got my business.

It is our experience that once a total quality effort gets off to a good start and the successes begin to add up, a kind of critical mass develops that causes the whole effort to gain momentum and enthusiasm. From that point on, it is as difficult to slow the effort as it was initially to get it started. Nearly everyone becomes a proponent of total quality.

IMPLEMENTATION VARIATION AMONG ORGANIZATIONS

People who are about to undertake the leadership of total quality implementation in their organizations invariably look to the published literature or the experiences of others for the recipe that will result in success for them. Unfortunately, that magic, succeed-every-time formula does not exist. Our organizations and their cultures are all different, they are staffed with people who are all different from each other, and their business situations are always unique. Therefore, the implementation plan that worked well for XYZ company will never fit exactly with the needs of ABC company. However, in the literature and the experiences of other organizations you will certainly find the ideas and techniques that can be tailored to your own situation. You will find that the approaches to implementation that have been successfully used cover the spectrum of possibilities. The point is this: there is no *one right way*. For a given organization with its special strengths and weaknesses, its peculiar business situation, and its unique culture, there may well be some *wrong ways*. There will also be more than one *right way*.

We have already discussed some of the starting tasks: making a commitment at the top, forming a steering committee of the top management staff, and defining the organization's vision and broad objectives. These are musts. There are some other necessary steps.

1. ***Train the steering committee.*** The basics of this training should include these things:
   - Deming's Fourteen Points and Seven Deadly Diseases (see Figures 8 and 9)
   - The seven tools and the add-ons
   - Team building
2. ***Identify organizational strengths and weaknesses.***
   - What are we really good at?
   - What needed strengths do we lack?
3. ***Identify the probable advocates of total quality.***
   - Which departments are most likely to be advocates of total quality?
   - Who will resist total quality?
4. ***Identify customers, both external and internal.***
   - Who are the organization's real, ultimate customers?
   - Who are the internal customers of the various departments or processes?
   - Who are the customers of the individual employees?
5. ***Develop a means for determining customer satisfaction (external/internal).***
   - Establish the current baseline against which you will measure improvement.

By completing these tasks, the steering committee will be able to make rational judgments about how the journey should be started. For example, if you conclude that one of your weaknesses is in data collection and analysis, it would probably not be advisable to start into total quality with a wholesale leap into process improvement. If you cannot establish the baseline data and collect and analyze data as changes are implemented, how will you know whether you are doing the right things? If that is a weakness, you will have to overcome it before you can do much with your complex processes. On the other hand, if this is one of your

1. **Create constancy of purpose for improvement of product and service.** Dr. Deming suggests that the role of any company should be to stay in business and provide jobs. Research, innovation, and continual improvement are mandatory in order to do that.
2. **Adopt the new philosophy.** No longer put up with poor quality and bad attitudes. These must be unacceptable.
3. **Cease dependence on mass inspection.** Quality cannot be inspected into a product. All inspection can do is cull out most of the defective ones, which will be reworked or thrown out. That is too expensive, and not satisfactory. Quality comes from relentlessly improving the processes that make the product.
4. **End the practice of awarding business on price tag alone.** Buying materials for your products on the basis of lowest price is fraught with problems. Instead, you should seek quality and value and establish long-term relationships with your good suppliers.
5. **Improve constantly and forever the system of production and service.** It is management's responsibility to constantly improve processes, products, and services, while reducing waste.
6. **Institute training.** We have neglected this extremely important function to the extent that too many Western workers do not know how to do their jobs.
7. **Institute leadership.** Find out what leadership is, and do it. It is not giving orders or threatening. It is leading, helping, facilitating.
8. **Drive out fear.** Too many workers continue to do their jobs poorly because they are afraid to ask or suggest. Fear has a huge economic and quality impact.
9. **Break down barriers between staff areas.** We must get people working as a team for the goals of the enterprise, not working to protect and maximize department objectives. Structures must support the whole, not isolate into fiefdoms.
10. **Eliminate slogans, exhortations, and targets for the workforce.** They do no good and are often seen as putting down the workforce, treating members like children. If the teams want to create their own slogans, let them.
11. **Eliminate numerical quotas.** Quotas send the signal to the people that volume is what counts, not quality or processes. They force people to achieve the quotas no matter what the cost in terms of waste or company reputation.
12. **Remove barriers to pride of artisanship.** Everyone wants to do a good job, but too often we do not provide people with the leadership, training, tools, or processes necessary. These barriers to pride of artisanship must be eliminated.
13. **Institute a vigorous program of education and retraining.** Every employee from top to bottom will have to be educated in total quality, the statistical tools, and teamwork.
14. **Take action to accomplish the transformation.** Make this everyone's job, from the top executive to the hands-on labor. Everyone must be involved, and the top levels must be committed to support and facilitate the effort.

FIGURE 8 Deming's Fourteen Points

strengths, you might make your first venture the establishment of one or more process teams, the task of which will be to flowchart a key process, understand how it works, characterize it to baseline its present capability, and then set about refining the process. In one high-tech company that used this approach, the steering committee identified the key processes and established cross-functional teams for each one. The committee capitalized on their data and analysis strengths to get the movement started. Each of the key process teams established lower-level process teams as required. Because everything we do is associated with some process, this company soon found that total quality had permeated its operations. Its Baldrige-based score, a score derived using the criteria for the Malcolm Baldrige Quality Award, more than doubled in a year and a half, placing it at the world-class level.

If you have a manufacturing group that you believe will advocate total quality, you might start by introducing just-in-time/Lean production techniques on the factory floor. Manufacturing has led the way to total quality in a great many companies. On the other hand, you may have some particular problem that has not been solved by the traditional methods. The approach used by many organizations is to enter total quality with the establishment of cross-functional teams (perhaps including the steering committee itself) applying total quality techniques to analyze and solve

1. **Lack of constancy of purpose.** You must have a long-range plan and stick to it. Otherwise, you are buffeted by every new influence, and no one knows where he or she is supposed to be headed.
2. **Emphasis on short-term profits.** The focus must be on the long-range vision, not this quarter's numbers, which often lead to counterproductive decisions.
3. **Evaluation by performance, merit rating, or annual review of performance.** We need to promote teamwork, not individual contribution. Everything about most evaluation systems in use today is counterproductive and demoralizing to employees.
4. **Mobility of management.** Managers need to stay in jobs long enough to learn them and then offer stability over a longer period. Total quality is a long-term project, and there must be continuity to see it through.
5. **Running a company on visible figures alone.** Dr. Deming rightly claims that the most important figures are unknown and unknowable. What numbers do you assign to a delighted customer, or to a team of employees who are fired up to solve process problems? Running by the numbers, especially short-term numbers, can take you in the wrong direction.
6. **Excessive medical costs.** (U.S. only) When the average American automobile's price includes $1,500 for medical insurance costs for the workers who built it, we are fighting an uphill battle to be competitive with the rest of the world.
7. **Excessive costs of warranty, fueled by lawyers who work on contingency fees.** (U.S. only) No comment needed. It is a competitiveness issue.

FIGURE 9 Deming's Seven Deadly Diseases

problems. This problem-solving team approach is probably the most common introduction to total quality. It is important that the problems to be attacked and the team structures be controlled by the steering committee—especially at first. In the beginning, everyone will lack experience. At the same time, enthusiasm can build very quickly. The combination of inexperience and overenthusiasm can produce chaos and, if unchecked, will surely fail to produce the desired results. During the first 6 months or so, nothing should be done that is not directed by the steering committee. In fact, the steering committee needs to stay on top of all total quality activities forever, at least to the point of receiving regular input from all the teams. Nevertheless, the steering committee must remain receptive to suggestions for problems to be solved. Some of those *ad hoc* problems probably should be on the list of early candidates.

Another valid approach, if you are strong in the statistical area, is starting total quality by implementing the use of the seven tools. You know by now that the application of these tools is not restricted to the manufacturing floor. They may be applied wherever processes are at work, and that is everywhere. Before this can happen, the people affected will require a few hours of instruction on the use of the tools.

The customer satisfaction approach is another valid entry. For this, the employees will have to identify their internal customers and determine their basis for customer satisfaction. Then teams can be deployed to find ways to improve their processes in light of their internal customers' expectations. Results can be seen almost at once with this approach because little time elapses between completing a process and getting the output of that process to the internal customer. This approach also works with external customers and is very important, but the cycle time in the external customer loop is much longer, so the information feedback is slower. Many times it does not exist at all except in customer satisfaction's impact to orders and the bottom line.

QUALITY TIP

The Eighth Deadly Disease

We would like to be presumptuous enough to add an eighth Deadly Disease to Deming's list of seven: *Executive incentive programs that involve stock that may be sold in less than 5 years after retirement.* Stock-option programs are the vehicle through which many executives acquire wealth, presumably by being wise managers, thereby enhancing the stock's value. However, there can be enormous pressure to make decisions that drive up the stock's price in the short term, sacrificing the long term, when executives are able to dispose of their stock holdings for personal gain while still employed by the company or within 1 or 2 years after retirement. The result can be that the corporate vision is abandoned, and with it the company's best prospects for the future. Executives may engage in schemes such as massive downsizing, selling off units, even selling out to another company, and many other stratagems that can quickly, if temporarily, raise the stock price. If they could not sell the stock until the fifth anniversary of their retirement, the incentive would be to make decisions compatible with the company's long-term interests (i.e., its vision).

Source: David L. Goetsch and Stanley B. Davis.

Although there is no one right way to implement total quality, the fundamentals apply in all cases. You have to approach it in a structured manner that takes advantage of your strengths, culture, and business situation and the personalities involved. Your first steps should be careful, deliberate, and well-monitored. Study the data and listen to the people. Use the feedback you gain to help make the mid-course corrections that will assuredly be required. Build on your successes and learn from your failures. Keep your eye on the vision, and never let Deming's Fourteen Points be out of mind. Communicate, communicate, and communicate some more.

IMPLEMENTATION APPROACHES TO BE AVOIDED

Before we immerse ourselves in the right way to approach a total quality implementation, let's dispense with some wrong approaches. There are surely more examples of inappropriate total quality implementation than there are of superlative ones. Not surprisingly, however, we do not learn about most of the failures without being directly involved. Still, there is a lot of information around from which we can identify approaches to be avoided.

The following discussion gives you some ideas of implementation approaches that you should avoid.

- ***Don't train all your employees at once.*** It became popular in the mid-1980s to play numbers games with the number of employees who had received training in total quality, the seven tools, SPC, and so on. Some organizations (including government) spent megadollars training thousands of employees from the top of the organization to the bottom as a first step. Then they found that the vast majority of those employees would have no use for the training for months or years. By that time, not having applied their new skills, the employees had forgotten most of the training. People find it discouraging to be trained in a new subject but unable to do anything with it. The right way to do it is to train small groups of your people just-in-time—just as they need it.
- ***Don't rush into total quality by putting too many people in teams.*** Another early total quality numbers game was keeping score by the number of teams that were deployed or the percentage of employees on teams. Management wanted numbers, and because it was often difficult to develop meaningful numbers in terms of increased profitability, customer satisfaction, reduction of waste—all attributable to total quality—the number of teams was something—but no one knew what. The one thing that was certain in these cases was that aside from the teams themselves, no one knew what they were doing, except spending money. This was a throwback to the early days of American quality circles. The idea then was to get everyone into quality circles and let the circles pick projects on which to work. This is not at all like Japanese quality circles. Taiichi Ohno started quality circles at Toyota as production process teams.[6] He postulated that rather than having assembly line operators work as individuals, as they do in a mass production factory, small teams possessing the skills demanded by their broader process(es) could be more efficient. In addition to the normal assembly process, Ohno also assigned quality checking, routine machine maintenance, and housekeeping duties to the teams. He also allocated time for them to discuss their work and develop ways to improve their processes. This was the genesis of the Japanese kaizen, continual incremental improvement.

  The people in early quality circles in the United States didn't necessarily work together, they had none of the additional duties, and they were not focused on kaizen. They did take an hour or so a week to meet and discuss problems, but few of the problems they discussed had much relevance to quality improvement. Teams should be formed deliberately as needed to take on specific issues or problems as directed by the steering committee. Don't worry about how many teams you have, only about results.
- ***Total quality implementation must not be delegated.*** One approach has been for top management to commit the organization to total quality and then to delegate the implementation to the quality assurance department. Beyond demonstrating colossal ignorance of the meaning of total quality, this also reveals something about the leadership at the top. In this case, top management sees it as another program to be endured, and since it is about quality, who better than the QA director to run it? One very competent, nationally known quality assurance professional and advocate of total quality got caught in this trap. He tried very hard for 2 or 3 years to make a successful total quality implementation, but everyone in the company knew the top management was not involved, so the roadblocks held and the program was a failure. A successful total quality implementation requires both complete commitment and active, personal, day-in, day-out involvement by top management and staff.
- ***Don't start an implementation before you are prepared.*** Sometimes higher level managers find it difficult to acknowledge that they don't know something. It should be obvious that plunging into anything as technically and sociologically complex as total quality without having a grasp of the subject will guarantee failure. A lot of plants can be found throughout the United States where the walls are plastered with control charts, where weekly meetings are held to review the data, and where phrases such as "employee involvement" abound. Yet in these same plants, there is no real continual improvement, no real involvement. What has happened is that the traditional department heads, without any total quality leadership, have given the boss what he or she wanted—charts and buzzwords. Be sure to become

educated on the subject of total quality before attempting to implement. This must include the top manager and his or her immediate subordinates.

AN IMPLEMENTATION APPROACH THAT WORKS

We have just discussed implementation approaches that have demonstrated through practice that they should be avoided. Experience has also provided a wealth of information on successful implementations and the techniques that made them that way. Much can be learned from successful implementations, but we must always be mindful that we will not be able to duplicate another's success by following exactly the same path; there are simply too many variables. Our 20-step total quality implementation process will work for any organization with a little tailoring here and there to accommodate the specific organization.

We have said that no two total quality implementations will be the same. However, every implementation will require certain steps, and these steps must be taken in a logical order. Refer to Figure 10. Our implementation model has three phases:

- Preparation
- Planning
- Execution

The preparation phase is necessary for any organization, and the steps are listed in the appropriate order. With the skills honed and the critical information developed in the prepara-

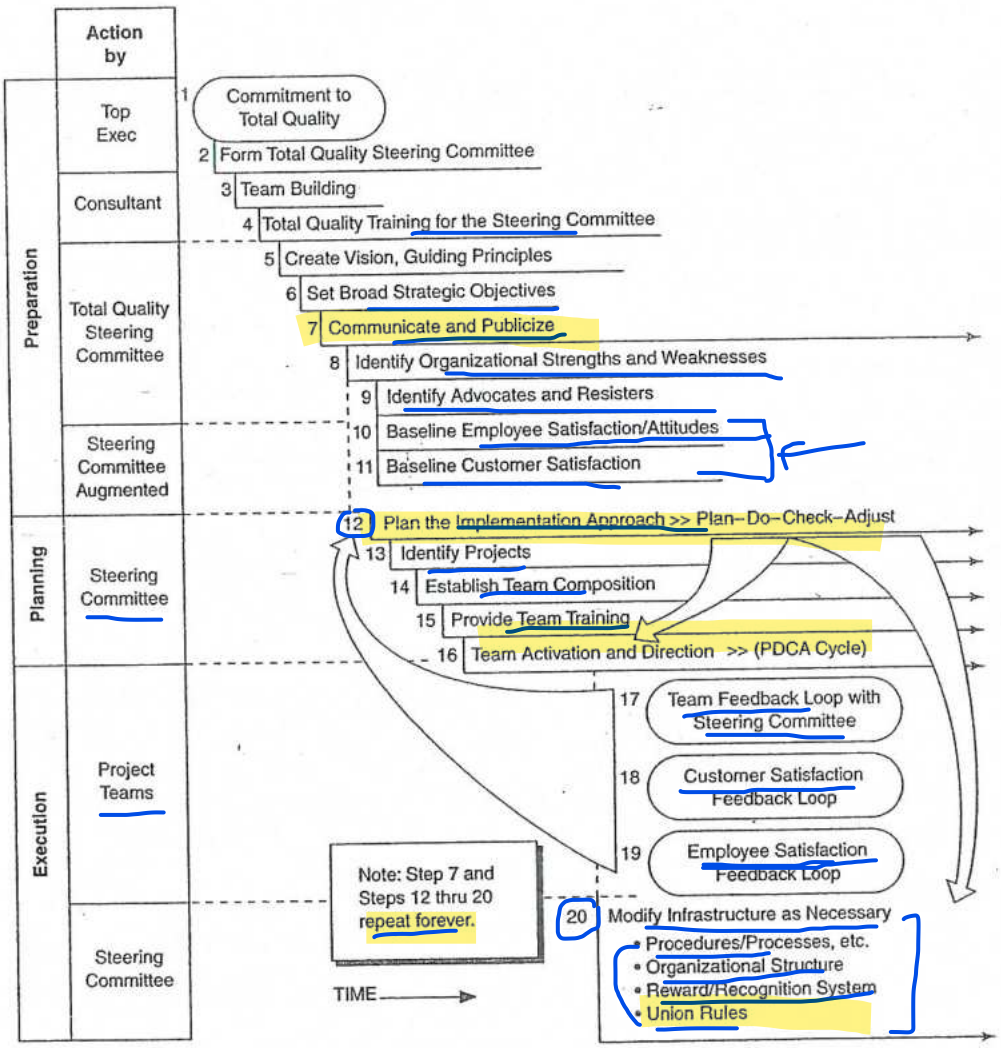


FIGURE 10 The Goetsch–Davis 20-Step Total Quality Implementation Process

tion phase, we can enter the planning phase. It is here that the unique strengths and weaknesses and other characteristics of the organization are accommodated by tailoring. Then we go into the execution phase, carrying out the planning just completed. At this point, we find ourselves in a continuous loop between planning and execution as we go further along the total quality pathway. Even when we can say that we have fully implemented total quality, this loop will continue to operate, making continual improvement and superior competitiveness a reality. As we go step-by-step through this 20-step implementation process, continue your reference to Figure 10 so that you develop a clear picture of how the steps interrelate and how they should be sequenced in time.

We have discussed things that must be done and other things you need to consider for your journey into total quality. Now these things must be put into a time-phased sequence: a schedule. You need to have a clear picture of what comes first and what follows, for some steps are prerequisites for others. The following statement is not meant to be a disclaimer, but the schedule cannot have a well-defined time scale. Only you can determine the time you require to do these things, how long certain steps will take. For that reason, the time scale must be undefined; however, when you apply it to your own implementation, you should apply a more precise scale to target milestone events. Be prepared to allow some flexibility because even within a specific organization, it may be difficult at first to project time requirements for some of the changes. Refer to Figure 10 for clarification of the phases of entry and execution of total quality.

The Preparation Phase (Steps 1 through 11)

This phase includes the steps labeled 1 through 11 in Figure 10, which are carried out in sequence. Even before Step 2 (forming the total quality steering committee) can take place, one all-important event must occur: the top executive must make the commitment of time and resources. Without that commitment, you should go no farther. Assuming that commitment, proceed as follows:

Step 2: Formation of the Total Quality Steering Committee

Action: Top executive designates immediate staff (direct reports) to be the total quality steering committee, with himself or herself as chair. If a union is involved, the senior union official should also be a member of the steering committee.

Note: Several names have been used for this committee. Whatever name you choose, the function will be the same.

Duration: The steering committee will be a permanent entity and will replace the former executive staff organization.

Step 3: Steering Committee Team Building

Action: The steering committee needs to go through a team-building session before it starts any total quality work. This will usually require an outside consultant.

Duration: This usually requires 1 to 3 days, preferably done away from the work environment.

Step 4: Steering Committee Total Quality Training

Action: The steering committee will require training in total quality philosophy, techniques, and tools before it starts any total quality work. Usually requires an outside consultant.

Duration: Two or 3 days of intensive training. This should be followed through in the long run with self-study and appropriate seminars.

Step 5: Creation of the Vision Statement and Guiding Principles

Action: The first real total quality work effort is creating the organization's vision statement and putting on paper the guiding principles under which the company is to operate. Typically the top executive initiates discussion by using "strawman" vision and principles. The objective is getting the steering committee's thoughts, refining the language, and concluding with short, meaningful documents that embody the hopes and aspirations of the company.

Duration: Plan on at least 1 full day.

Step 6: Establishment of Broad (Strategic) Objectives

Action: The steering committee flows the vision statement into a set of broad company objectives. These are by nature on a grand scale—for example, "Become the dominant player in our market in 5 years." These are strategic objectives. From these flow a set of supporting tactical objectives that go into specifics—for example, "by introducing new products on a 9-month cycle over the next 3 years."

Duration: This will take at least a full week but probably will be spread over several weeks. Take the time to do this step with consideration and deliberation, but on the other hand, set your schedule and stick to it.

Step 7: Communication and Publicity

Action: The top executive and the steering committee should communicate information about steps 2 to 4 as they occur. At this point, however, there should be a communication blitz. Make sure that everyone in the organization knows about the vision, the guiding principles, the objectives, and total quality. It is very important that they know why total quality is being implemented. If you don't tell them, the rumor mill will fill the void. Employees should see the top executive as the champion, with the support of the steering committee. This is very important.

Duration: Starts now and goes on forever.

Step 8: Identification of Organizational Strengths and Weaknesses

Action: The steering committee must objectively identify the strengths and weaknesses of the organization.

This information will help guide it to the best total quality implementation approach and may also highlight deficiencies that must be corrected.

Duration: Plan on a full day.

Step 9: Identification of Advocates and Resisters

Action: (May be parallel to or after Step 8.) The steering committee should try to identify those in key slots who are likely to be total quality advocates and those who are likely to resist total quality. This will help in selecting the early projects and team members.

Duration: Should require no more than an hour or two if the members independently prepare their assessments prior to the meeting.

Step 10: Baseline Employee Satisfaction/Attitudes

Action: (May be parallel to or after Step 8.) With the help of the human resources department or an outside consultant, the steering committee should attempt to gauge the current state of employee satisfaction and attitudes. Although there are sophisticated devices for determining this information, it is probably only necessary to make an objective judgment. Having that established, you will later be able to determine whether your total quality changes are working effectively, as shown by improving satisfaction and attitudes.

Duration: Allow a week to do it in-house and at least a month if you have an outside firm do it. Should be repeated annually.

Step 11: Baseline Customer Satisfaction

Action: (May be parallel to or after Step 8.) The steering committee, perhaps augmented by the department that works closest with customers, should attempt to obtain objective feedback from customers to determine their level of satisfaction. Depending on the size of the customer base, the selection of customers to be surveyed may be random. Be certain that someone doesn't pick only those known to be favorably disposed. Having this information will allow you to judge the effectiveness of your total quality efforts as seen by the ones who make the final determination—your customers.

Duration: Allow 2 months if you send out survey forms and 2 weeks if you do it by phone. Should be repeated annually.

The Planning Phase (Steps 12 through 15)

Step 12: Plan the Implementation Approach—Then Use Plan–Do–Check–Adjust (PDCA Cycle)

Action: Now is the time for the steering committee to start planning the implementation of total quality. This step becomes continuous because after initial projects are under way, information will be fed back to this step to accommodate course correction, adjustment, and so on. In addition, this step will continue to spin out new projects and teams. Also, once total quality is in motion, this step effectively shifts to operate within the PDCA cycle, as originated by Walter Shewhart.[7]

Duration: Never ends. This is the step from which the total quality process is managed, not only at the implementation stage but for as long as the process exists.

Step 13: Identification of Projects

Action: The steering committee is responsible for selecting the initial total quality projects, based on the strengths and weaknesses of the company, the personalities involved, the vision and objectives, and the probability of success. The early projects must be selected to assure success in order to set a foundation of positive experience from which to move to the more difficult challenges later on. The steering committee should be open to suggestions for projects from all sources.

Duration: Initial projects selected over a few days. Process continues forever.

Step 14: Establish Team Composition

Action: After the projects have been selected, the steering committee establishes the composition of the teams that will execute them. Most teams will be cross functional, having representation from multiple departments or disciplines, as appropriate for the project at hand. This is one step where it is handy to know who the advocates are.

Duration: This task goes on forever.

Step 15: Provide Team Training

Action: Before a new team can go to work, it must be trained. Training should cover basics of total quality and tools appropriate to the project. Training may be done by a member of the steering committee.

Duration: At least one-half day, followed by facilitation. As new teams are formed, the need for training will continue until eventually all employees are trained and experienced.

The Execution Phase (Steps 16 through 20)

Step 16: Team Activation and Direction (Use PDCA Cycle)

Action: The steering committee gives each team its direction and activates it. Teams work on their assigned projects using the total quality techniques they have learned. They use the plan–do–check–adjust cycle as their total quality process model.

Duration: Project teams, depending on the project, may have life spans of weeks, months, or longer. Measurable results must continue to flow, however, to ensure that the team is being effective.

Step 17: Team Feedback Loop to the Steering Committee

Action: Through this step, the project team closes the loop with the steering committee by providing feedback

information on progress and results. This feedback is usually in the form of presentations to the steering committee. Early on, this loop should be tight, with feedback coming in frequent packets—perhaps weekly. As the project gets on track and stabilizes, monthly feedback is appropriate. Never let it go longer than that. The steering committee uses this feedback to determine if adjustments or changes in direction are required. Any changes desired are fed back to the project team, which carries out the new instructions. Both the team and the steering committee use the PDCA cycle.

Duration: Specific projects may have finite lives of weeks, months, or longer, but this process across all the projects goes on forever.

Step 18: Customer Satisfaction Feedback Loop

Action: Special project teams are deployed to obtain customer feedback information, covering both external and internal customers. Formal external customer surveys should be conducted annually, and other customer satisfaction data (sales results, warranty data, customer service input, data from customer visits, etc.) are collected and processed on a continual basis. Internal customer satisfaction is baselined for key processes and monitored continually. (This latter may be done by the project team assigned to the process in question.) All of this information is fed back to the steering committee on a regular basis, certainly no less frequently than quarterly. This information is digested in the steering committee's PDCA cycle and influences direction changes issued to the project teams and also the formation of new project teams.

Duration: Forever.

Step 19: Employee Satisfaction Feedback Loop

Action: Another special project team periodically takes the pulse of employee attitude and satisfaction. Formal surveys may be done annually, and in between, it is necessary for the steering committee and other managers only to stay close to the employees to develop rather accurate information on attitude and satisfaction. This information is fed to the steering committee as another stream of data on which to evaluate progress and determine any necessary course corrections.

Duration: Forever.

Step 20: Modify Infrastructure as Necessary

Action: Feedback to the steering committee from steps 17, 18, and 19 (from project teams, customers, and employees) will guide the steering committee to address necessary changes in the corporate infrastructure—procedures and processes, organization structure, awards and recognition programs, union rules, and so on. Many times the changes will have to be made by the steering committee itself (e.g., those involving organization structures). On other occasions, it is appropriate to authorize the project teams to make the changes *that are needed* (e.g., those involving the processes on which they are working).

Duration: Because we are talking about continual improvement, this goes on forever.

We have now walked through the various implementation phases. In this exercise, we have followed the process from the time the top executive decided to embrace total quality through working teams. Starting with Step 12 and going through Step 20, we have a closed-loop system that will continue for as long as the total quality process is in use. The feedback to the steering committee provides the information it needs to manage the process. The steering committee, in turn, issues new instructions, establishes new teams, and so on to keep efforts going in the direction that will achieve the objectives and remain in harmony with the vision.

Step 7 (communication and publicity) also goes on forever. We cannot overemphasize the importance of keeping employees informed. Many companies have found that through innovative communication, it is possible to stimulate the kind of enthusiasm throughout the ranks that really produces advocates.

Our coverage of this material is necessarily concise. For a complete in-depth treatment of the Goetsch–Davis 20-step total quality implementation process, you are invited to read our book, *Implementing Total Quality* (Prentice Hall, 1995).

GETTING ON WITH IT

Whether an organization can go through this kind of an implementation without the help of a consultant will depend on the internal availability of one or more experts. Students who study total quality in college can become these internal experts. Rather than trying to muddle through, it would be far better to enlist the aid of a consultant to get you through the implementation and into execution. It is certainly possible to pay a lot of money for such services, but it is by no means necessary. Most consultants would prefer to work with you on a part-time basis (simultaneously servicing other clients). A typical 6-month implementation would probably require I person-month or less of consulting services. This could be a wise investment for your organization because the "muddle through" method is almost sure to fail, after which it will be doubly difficult to recover, to try again.

Virtually every type of enterprise can benefit from total quality. Starting on the journey now may put you ahead of your competition. Failure to start now may leave you behind and doomed to failure as the whole world embraces the principles of total quality.

WHAT TO DO IN THE ABSENCE OF COMMITMENT FROM THE TOP

We have said repeatedly that no entity can truly become a total quality organization without complete, unwavering, participative commitment from the very top. For those of you who have that commitment, your

path is clear—you know what to do and how to proceed. However, many of you will not be so fortunate, and you face a dilemma. Should you try to push total quality from where you are, or should you forget it and wait for top management to come around? There can be no hard and fast answer to this. So much depends on where you are in the organization and whether the top managers are outwardly hostile to total quality or merely unknowledgeable. Even the geographical structure of the organization is a factor.

If your top management is hostile to total quality, it would not seem prudent for you to push the subject much beyond trying to enlighten them. Even that could be hazardous, depending on your relationship with the management group. Certainly, any overt total quality initiatives on your part in defiance of management's wishes would not be in your best interest. If enlightenment does not work, it may be time to consider moving on to different employment. That is not always a reasonable option, but long-term prospects for your current employment are not bright either, given top management's attitude toward total quality.

If your top managers are simply ambivalent toward total quality, perhaps because they do not know much about it, you have a whole different ball game. Assuming your position gives you some latitude of operation, you may be able to construct a mini-implementation within your department that can improve performance in many areas. To do this, you must be the head of a department or must be able to influence a department head who will work with you. Because departments can range in size from just a handful of people to a complete stand-alone facility far removed from the home office, the magnitude of accomplishment of a departmental total quality implementation can vary greatly. The head of a stand-alone facility can look at the implementation almost as if he or she headed the company. The more common situation, where the department is one of many, proximally located, will not offer the same freedom of action, but it is still worth pursuing. Generally speaking, all processes contained within the department, even though they have extradepartmental suppliers and customers, are good candidates for a total quality effort. You should concentrate your efforts there first. After you have gained some successes that have been noticed by top management and other departments, you can begin to push for expansion into the cross-functional processes, requiring other departments to join you in total quality initiatives.

Recognizing that *departmental total quality* is a contradiction in terms (i.e., it cannot be *total quality* until every aspect of the organization is involved and committed to it), implementing total quality in a single department is better than not doing it at all. If the implementation is well-done, the gains will be significant enough to attract the attention of other departments and of top management. Your department may provide the seeds for the larger organization to become involved.

Getting started in a single department is not much different from the process we have just studied for a company-wide implementation. The numbers of people involved in every step may be smaller, but most of the steps are required. The following list briefly addresses each of the 20 steps for applicability in a departmental implementation:

- ***Step 2.*** Unless it is a very large department, such as a stand-alone plant or something similar, you may not require a steering committee. For a large department, we would recommend one.
- ***Steps 3 and 4.*** If you have a steering committee, you will need to give the members some training. Because you are doing this on your own without top management's involvement, don't expect a lot of support money at this point.
- ***Steps 5, 6, and 7.*** Setting the vision, mission, and guiding principles for your department is a good idea. If these exist at the company level, yours should flow directly from them and support them. If the company has no vision, mission, or guiding principles, be sure to have yours approved by top management before proceeding. Once that is done, communicate them to every department employee.
- ***Steps 8 and 9.*** This is just as important at the department level as it is for the larger organization. The identification of department strengths and weaknesses and of those likely to help you will be of invaluable assistance in selecting your initial projects.
- ***Steps 10 and 11.*** We believe that it will be important for you to know your employee attitude index within the department. In terms of baselining customer satisfaction, you will probably be looking at internal customers in other departments, but the same considerations apply. In this case, it should be easy to survey for the information.
- ***Step 12.*** Must be done. No matter what the scale, the implementation approach should always be thoroughly planned.
- ***Step 13.*** You should identify your initial projects based on your department's strengths and weaknesses, where your support is, and, very important, the processes and activities that are contained completely within your department. Try to pick initial projects that can yield measurable gains without significant expense.
- ***Steps 14, 15, and 16.*** Follow the same procedure as for the larger organization, but recognize that you may have to improvise in the training step in the absence of dollar support.
- ***Steps 17, 18, and 19.*** These steps follow the same procedures as for the larger organization except that customer feedback will probably be from your internal customers in other departments. If you elect not to use a steering committee, the feedback path will be directly to you.
- ***Step 20.*** Although you may find it advantageous to make some intradepartmental infrastructure changes, you will probably have to secure approval of top management before the fact.

As in the earlier discussion, steps 12 through 20 become a repeating cycle even within a departmental implementation. Eventually, it will become clear whether your implementation has piqued the interest of top managers, encouraging them to spread the implementation to other departments, or whether total quality will go no further in the organization. Another possibility is that your peers may join you department by department. This is far from the ideal way to implement total quality in any organization, but it is preferable to discarding total quality out of hand.

IMPLEMENTATION STRATEGIES: ISO 9000 AND BALDRIGE

Organizations that are not ready to undertake a full total quality implementation but that want to move in that direction can use the criteria of several different award and certification programs as a starting point. The two programs that we recommend are ISO 9000 and the Malcolm Baldrige Award.

ISO 9000 as a Starting Point

If an organization has not yet committed to total quality but is in a business that could benefit from ISO 9000 registration, going through the preparation steps will automatically provide a start into total quality. Although ISO 9000 and total quality are not equivalent, any total quality organization should apply the kinds of procedures, checks, and management involvement required by ISO 9000. ISO 9000 is a subset of total quality, but it is close to TQM.

ISO 9000 registration requires, for most organizations, a lot of work. If starting without any written procedures, if processes are not well-documented, and if there is no quality system or quality manual, an organization faces an uphill battle. But the work required is work that must be done for total quality anyway. ISO 9000 preparation can get an organization started on a total quality implementation.

Self-Assessment Based on Baldrige or Similar Criteria

The Malcolm Baldrige National Quality Award program, which operates under the auspices of the National Institute of Standards and Technology (NIST), was established in 1987 by legislation (P.L. 100–107) and is intended to:

- Promote awareness of the importance of quality improvement to the national economy.
- Recognize organizations that have made substantial improvements in products, services, and overall competitive performance.
- Foster sharing of best-practices information among U.S. organizations.

From 1988 through 2010, 91 organizations have received the coveted Baldrige Award. Competitors for the award are evaluated according to criteria organized into seven categories. The categories are weighted in value, with a maximum score being 1,000. The list of evaluation criteria, which is updated periodically, is shown in Figure 11. Each of the seven categories is broken down into two or more subcategories, so that the evaluation covers the 17 areas of the organization's operations considered most meaningful to an evaluation of world-class ranking. Each subcategory is further broken down two more levels to enable the evaluation of the actual processes used.

Competing for the Baldrige Award can be quite expensive, but at the time of this writing, at least 45 states sponsor quality programs based on the Baldrige. The state competitions offer most of the benefits at a much lower cost. (The most significant difference lies in the prestige of the national award.) Most states also offer self-assessment criteria derived from the Baldrige. These, or the Baldrige criteria themselves, can be used by organizations wishing to assess themselves against world-class standards without going through the actual competition.

Virtually all of the Baldrige competitors, both the winners and those who have not won, say that the real value of the Baldrige Award is not in the award but in the preparation. Consequently, more and more organizations are going through the preparation phase without any intention of competing for the prize. What does this do for them? It shows them how they stack up against a world-class standard and provides them with a list of needed improvements. If an organization has not yet committed to total quality, conducting a Baldrige-based self-assessment will provide a scorecard for comparison against the best in the world. More than that, it will clearly identify the areas that most need to be improved, thus providing the impetus for implementing total quality, and putting all your people to work on the areas of need. Do that in the context of the 20-step total quality implementation process.

Do not get the idea from this discussion that an organization can implement total quality without the order, discipline, and planning suggested by this text. Ultimately, organizations will need everything presented here.

QUALITY TIP

Seeing It as It Is

As a word of caution, a self-assessment score would probably not hold up against an assessment by qualified outside assessors. Much of our consulting effort has been involved in these assessments. Whenever we have conducted a Baldrige-type assessment, we have always required the executive team to conduct a self-assessment first. Without exception, the self-assessment score is higher than our assessment team's score—usually by 200 to 300 points. Many executives think their organizations' performance is better than it really is. The facts emerge from the middle and lower levels of the organization; hence, the difference in scores.

Source: David L. Goetsch and Stanley B. Davis.

1. **Leadership** (120 points)
   Examines how the organization's senior leaders guide and sustain the organization; the organization's governance; and how the organization addresses its ethical, legal, societal, and key community responsibilities.

2. **Strategic Planning** (85 points)
   Examines how the organization develops strategic objectives and action plans; how these objectives and action plans are deployed; how they are changed if required; and how progress is measured.

3. **Customer Focus** (85 points)
   Examines how the organization engages its customers for long-term marketplace success, including how the organization listens to the voice of the customers, builds customer relationships, and uses this for improvement and innovation.

4. **Measurement, Analysis, and Knowledge Management** (90 points)
   Examines how the organization selects, gathers, analyzes, manages, and improves its data, information, and knowledge assets; how it manages its information technology; and how it reviews and uses reviews to improve its performance.

5. **Workforce Focus** (85 points)
   Examines the organization's ability to assess workforce capability and capacity needs and build a workforce environment conducive to high performance in alignment with the organization's vision and objectives.

6. **Operations Focus** (85 points)
   Examines how the organization designs, manages, and improves its work systems and work processes to deliver customer value and achieve organizational success and sustainability; and readiness for emergencies.

7. **Results** (450 points)
   Examines the organization's performance and improvement in all key areas—product and process outcomes, customer-focused outcomes, financial and market outcomes, workforce-focused outcomes, and leadership and governance outcomes. Also examines performance levels relative to those of competitors and other organizations providing similar products and services.

FIGURE 11 Seven Categories of Criteria for the Malcolm Baldrige National Quality Award
Source: National Institute of Standards and Technology, October 2011.

By using ISO 9000 or quality award assessment criteria, an organization can get started. But the full-fledged implementation we have described will be needed if an organization is to realize the full benefit of total quality.

Addresses for ISO 9000 and Quality Awards Information

For ISO 9000, ANSI/ISO/ASQ Q9000:

American Society for Quality
PO Box 3005
Milwaukee, WI 53201-3005
Phone: (U.S. & Canada) 800-248-1946
Web: www.asq.org

For the Malcolm Baldrige National Quality Award:

Baldrige Performance Excellence Program
(Malcolm Baldrige National Quality Award)
100 Bureau Drive, Stop 1020
Gaithersburg, MD 20899-1020
Web: www.nist.gov/baldrige/
E-mail: nqp@nist.gov

You may also contact the ASQ, as listed above.

SUMMARY

1. The traditional way of doing business presents the following problems:
   - We are bound to a short-term focus.
   - The traditional approach tends to be arrogant rather than customer focused.
   - We seriously underestimate the potential contribution of our employees, particularly those in hands-on functions.
   - The traditional approach equates better quality with higher cost.
   - The traditional approach is short on leadership and long on bossmanship.
2. The requirements for implementation are as follows: commitment by top management, creation of an organization-wide steering committee, planning and publicizing, and establishing an infrastructure that supports deployment and continual improvement.
3. The role of top management can be summarized as providing leadership and resources. The role of middle management is facilitation.
4. Although implementation must vary with each organization, the 20 fundamental steps offered in this chapter must be followed, generally in the order given. Tailoring to the organization's specific culture, values, strengths, and weaknesses is done in the *planning* phase, steps 12 through 15.
5. Implementation approaches that should be avoided are as follows: don't train all employees at once, don't rush into total quality by putting too many people in too many teams too soon, don't delegate implementation, and don't start an implementation before you are prepared.
6. Implementation phases are as follows: preparation phase, planning phase, and execution phase.
7. Going through the ISO 9000 registration steps will give an organization a good start on implementing total quality. ISO 9000 is an international standard for providers of goods and services that sets broad requirements for the assurance of quality and for management's involvement.
8. The Malcolm Baldrige National Quality Award evaluates candidates for the award according to criteria in seven categories: leadership; strategic planning; customer focus; measurement, analysis, and knowledge management; workforce focus; operations focus.

KEY TERMS AND CONCEPTS

Advocates
Baseline customer satisfaction
Baseline employee satisfaction/attitudes
Commitment by top management
Communicate and publicize
Customer feedback
Customer focused
Employee feedback
Evaluation criteria
Execution phase
Infrastructure
Interchangeable worker
ISO 9000
Leadership
Malcolm Baldrige National Quality Award
National Institute for Standards and Technology (NIST)
Organization
Organization-wide steering committee
Planning and publicizing
Planning phase
Preparation phase
Production labor costs
Resisters
Short-term focus
Strategic (broad) objectives
Strategic planning
Tactical (specific) objectives
Team activation—PDCA cycle
Team composition
Team training
Union considerations
Vision statement and guiding principles
World-Class Standard

FACTUAL REVIEW QUESTIONS

1. What is meant by the statement "We are bound to a short-term focus"?
2. How does the traditional approach to doing business equate quality with higher cost?
3. Differentiate between leadership and bossmanship.
4. List and explain the requirements for total quality implementation.
5. Describe the necessary components of an infrastructure that supports goal deployment and continual improvement.
6. What is the role of top management in the implementation of total quality?
7. What is the role of middle management in the implementation of total quality?

8. List the implementation steps that follow after the vision statement and broad objectives have been developed.
9. List and briefly explain implementation approaches that should be avoided.
10. Implementation of total quality happens in phases. Explain each phase in the order it occurs.
11. What is ISO 9000 registration, and how does it relate to total quality?
12. List the various categories of criteria for the Malcolm Baldrige National Quality Award.

CRITICAL THINKING ACTIVITY

1. The chart below was developed from the J.D. Power and Associates *Initial Quality Studies* for the years 2004 through 2007. Using Jaguar as an example, we see that in 2004, the Jaguar nameplate was ranked 3rd in initial quality with 98 problems per 100 cars, improved to 2nd in 2005, and dropped to 5th in 2006 and then to 6th in 2007. When you compare the ratings of the American nameplates (marked with asterisks), do you find a trend of overall improvement in rankings? What do the rankings and number of problems suggest for the American, Japanese, Korean, and European cars? Who (by nameplate or geographic area) seems to have the best record over this four-year period, and which nameplates seem not to "get it"?

   Note: Lexus, Honda, Infiniti, Toyota, Acura, Nissan, and Mazda are Japanese nameplates. Hyundai and Kia are Korean. Jaguar, Mercedes Benz, Audi, BMW, and Volvo are European nameplates.

2. E-Z Open Manufacturing Company is a leading maker of manual can openers. In the year just closed, E-Z Open controlled 17.2% of the manual can opener market in North America. That placed the company in the number two sales position for manual can openers. The company in the number one position, Saf-T Products Co., had a 22.3% share of the North American market. E-Z Open was eager to expand its market with a new rechargeable battery-operated can opener. Saf-T also has an electric can opener, but it is a countertop model that must be plugged in to operate. E-Z Open thinks it has a more desirable product with a battery-operated model because it will not tie up kitchen counter space, nor will it be encumbered by an electric cord. In addition, both the manual and the electric models now have removable cutter heads that can easily be cleaned. (Difficulty in keeping can openers clean has been a problem since the first rotary cutter models appeared 80 years ago.)

   Already well into the early work of a TQM implementation, E-Z Open is gearing up for a big year. It is at the point where it needs a vision statement, guiding principles, a mission statement, and a set of broad objectives. You have been retained as a consultant to help develop all of these. The company will hold an off-site meeting of the steering committee in 2 weeks, and you are to attend. It has asked you to provide the "strawman" documents to kick off the meeting. Your task is to develop the initial versions of each of the documents except the objectives.

3. E-Z Open Manufacturing's organization structure is straight out of the 1950s. The president is the senior executive, and he has a secretary and five department heads reporting to him. The departments are product development, manufacturing, finance, marketing, and human resources. Each is headed by a vice president (VP). Quality assurance is headed by a manager who reports to the manufacturing VP. The VP of product development has 35 people working on designs for a new family of small kitchen appliances, which the company hopes will render the firm immune to the dreaded can opener demand cycle.

Initial Quality Study **Nameplate Ranking, 2004–2007**
(ranked by problems per 100 vehicles)

Nameplate	2004	2005	2006	2007
Lexus	1/87	1/81	2/93	2/94
Cadillac*	2/93	5/104 tie	7/117 tie	25/135
Jaguar	3/98	2/88	5/109	6/112 tie
Honda	4/99	12/112	6/110	4/108
Buick*	5/100 tie	4/100	23/134	14/127
Mercury*	5/100 tie	16/120	16/129 tie	8/113
Hyundai	7/102	10/110 tie	3/102	12/125 tie
Infiniti	8/104 tie	9/109	7/117 tie	9/117
Toyota	8/104 tie	7/105	4/106	6/112 tie
Mercedes Benz	10/106	5/104 tie	27/139	5/111
Audi	11/109 tie	8/106	18/130	26/136
BMW	11/109 tie	3/95	29/142	21/133
Volvo	14/113	31/140 tie	20/133 tie	16/129
Acura	15/117	15/116	10/120 tie	17/130
Chevrolet*	16/119	20/127 tie	14/124	15/129
Chrysler*	17/120	19/121	10/120 tie	27/151
Dodge*	18/121 tie	24/130	19/132	30/156
Lincoln*	18/121 tie	13/113	12/121 tie	3/100
Pontiac*	20/122	22/129	20/133 tie	21/133
Ford*	23/130	20/127 tie	15/127	10/120
Saturn*	30/149	27/136	16/129 tie	19/132
Kia	31/153	31/140 tie	26/136	12/125 tie
Nissan	32/154	16/120 tie	12/121 tie	19/132
Mazda	33/157	35/149	31/150	34/163
Hummer*	37/173	10/110 tie	36/171	33/162

1st number is the rank for that year.
2nd number is the number of problems per 100 vehicles.
The chart does not include all makes.
*American nameplate.
Source: Adapted from J. D. Power and Associates *Initial Quality Studies*—2004 through 2007.

Manufacturing is aware of the new-product development effort and is concerned that it might face problems getting these products into production. Finance figures that the company cannot build mixers with the tools used for making can openers but has no clue as to the investment size. Meanwhile, marketing, gleeful that it will soon have something new to sell, keeps sending ideas for still more new products into product development. Quality assurance is totally occupied inspecting can openers and is out of the loop for the new products. You have gotten a sense for this, and you think the infrastructure is an impediment to the growth the firm is anticipating. What would you have the company do?

4. Using your place of work as the model, how does (or could) TQM benefit it in general, and in particular, what improvements would you expect from following the 20-step implementation process? (If you are a full-time student, and not employed, skip this question.)
5. Using your college as the model, explain how implementing a total quality program might benefit both the institution and its students. Include specific areas for improvement.

DISCUSSION ASSIGNMENT 1

McDonnell Douglas Corporation

McDonnell Douglas is now part of the Boeing Company, but that does not diminish in any way the turnaround that took place at McDonnell Douglas between 1992 and 1997. Times were not good for the company in the early 1990s. With the military buildup a thing of the past, the huge military division watched as sales plummeted. The commercial aircraft division struggled to be competitive with Boeing and Airbus. Waste and inefficiency were rampant. McDonnell Douglas stock sat at $9 a share in 1992—the lowest in anyone's memory. The company, once the nation's largest defense contractor, and the world's number two supplier of commercial aircraft, was in serious trouble.

The senior management staff under the leadership of John McDonnell, then board chair, decided to try total quality management. They got off to a very rocky start but learned from their mistakes and by 1992 were making good progress. Starting that year, executives were measured on three items: cash flow, return on net assets, and TQM, with the latter being tied to improvement on a Baldrige self-assessment score. In 1992, the self-assessment score was 200 (on the 0–1,000 scale). Over the next 3 years, the score increased by 100 points per year. This took the company from being a so-so performer in the traditional ranks to being a high midlevel performer in the TQM realm.

McDonnell Douglas found that as its Baldrige self-assessment score improved each year, its key business performance indicators tracked in parallel fashion. By 1995, its stock valuation reached $70 per share, profits were several times greater than in 1992, cash was up, and debt was down—all in a vastly smaller market. TQM literally turned around this giant company to the extent that the Boeing Company considered it imperative to merge in order to save Boeing. (The merger became final on August 1, 1997.)

DISCUSSION QUESTIONS

Discuss the following questions in class or outside of class with your fellow students:

1. Explain how the use of TQM could contribute to the improvement noted in McDonnell Douglas Corporation's key business performance indicators.
2. What was John McDonnell's motive in making improvement in the company's Baldrige self-assessment score a part of executive performance evaluations?

Source: From a paper delivered by John McDonnell, board chair, McDonnell Douglas Corporation, at the Florida Sterling Awards for Quality, June 1995, Orlando, Florida.

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ISO 9000 AND TOTAL QUALITY: THE RELATIONSHIP

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ISO 9000 AND TOTAL QUALITY: THE RELATIONSHIP

There can be no improvements where there are no standards. —***Masaaki Imai***

MAJOR TOPICS

- ISO 9000: The International Standard for Quality Management Systems
- ISO 9000's Objective
- How ISO 9000 Is Applied to Organizations
- The ISO 9000 Quality Management System: A Definition
- Authority for Certification/Registration
- ISO 9001 and Industry-Specific Applications
- Organizational Registration to ISO 9001
- The Benefits of ISO 9000
- The Origin of ISO 9000
- Comparative Scope of ISO 9000 and Total Quality Management
- Management Motivation for Registration to ISO 9001
- ISO 9000 and Total Quality Management Working Together
- The Future of ISO 9000
- ISO 9000: Versions/Updates

ISO 9000: THE INTERNATIONAL STANDARD FOR QUALITY MANAGEMENT SYSTEMS

The ISO 9000 is a family of standards and guidelines related to the quality management system (QMS). It sets the requirements for the assurance of quality and for management's involvement. The thrust of ISO 9000 is for organizations to implement a QMS conforming to the standard's requirements and, through the consistent, rigorous employment of the QMS, to

- Improve customer satisfaction by fulfilling customer requirements;
- Achieve continual improvement of organizational performance and competitiveness;
- Continually improve its processes, products, and services; and
- Comply with regulatory requirements.

It is important to note that ISO 9000 does not specify a level of quality or performance for any product or service provided by an organization. That is left to the organization to determine with its customers. The ISO 9000 is about standardizing the approach organizations everywhere use to manage and improve the processes that ultimately result in their products and services. The ISO 9000 is applicable to any organization, whether in the private or the public sector, whether large or small, and applies to those components of the organization that can have an impact on product or service quality. These typically include the departments responsible for engineering/design, purchasing, manufacturing, quality assurance, and delivery of the organization's products and services.

When an organization demonstrates conformity to ISO 9001 to an independent (3rd party) registrar firm, the registrar can certify (or register) the organization. Registration provides assurance to customers worldwide that products or services from the organization can be expected to consistently meet customer requirements. To maintain its registration, the organization must constantly strive to ensure that the QMS continues to function effectively and that it is continually improved. That is done through consistent and rigorous application of the QMS and a system of formal, documented internal audits in interaction with the organization's top management, interspersed with periodic independent audits by the registrar firm. Registration may be lost if the registrar's audits determine that the organization is not conforming to the requirements of its registered QMS.

The Eight Principles: ISO 9000's Basis

The ISO 9000 QMS is based on eight principles from total quality management (TQM):

1. **Customer Focus.** Understand the customer's needs, meet the customer's requirements, and strive to exceed the customer's expectations.
2. **Leadership.** Establish unity of purpose and organizational direction and provide an environment that promotes employee involvement and achievement of objectives.
3. **Involvement of People.** Take advantage of fully involved employees, using all their abilities for the benefit of the organization.

QUALITY TIP ▽

Quality Management

"Quality Management is what the organization does to fulfill:

- the customer's quality requirements, and
- applicable regulatory requirements, while aiming to
- enhance customer satisfaction, and
- achieve continual improvement of its performance in pursuit of these objectives."

Source: ISO 9000 and ISO 14000, in brief.

4. **Process Approach.** Recognize that things accomplished are the results of processes and that processes along with related activities and resources must be managed.
5. **System Approach to Management.** The multiple interrelated processes that contribute to the organization's effectiveness are a system and should be managed as a system.
6. **Continual Improvement.** Continual improvement should be a permanent objective applied to the organization and to its people, processes, systems, and products.
7. **Factual Approach to Decision Making.** Decisions must be based on the analysis of accurate, relevant, and reliable data and information.
8. **Mutually Beneficial Supplier Relationships.** Both the organization and the supplier benefiting from one another's resources and knowledge results in value for all.

These eight principles will be recognized from your study of TQM and from Dr. Deming's Fourteen Points. They represent the total quality philosophy to which the organization must adhere in order to develop the cultural environment necessary for an effective, conforming QMS.

Plan–Do–Check–Act: ISO 9000's Operating Principle

Plan–Do–Check–Act is now the *operating principle* of ISO's management system standards. Its function is to operate in a never-ending loop, as described in the following steps and shown in Figure 1, resulting in continual improvement for products/services, processes, and systems of processes.

1. **Plan.** Establish objectives and develop the plans to achieve them.
2. **Do.** Put the plans into action.
3. **Check.** Measure the results of the action; that is, is the planned action working, or were the objectives met?
4. **Act (or Adjust).** Learn from the results of the third (Check) step, make any necessary changes to the plans, and repeat the cycle.

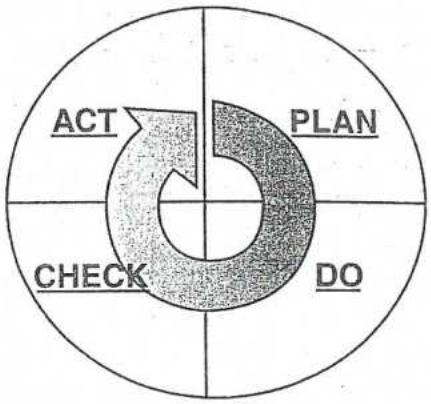


FIGURE 1 Plan–Do–Check–Act Cycle

ISO 9000'S OBJECTIVE

Aims of ISO 9000

The original aim of ISO 9000 was to ensure that the products or services provided by registered organizations were consistently fit for their intended purpose. The ISO 9000 raised the standard's aim to a new level. Customer focus and continual improvement, along with the other six quality management principles that have been incorporated into the standard, are intended to make registered organizations more competitive. This is essentially the same objective as that of total quality management.

HOW ISO 9000 IS APPLIED TO ORGANIZATIONS

No organization is required by any government to use ISO 9000. Some government and corporate customers may well require their suppliers to be ISO 9000 registered (or at least conforming), but usually whether to adopt the ISO 9000 QMS is strictly up to the organization's management. Once management decides to go with ISO 9000, then it is faced with the task of developing its QMS to conform to the requirements of ISO 9001. The ISO 9001 lays down the requirements for *what* an organization's QMS must do but does not dictate *how* the QMS should do it in any particular organization. The organization determines that for itself and, if seeking registration, employs an accredited registrar firm to verify its conformance to ISO 9001. Without getting into details beyond the scope of this chapter, the organization, once registered, must

- Apply its QMS to its operations according to the standard and exactly as the QMS states.
- Continually assess the effectiveness of the QMS and make changes to improve it.
- Conduct periodic internal QMS audits.
- Submit to external (3rd party) surveillance audits at least annually by its registrar.
- Submit to a new registration audit every third year by a registrar.

istration will be granted. Otherwise, the registrar will inform the organization of the areas requiring work (but will not tell the company specifically what must be done), and another audit will be scheduled.

6. Whether registered or not, the organization must conduct its own internal audits to ensure that the systems, processes, and procedures are working effectively.
7. Once registered, the outside registrar will make periodic audits for the same purpose. These audits must be passed to retain registration.

An important point to remember about ISO 9000 is that the organization has to respond to all ISO 9001 requirements and tell the registrar specifically *what it is going to do and how it is to be done.* The ISO does not tell the organization what it must do or how to do it. To retain registration, the organization *must do what it said it would do.*

THE BENEFITS OF ISO 9000

Organizational Benefits

The ISO claims that beyond customer satisfaction, cost and risk-management benefits will also accrue to the organization. These benefits translate to improved competitiveness—the same as TQM's objective. The ISO claims these benefits result from emphasizing the eight quality management principles on which the standard is based.

Customer Benefits

Customers want products or services that meet their requirements, and they want them at a competitive price. Like TQM, ISO 9001 can help the organization in both areas. Customer requirements will be met if the organization listens to customers and designs and manufactures its products accordingly. Prices can be more competitive because waste is minimized as improved processes become more efficient, benefiting both the organization and its customers. Customers have increased confidence in the products and services of ISO 9000-registered organizations because they know that appropriate quality management processes are employed and that an independent registrar ensures that this continues to occur.

THE ORIGIN OF ISO 9000

The ISO 9000 and total quality management originated independently of each other, for different reasons, in different parts of the world, and at different times. You are already familiar with the post–World War II origins in Japan of the total quality movement. The ISO 9000 series of standards was originally developed in response to the need to harmonize dozens of national and international quality standards that then existed throughout the world. To that end, the ISO, a worldwide federation of national standards organizations from more than 158 nations, formed Technical Committee 176 to develop ISO 9000.

The ISO 9000 was developed by this international team that includes the American National Standards Institute (ANSI), the U.S. member of ISO. The ANSI was represented by the American Society for Quality (ASQ), its affiliate responsible for quality management and related standards. The first version of ISO 9000 was released in 1987. By that time, the total quality management movement was more than 35 years old. As a result of this standard, suppliers of products and services are able to develop and employ a QMS that is recognized by all their customers regardless of where on the planet those customers might be.

COMPARATIVE SCOPE OF ISO 9000 AND TOTAL QUALITY MANAGEMENT

There are two principal quality initiatives at work in the world today: ISO 9000 and Total Quality Management. Consequently, it is helpful to explain the relationship between the two. The following statements outline the relationship. Each statement is explained in the sections that follow in this chapter.

- ISO 9000 and TQM are not interchangeable.
- ISO 9000 is compatible with, and can be viewed as a subset of, TQM.
- ISO 9000 is frequently implemented in a non-TQM environment.
- ISO 9000 can improve operations in a traditional environment.
- ISO 9000 may be redundant in a mature TQM environment.
- ISO 9000 and TQM are not in competition.

ISO 9000 and TQM are Related but Not Interchangeable

Although ISO 9000 made a great leap toward TQM with the 2000 release, they are not yet the same, and probably never will be. By definition, ISO 9000 is concerned only with quality management systems for the *design, development, purchasing, production, installation,* and *servicing* of products and services.

On the other hand, total quality management, by definition, encompasses every aspect of the business or organization, not just the systems used to design, produce, and deploy its products and services. This includes all support systems such as human resources, finance, and marketing. Total quality management involves every function and level of the organization, from top to bottom.

Total quality management also means that management is responsible for developing the organization's vision (what it hopes to be at a point in the future), establishing guiding principles (a code of conduct for the organization and all of its employees), and setting the strategy and tactics

Characteristics	ISO 9000	TQM
Customer focus (internal and external)	✓	✓
Obsession with quality		✓
Scientific approach to problem solving	✓	✓
Long-term commitment	partial	✓
Teamwork		✓
Continual process and product improvement	✓	✓
Education and training intensive	✓	✓
Freedom through control		✓
Unity of purpose	✓	✓
Employee involvement and empowerment	partial	✓

FIGURE 3 Total Quality Management Characteristics Compared with Those of ISO 9000

for achieving the vision within the constraints of the guiding principles. In a TQM organization, the vision is pursued with input from an empowered workforce that cooperates and collaborates with management.

Total quality management, based on the teachings of Deming, Juran, Ishikawa, and others, with criteria defined by Deming's Fourteen Points, Juran's Ten Steps to Quality Improvement, and the Malcolm Baldrige National Quality Award, is more pervasive and demanding—literally requiring the transformation of the organization.

The primary difference between ISO 9000 and TQM is in the degree to which the total organization is involved. Whereas TQM requires the involvement of all functions and levels of the organization, ISO 9000 does not require the QMS to include functions and levels that play only indirect roles in the management and execution of the product or service realization processes. Functions that typically are not involved under the QMS include human resources, finance (accounting), sales, and marketing.

Figure 3 illustrates how close ISO 9000's evolution has brought it to TQM.

TQM is defined as an approach to doing business that attempts to maximize the competitiveness of an organization through the continual improvement of the quality of its processes, products, services, people, and environments by emphasizing the characteristics listed in Figure 3.

ISO 9000 is Compatible with, and Can Be Viewed as a Subset of, TQM

Clearly, TQM and ISO 9000 are not quite the same thing. However, there is nothing inherent in ISO 9000 that would prevent it from becoming part of a larger total quality management environment. There are many examples today of companies that have successfully included ISO 9000 as part of a larger total quality effort. Organizations that are already at some level of TQM maturity typically have found it easy to implement ISO 9000. This is because a TQM environment, with its infrastructure of top-management commitment, documented processes and procedures, continuous improvement, obsession with quality, and so on, easily supports the requirements of ISO 9000.

ISO 9000 is Frequently Implemented in a Non-TQM Environment

Although total quality is compatible with and may well facilitate an ISO 9000 implementation, it is by no means a prerequisite for ISO 9000. In fact, it is safe to say that the majority of ISO 9001–registered organizations have not fully adopted total quality—at least, not yet.

ISO 9000 Can Improve Operations in a Traditional Environment

By "traditional environment," we mean an organizational environment that has persisted in companies for decades, until the total quality management movement began to change things. A traditional organizational environment is one that still operates according to the "old way of doing things" rather than according to the principles of TQM.

When ISO 9000 is implemented by a traditional organization, the company should be the better for it. We will not go so far as to say it *will* be the better for it because much depends on the organization's reasons for adopting ISO 9000 and the degree of executive-level commitment to it. Put another way, if ISO 9000 is approached inappropriately and for the wrong reasons, it can become nothing more than a marketing ploy, and the organization's functional departments might develop even more problems than they had before ISO 9000.

ISO 9000 May Be Redundant in a Mature TQM Environment

Just as ISO 9000 should help traditional organizations, it should also benefit TQM organizations. However, in an organization that has achieved a high level of maturity in its total quality journey—say, in the 400–600 range on the Baldrige scale of 1,000 points—all ISO 9000 criteria may already be in place. In such a case, the only compelling reason for registration under ISO 9001 would be for marketing purposes. What would a company such as Toyota gain from ISO 9000 registration? Probably nothing. It already does everything required by ISO 9000. Its products and processes are recognized as world class. Consequently, it wouldn't gain even a marketing advantage. However, there are many fine TQM organizations that are not as well-known as Toyota. Such organizations, even though they may already meet or exceed the requirements of ISO 9000, may find it necessary to register in order to let potential customers know that their products or services satisfy the international standard.

ISO 9000 and TQM are Not in Competition

This is not a case of one or the other. Organizations can adopt TQM or ISO 9000, or both. While there may be those who advocate one to the exclusion of the other, in the larger scheme of things the two concepts fit well with each other. Both have worthwhile and similar aims. Our view is that not only are TQM and ISO 9000 compatible but they also actually support each other and are complementary. There are good reasons for using both in a single management system.

MANAGEMENT MOTIVATION FOR REGISTRATION TO ISO 9001

Management motivation for adopting either ISO 9000 or TQM can vary widely. There are both appropriate and inappropriate motives. For example, if a company seeks ISO 9001 registration merely to obtain a marketing advantage, its motive is inappropriate. As a result, the organization will likely give little more than lip service to adopting the standard. Appropriate motives for adopting ISO 9000 include the following:

- To improve operations by implementing a QMS that satisfies the ISO 9000 requirements for management responsibility; resource management; product realization; and measurement, analysis, and continual improvement
- To create or improve a QMS that will be recognized by customers worldwide
- To improve product or service quality or the consistency of quality
- To improve customer satisfaction
- To improve competitive posture
- To conform to the requirements of one or more major customers (although adoption would be better motivated by internal considerations, such as the preceding five)

What we are saying here is that, ideally, management will adopt ISO 9000 as a way to make real improvements in the company's operations, serve its customers in a more responsible way, and, as a result, be more successful. This approach is more likely to ensure commitment and participation by top management. Approaching ISO 9000 from a strictly marketing perspective may result in a negative reaction to the amount of work required by the functional departments and in only enough management commitment to do the bare minimum for registration. In other words, if ISO 9000 is viewed as a necessary evil that one must adopt to compete in certain markets, every dollar and every hour spent on ISO 9000 will be seen as a burden to be endured rather than an investment in the organization's future. By definition, a burden is a load that is difficult to bear; the connotation is negative. When negative feelings abound among employees, commitment to ISO 9000 will suffer. It may be possible to fool the ISO 9000 registrar's auditor, but we guarantee that customers will not be fooled for long. Newfound markets will soon wither and disappear. If ISO 9000 is to have a real and permanent effect, it must be approached with a positive attitude and the unwavering commitment of top management.

ISO 9000 AND TOTAL QUALITY MANAGEMENT WORKING TOGETHER

We have discussed the fact that ISO 9000 and TQM are different in scope and were developed from different perspectives but now have similar requirements and objectives. Today, more than ever, the two concepts are compatible. With the exception of certification and audits, TQM requires everything required by ISO 9000 registration. However, even a mature TQM organization, one that does everything it would do under ISO 9000 and more, may not have the worldwide recognition afforded by ISO 9000 registration. There is no corresponding international certification for TQM. For this reason, even the mature TQM organization may find it necessary to seek ISO 9000 registration as a way to satisfy the demands of its customers. On the other hand, a traditional organization that is registered under ISO 9001 may find that it needs the larger TQM implementation to become or stay competitive. The ISO 9001 registration can be a good first step into TQM.

In fact, people who understand both ISO 9000 and total quality have concluded that the two are compatible and that ISO is properly seen as a subset of total quality.

Movement from ISO 9000 to TQM and Vice Versa

An organization that has its processes documented and under control, such as a company involved in total quality management, should find it relatively easy to prepare for

ISO 9000. Correspondingly, a traditional organization that has successfully registered under ISO 9001 will have a head start, should it decide to implement total quality. The major issues with ISO 9000 are securing top-management commitment, focusing on customer requirements and satisfaction, and documenting processes and procedures. Total quality management requires the same.

ISO 9000 as an Entry into Total Quality Management

How to get started is always an issue for organizations just beginning their total quality journey. Organizations beginning the process may find that a good strategy is registration to the ISO 9001 standard. The ISO 9000 preparation projects can be pursued as the entry projects for implementing total quality management.

We have already discussed the fact that ISO 9000 and total quality are compatible, making many of the same demands on the organization, and also that ISO 9000 is, for all practical purposes, a subset of total quality. For an organization that is attempting to adopt total quality and that would also benefit from ISO 9000, our 20-step implementation process should be considered. At the planning phase, steps 12 through 15, the initial implementation approach should be designed to include the steps necessary for ISO 9001 registration. By adopting this strategy, the organization will be engaged in both a total quality management implementation and an ISO 9000 preparation. The ISO 9000 effort will benefit from the total quality preparation phase by having the following components: an executive-level steering committee, a vision with the attendant guiding principles, a set of broad objectives, baselines on employee and customer satisfaction, an objective view of the organization's strengths and weaknesses, and an indication of which employees at all levels can be counted on for support during the implementation. In addition, the organization will have a well-thought-out means of communicating with employees and all other stakeholders to keep them apprised of the changes taking place, why they are happening, and what they will mean to everyone.

The recommendations in the preceding paragraph apply to organizations that have not yet implemented total quality or ISO 9001 but that are thinking about it. However, what about the organization that has already started working on ISO 9000 or has already achieved registration? How should such an organization approach the larger task of implementing total quality? The effort expended on ISO 9001 clearly should be seen as a head start, assuming ISO 9001 registration is approached as a way to improve the organization and not simply as a marketing gimmick. To the degree that the organization has already accomplished the early steps of the 20-step implementation process for total quality management, count it as progress toward the eventual complete implementation of TQM.

This organization should go back and execute any steps that have not already been completed before moving on. For example, there is no requirement in ISO 9001 for forming a steering committee (Step 2) composed of the top managers, so it is doubtful one has been established. Similarly, steps 3 (team building for the steering committee) and 4 (total quality training for the steering committee) are not required by ISO 9000 and will not have been done. The same may be said for steps 5, 8, 9, 10, and 11. The ISO 9001 does not require registered organizations to have a vision statement or a set of guiding principles under which the organization will operate.

Nothing in ISO 9001 would require an examination of organizational strengths and weaknesses or the baselining of employee and customer satisfaction. All of these should be done for TQM, and all will benefit ISO 9000. Having gone back to complete steps 1 through 11, the steering committee should start its planning phase by incorporating its ISO 9001 activities into the total quality initiative, using steps 12 through 17, and then expand beyond ISO 9000 from there.

In summary, the organization that is already involved in ISO 9000 should see itself as having a head start on the larger TQM implementation. One that has started neither, although seeing TQM and ISO 9000 as beneficial, might approach ISO 9001 as a logical part of the initial total quality journey.

THE FUTURE OF ISO 9000

Credibility of the Standard

Consider for a moment the importance of credibility as related to ISO 9000 registrations. The ISO 9000 is viable as a standard only as long as its registrations are honestly and competently issued. If that cannot be assured, then ISO 9000 will die. Many, including the authors, believe that the credibility of ISO certification has become diluted because there has been insufficient oversight of the registrars. Some are excellent, but others have been less than stellar in their assessments and awarding of certificates. To correct this problem, ISO, together with the International Electrotechnical Commission (IEC), has issued a new standard ISO/IEC 17021:2006, which is designed to restore the confidence in management system registration. It places rigorous requirements for competence and impartiality on the certifying bodies. Registrar conformity will be verified by the accrediting bodies, both by reviewing the registrar's organization, personnel, and procedures and by observing actual audits performed by the registrar. With this step, ISO has implemented a critical safeguard for the credibility of ISO 9000.

Updating ISO 9000

The ISO 9000 has been revised three times since its original release. The 2000 version incorporated major changes in the standard as it was being developed and improved through the incorporation of features from total quality management. The 2008 version has few significant changes.

ISO 9000: VERSIONS/UPDATES

Since the development of the first ISO standard in 1987, the standard has been updated periodically to reflect lessons learned and changes in the international business arena. The various updates to ISO 9000 are summarized as follows:

- **ISO 9000:1987.** This initial version of the ISO 9000 standard contained three models for quality management systems. It was structured like the United Kingdom's BS 5750 Standard. The three models for quality management systems were: (1) ISO 9001:1987—Quality Assurance in Design, Development, Production, and Installation Services; (2) ISO 9002:1987—Quality Assurance in Production, Installation, and Servicing (did not cover the development of new products); and (3) Quality Assurance in Final Inspection and Test. This version required mountains of paperwork as evidence of compliance with documented procedures. Many organizations thought the "cure" was worse than the "disease" when applying this version of the standard.
- **ISO 9000:1994.** This version continued to require comprehensive evidence of compliance with properly documented procedures, but it did begin to move toward process improvement by emphasizing preventive actions rather than just checking the final product. However, it was a burdensomely bureaucratic standard in which the "cure" was still worse than the "disease."
- **ISO 9001:2000.** This version combined ISO 9001, 9002, and 9003 into one document that is ISO 9001. The distinguishing feature of this version is that it was brought more closely in line with the basic tenets of quality management. For example, the most significant change is that this version of the standard makes process management its centerpiece. It also requires active involvement of an organization's executives. In other words, it does not allow responsibility for ISO registration to simply to be delegated to mid-ranking personnel and forgotten about. A final significant change in this version is its goal of improving organizational effectiveness through the application of performance metrics.
- **ISO 9001:2008.** This version is not substantively different from ISO 9001:2000, but there are several additional requirements that are important. These are as follows: (1) The quality policy must be a formal statement from upper management that is linked to the organization's business and management plan, (2) The quality policy must be understood and used by all personnel at all levels, (3) All personnel must have measureable work objectives, (4) The quality system is audited regularly for conformance and effectiveness, (5) Decisions about the quality system are based on recorded data, (6) Records allow problems to be traced to their source by including where and how raw materials were processed, (7) The organization must have a comprehensive system for communicating with customers about any and all aspects of the relationship, (8) Product development must have planned stages with testing at every stage, and test results must be documented to indicate whether the product meets all applicable requirements, (9) Organizational performance must be regularly reviewed, and (10) The organization must have documented procedures for dealing with nonconformances.

ISO 9001: The Contents

When the original three ISO standards—9001, 9002, 9003—were combined to create ISO 9001:2000, the contents of the new document were also standardized. The contents of ISO 9001 are now as follows:

- Foreword
- Introduction
- Requirements
  - Section 1: Scope
  - Section 2: Normative Reference
  - Section 3: Terms and Definitions
  - Section 4: Quality Management System
  - Section 5: Management Responsibility
  - Section 6: Resource Management
  - Section 7: Product Realization
  - Section 8: Measurement, Analysis, and Improvement

Organizations seeking ISO 9000 registration are required to address all eight sections of the standard, but only sections 4 through 8 require implementation within the QMS.

SUMMARY

1. The following statements describe the relationship between ISO 9000 and TQM: ISO 9000 and TQM are not completely interchangeable; ISO 9000 is compatible with, and can be a subset of, TQM; ISO 9000 is frequently implemented in a non-TQM environment; ISO 9000 can improve operations in a traditional environment; ISO 9000 may be redundant in a mature TQM environment; and ISO 9000 and TQM are not in competition.
2. The origins of ISO 9000 and total quality management are vastly different. The ISO 9000 was developed in response to the need to harmonize dozens of national and international standards relating to quality. Total quality got its start in Japan around 1950 as a way to help that nation compete in the international marketplace.
3. The aim of ISO 9000 is to enable organizations to better serve their customers and to be more competitive through adherence to the standard's eight quality management principles.

4. Appropriate motivations for implementing ISO 9000 are as follows: to improve operations, to improve or create a quality management system, to improve the consistency of quality, to improve customer satisfaction, to improve competitive posture, and to conform to the requirements of customers.
5. The ISO 9000 and TQM are compatible in that ISO 9000 can be a complementary subset of TQM. The ISO 9000 can give an organization a head start in implementing TQM.

KEY TERMS AND CONCEPTS

Accreditation
Accredited registrar
Aims of ISO 9000
American National Standards Institute (ANSI)
American Society for Quality (ASQ)
Authority for certification/registration
Benefits of ISO 9000
Credibility of the standard
International Organization for Standardization (ISO)
ISO 9000
ISO 9000 and TQM are not interchangeable
ISO 9000's eight quality management principles
ISO 9001
Management motivation for registration
Origin of ISO 9000
Plan–do–check–act cycle
QMS audits
Quality management system (QMS)
Quality objectives
Quality policy
Tailored standards
Technical Committee 176
Traditional organizational environment

FACTUAL REVIEW QUESTIONS

1. List six statements that summarize the comparative scope of ISO 9000 and TQM.
2. Explain the origins of ISO 9000 and TQM. How are they different?
3. Contrast the aims of ISO 9000 and TQM.
4. List three appropriate reasons for implementing ISO 9000.
5. What is the most appropriate rationale for i... ing TQM?
6. What are the industry-specific standards for th... motive, aerospace, and telecommunication indust...
7. Describe how you would use ISO 9000 as an entry i... TQM.

CRITICAL THINKING ACTIVITY

Implementing Total Quality

Create a matrix that shows how ISO 9000 registration fits into a broader total quality implementation.

DISCUSSION ASSIGNMENT 1

ISO 9000 or TQM: Which Will It Be?

Reliance Control Systems is a large manufacturer of control systems for the electrical power generation and distribution industry. Over the past few years, Reliance has watched overseas competitors take away market share with products that are priced lower and that, at the same time, have developed a reputation for better reliability. The company is not in a dangerous position yet, but the Board of Directors wants to see a concerted effort to improve the company's competitive posture. Among the senior management, two factions have developed. One, led by the vice president of operations, is pressing the CEO to implement total quality management. After all, the aim of TQM is improved competitiveness, and that is just what is needed. On the other hand, the manufacturing vice president (VP) and the director of quality assurance are making the case for ISO 9000:2000.

DISCUSSION QUESTIONS

Discuss the following questions in class or outside of class with your fellow students:

1. Assume that you are siding with the VP of operations, and list the arguments for implementing TQM.
2. Now assume that you are with the heads of manufacturing and quality assurance. List the arguments for ISO 9000.
3. You have heard both sets of arguments, and you believe there might be a third approach that could satisfy both factions. What would you propose?

ENDNOTE

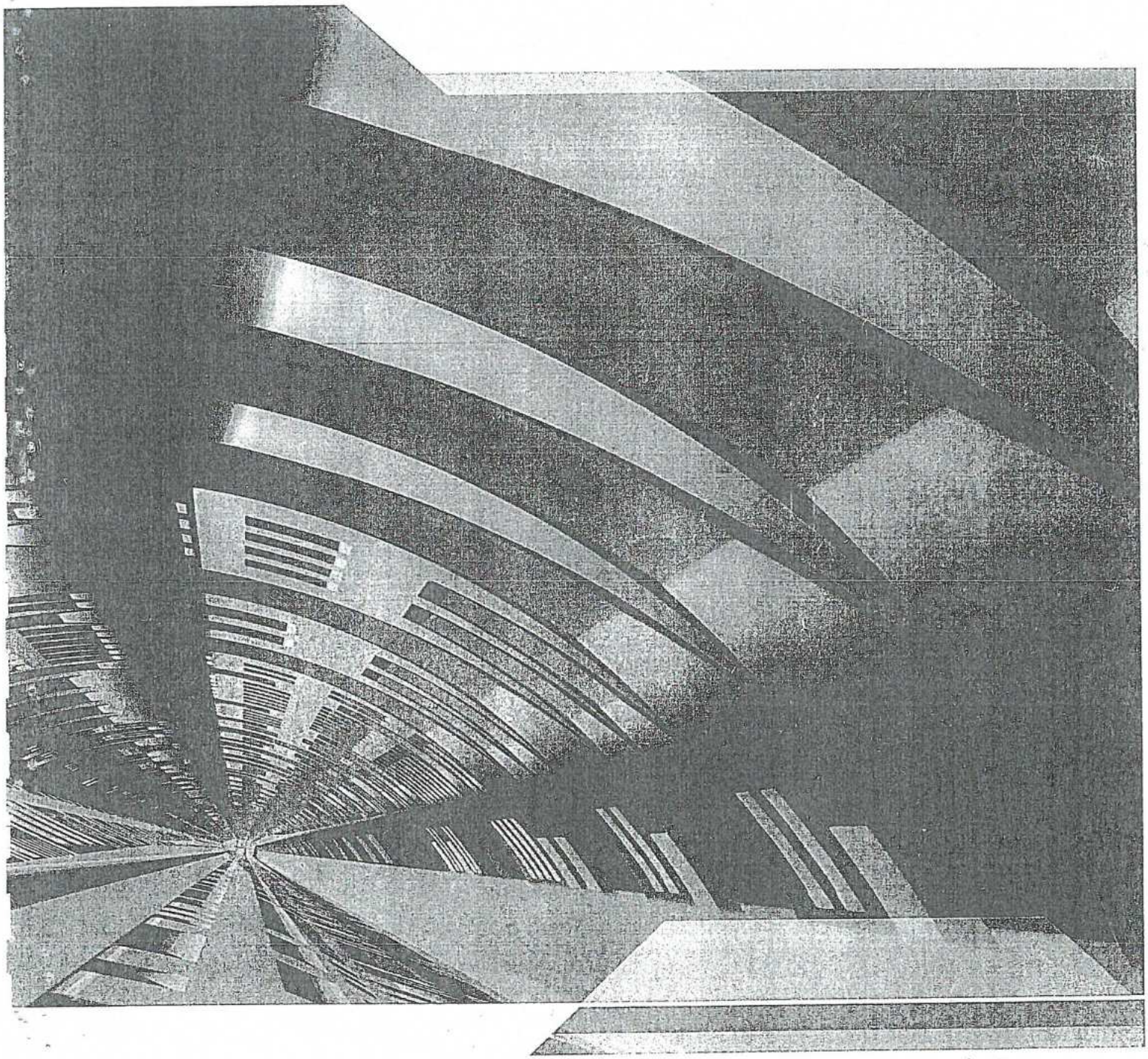
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David L. Goetsch Stanley Davis

Seventh Edition



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QUALITY FUNCTION DEPLOYMENT

Because it is the customers who must buy the product and who must be satisfied with it, the product must be developed with their needs and wants as the principal inputs to the new product development project. When that is not the case, the new product is often disappointing.—**Ronald G. Day**

MAJOR TOPICS

- What Is Quality Function Deployment?
- Introducing Quality Function Deployment's House of Quality
- Developing the Set of Customer Needs (WHATs): House of Quality Matrix Number 1
- Planning the Improvement Strategy: House of Quality Matrix Number 2
- Selecting the Technical Requirements (HOWs): House of Quality Matrix Number 3
- Evaluating Interrelationships between WHATs and HOWs: House of Quality Matrix Number 4
- Evaluating the Direction of Correlation between HOWs: House of Quality Matrix Number 5
- Selecting the Design Targets (Values) of the HOWs: House of Quality Matrix Number 6

A fundamental element of total quality is customer-defined quality. A key element is customer involvement. Customer involvement is the fuel that powers Quality Function Deployment.

WHAT IS QUALITY FUNCTION DEPLOYMENT?

Quality function deployment (QFD) is a specialized method for making customer needs/wants important components of the design and production of the product or service. We advise you not to get hung up on the name of the process. There has been both a loss of meaning in the translation from Japanese to English, and an evolution in the QFD process which has morphed into something rather different from that to which the name was first attached. However, the original English name, Quality Function Deployment, and its abbreviation QFD are apparently with us to stay, and we should have no difficulty with that.

Since QFD was first introduced in the West in the 1980s its history has been spotty. Should you search the internet for success stories you may find more detractors than proponents. The primary complaints seem to be:

- The Matrices are difficult to use and too time consuming for our new lean organizations.
- The math used to establish priorities lacks the precision necessary for a Six Sigma company.
- Questions regarding the validity of the math.
- Difficulty in obtaining a clear understanding of customer wants.

That being said, there are many organizations around the world that successfully use QFD, often in a tailored form that best fits their specific needs. The motivation to use it is logical—everyone would agree that it is preferable to design and manufacture a product that satisfactorily addresses the needs of prospective customers than one that doesn't. Further, in going through the QFD process, all the functional departments of the organization are involved from day one, and this is a primary objective of TQM. So we think there is a place for QFD in Total Quality, and this chapter is intended to acquaint you with the concepts and the basics of its process. Just be aware, should you decide to use QFD at some point, that it may not be appropriate for all cases, and that your particular application may have to be tailored to your specific circumstances. Quality Function Deployment is still evolving, and software is now available to make the process easier and more reliable.

One of the keys to achieving customer satisfaction and continual improvement is understanding your customer's needs and wants, and using them to guide the design and follow-on processes that create a product your customer will purchase and use. This was, and remains, the main focus of QFD. Developed by Japanese quality expert Dr. Yoji Akao

The House of Quality

The "house of quality" introduced in 1972 in the design of an oil tanker has become so strongly associated with Quality Function Deployment (QFD) that many now believe that it is the QFD model. In reality, the house of quality is a QFD tool—an important one but still just one of several tools associated with the concept.

in 1966, QFD combined quality strategies with "function deployment" from the field of *Value Engineering*. In a sense, with QFD the customer—the potential user of the product—becomes part of the team that designs the product. It is a system that guides designers and planners to focus on the attributes of a product which are the most important to the customer. It involves:

1. Identifying customer needs known in QFD-speak as the "Voice of the Customer" (VOC).
2. Identifying the product attributes that will most satisfy the VOC.
3. Establishing product development and testing targets and priorities that will result in a product or service that satisfies the VOC.

One might think that all of this is rather obvious. Of course, any product should be designed to do something that customers want done. So, naturally, any company that develops a product or service must do all of these things already, right? It may seem to be common sense. Unfortunately, the list of new products coming into the market has a surprising rate of failure. Customers quickly reject products that do not satisfy their wants. The road to market is strewn with the likes of the Edsel automobile (1958), New Coke (1985), the smokeless cigarette (1988). These are some of the more noteworthy and costly (all over $1 billion) market flops, but countless other less-infamous offerings have crashed and burned because they were products that no one had asked for. This must mean that companies do not always ask for their customers' input, or they do not understand what their customers tell them, or that they simply don't do a good job of translating customer wants into product functions and attributes that will satisfy them. Over half a century General Motors went from the largest corporation to bankruptcy by making it a virtual religion to ignore customer wants. Many others, large and small, have followed similar paths. The QFD requires that you obtain customer-want input and translate it into the set of product attributes most likely to satisfy the VOC, and can even follow through the processes of production and testing that best satisfies the customer wants. The QFD process involves the development and analysis of the set of matrices known as the "House of Quality" (HOQ) explained in this chapter.

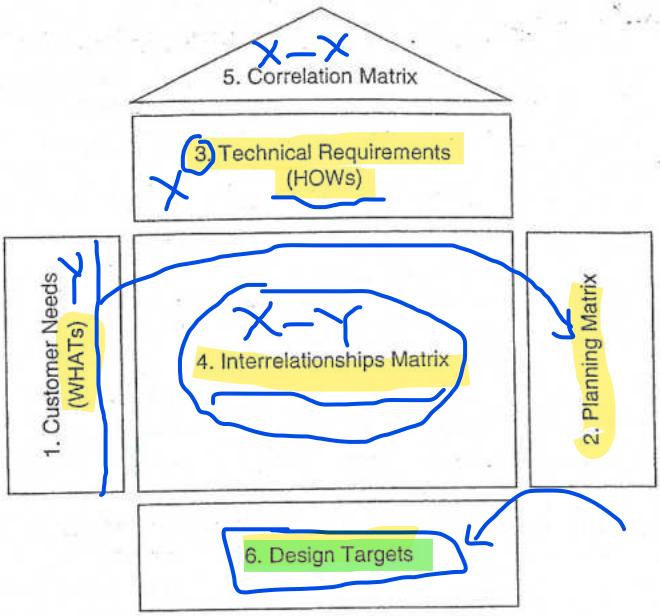


FIGURE 1 QFD's House of Quality

INTRODUCING QUALITY FUNCTION DEPLOYMENT'S HOUSE OF QUALITY

The heart of QFD is the set of interrelated matrices known as the House of Quality (HOQ), so named because the complete matrix takes on the appearance of a house. Examining Figure 1 you will see that the HOQ is made up of six submatrices. The HOQ is utilized by a multifunctional QFD team (1) to take input requirements from the customers, and translate them into a set of customer needs, known in the QFD world as the "voice of the customer" (VOC) and (2) from the VOC, and some benchmarking with competing products, determine the prioritized features of a new (or improved) product or service that will best respond to the VOC.

Value Engineering

Value Engineering as a process was developed at General Electric during World War II. It is a method of raising the value of products or services through the analysis and examination of not what the product or service *is*, but rather what it does, that is, its *functions*. In value engineering, *value* is said to have two components: *function* and *cost*, and their relationship is:

$$V = F/C$$

Where: V = *Value*, F = *Function*, and C = *Cost*

If the product's function (performance) is improved while the cost is held steady or reduced, then its value is increased.

QFD Gives the Customer a Real Voice

Quality Function Deployment is a concept that seeks to give the customer a real voice in the design and production of the organization's products. In fact, the voice of the customer (VOC) is fundamental to QFD. Translating the VOC into reality in the product is what QFD attempts to do. When it is used properly, QFD ensures that product design and manufacture are not just informed by the VOC, but are actually guided by it.

The component matrices making up the HOQ are utilized in formal sequence from 1 through 6. In this chapter we will take you through the process using a relatively simple and fictitious project of improving a publishing company's marketing position for its textbooks.

DEVELOPING THE SET OF CUSTOMER NEEDS (WHATs): HOUSE OF QUALITY MATRIX NUMBER 1

Gathering Customer Needs Input

Our hypothetical company publishes a series of textbooks for the college market. The company is not happy with its current position in the market, and intends to rework its offerings with the objective of improving its market share. The company realizes that to do that, they must produce textbooks that potential customers will want. They plan to apply QFD to the publishing world.

The premise of QFD is that before any product or service is designed, the producer should have a good understanding of his potential customers' needs in order to improve the likelihood that the product or service will be a market success. That the producer should be aware of customer needs seems logical, but it sounds far easier than it is. Before the textbook rework is started, the QFD team must work diligently to determine what potential customers would like to see in terms of attributes and features of the product—and perhaps—what they don't like about our current product. How do we get that customer input? For any product category there are a number of ways, including focus groups, user groups, polling customers of existing similar products, surveys, questionnaires, customer service inputs, warranty activity, and in any other way the organization can think of. Any of these methods can take several weeks, and some will cost a lot of money.

Refining the Customer Needs Inputs

Once the cross-functional QFD team has assembled sufficient information on what characteristics, attributes and features customers say they need, the information must be distilled into something useful. Typically the problem is that the inputs invariably cover the spectrum from some really good ideas and nuggets of information to some that are trivial or frivolous, and the volume of information so great that the designers are unable to cope with it. The data must be sorted into a prioritized set of the most important customer needs. At this point we will call on some QFD Tools, the first of which is the *Affinity Diagram*. Refining a large collection of data into something that represents the essence of the VOC is done through the analysis techniques of the affinity diagram, and QFD team discussion.

Using the Affinity Diagram

Affinity diagrams are used to promote creative thinking. They can be very helpful in breaking down barriers created by past failures and in getting people to give up ingrained paradigms that impede our ability to find new and different approaches. This is a critical element in achieving continual improvement. Affinity diagrams give structure to the creative process by organizing ideas in a way that allows them to be discussed, improved, and interacted with by all the participants. Affinity diagrams are used most appropriately when the following conditions exist:

- When the issue in question is so complex and/or the known facts so disorganized that people can't quite "get their arms around" the situation
- When it is necessary to shake up the thought processes, get past ingrained paradigms, and get rid of mental baggage relating to past solutions that failed
- When it is important to build a consensus for a proposed solution

Figure 2 is an affinity diagram developed by the publisher's QFD team. With it, the goal was to organize the

QUALITY CASE ▼

Raytheon and a Culture of Quality

Raytheon has a long history of global quality leadership. Founded as the American Appliance Company in 1922, Raytheon evolved over time into a major developer of national defense technologies and systems that are, in turn, converted to civilian use. For example, the microwave oven came about when Raytheon adapted World War II radar technology for civilian use. Raytheon's corporate culture is one in which its scientists, engineers, and manufacturing personnel are never satisfied with a given product or solution. Continual improvement is the cornerstone of Raytheon's culture of quality. Even its processes that have been recognized as best practices are subject to continual improvement. One of Raytheon's principal goals is to equip America's military personnel with the newest and best warfighting technologies so war fighters have an edge on the modern battlefield.

For exemplifying the principles of total quality, Raytheon's Missile Systems plant in Louisville, Kentucky, was awarded the coveted Shingo Prize for Excellence in Manufacturing. The judges cited the following achievements in making the award:

- Increase in sales of 135% during the period considered
- Increase in bookings of 230% during the period considered
- On-time delivery rate of 100% during the period considered
- Improvement in operational efficiency of more than 15% over a two-year period
- Selection of 20 of the company's site processes as best practices by the Best Manufacturing Practices Center of Excellence of the Office of Naval Research

Raytheon's commitment to quality helps ensure that when America's soldiers, sailors, airmen, and marines go in harm's way, they are equipped with the latest and best warfighting technologies available.

Source: www.reliableplant.com/articles/Print/4697.

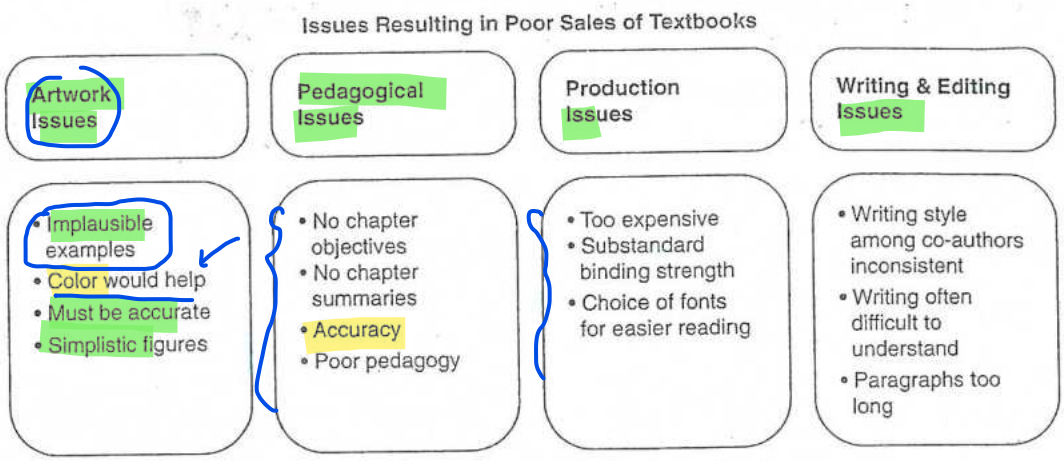


FIGURE 2 Affinity Diagram: Issues Resulting in Poor Sales of Textbooks

customer input (both what they want that the publisher didn't offer, and what they did not like about the current books) to clarify the reasons the books were not selling well. The result will be a categorized list of the customers' issues which can then be reviewed and analyzed. Such affinity diagrams are developed through these steps:

1. A cross-functional team of employees is used. It may be the QFD team or another one specifically charged with developing the affinity diagram. Either way, teams typically have membership from all relevant functional departments (e.g., sales/marketing, design/engineering, production/manufacturing, quality, finance, materials/procurement, warehousing). Our team has participants from sales, marketing, production, editorial, and finance.
2. The issue to be discussed is stated without detailed explanation. Too much detail can inhibit creative thinking and throw up barriers that prejudice participants. In our case, the issue was stated as follows: "Why are our textbooks not selling better?"
3. Responses of participants, armed with customer input, are stated verbally and recorded on 3 × 5 cards—one idea per card. Care must be taken to use the actual words of the customers to avoid any inadvertent translation of ideas. Also, at this point there should be no judgmental comments about the ideas proposed. The goal is to solicit and record as many ideas as possible. Judgmental comments will inhibit the process.
4. The cards are spread on a large table, and participants are asked to group them. Cards with related ideas are grouped together. Cards that don't fit with any particular group are put together as a miscellaneous group.
5. Participants examine the cards in each group and try to find a descriptive word that contains the essence of the various cards in that group. This word or brief phrase is written on a card that is placed at the top of the group and becomes the heading for that group of ideas.
6. The information on the cards is replicated on paper with boxes around each group of ideas. Copies of the draft affinity diagram are distributed to all participants for corrections, revisions, additions, or deletions. The finished diagram should resemble the one in Figure 2.

Using the Tree Diagram

The next tool to be used is the Tree Diagram. Tree diagrams can be used for countless purposes. It will be used here simply to refine the affinity diagram results to make the list the customer needs, or WHATs that will be placed in the HOQ. Although a tree diagram could go all the way down into the nuts and bolts of a new design, remember that the objective here is not to design the new product, but to list the items to be addressed by the design team once the entire HOQ is completed. Follow these steps:

1. Clearly identify the issue/problem to be solved. It can be taken from the affinity diagram, or it can be a problem that was identified through discussion of the affinity diagram. Write it on a card and place the card at the top of a large table.
2. Have the team conduct a brainstorming session in which participants record on 3 × 5 cards all possible tasks, methods, solutions, and activities relating to the affinity diagram issues. Continually repeat the following question: "To achieve this, what must happen first?" Continue this until all ideas have been exhausted.
3. Lay all the "what-must-happen" cards on the table below problem card. Put them in order based on what must happen first, working from top to bottom. As this task progresses, it may be necessary to add task cards that were overlooked during the brainstorming session.
4. Duplicate the table's layout of cards on a sheet of paper and distribute copies to all participants. Allow participants to revise and correct the document.
5. Figure 3 is a partial tree diagram that was developed to address the issues identified in Figure 2. We have deliberately oversimplified our tree diagram to keep the HOQ construction easier to follow. Notice that the

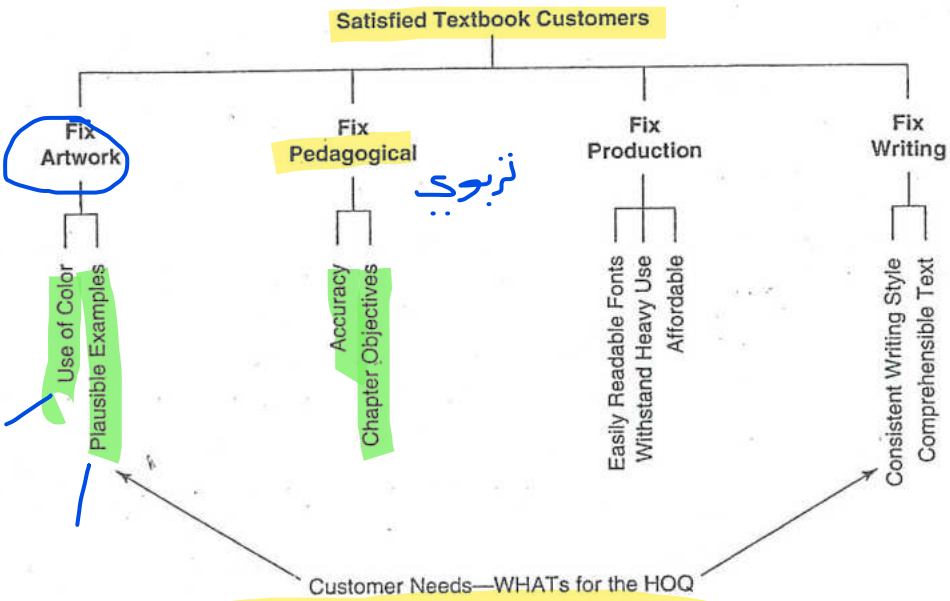


FIGURE 3 Tree Diagram: Developing the WHATs for the HOQ

team's choice of things that must happen to make our textbook artwork acceptable to customers includes the use of color in the artwork, and ensuring that examples are plausible. These two items represent the abbreviated customer needs with respect to our artwork issues.

In practice, the team reduces the total list of needs to those considered by the team to be the most significant. The final list of customer needs covering the complete set of issues may be as many as twenty or thirty, or a few as eight to ten, depending on the situation. These needs are *what* the customers would like to see in (or have corrected in) the product. They are *what* the company must address in order to produce a product that will find favor with customers. This list representing the VOC, is entered into the first HOQ matrix called *Customer Needs*, or *WHATs*. We illustrate this in Figure 4.

Note: The final customer needs should be nonlimiting and nonspecific in terms of solution and measurement to allow the team to consider without bias all possible approaches to meet the needs.

Customer Importance

Also coming out of the analysis is the team's best estimate of the relative importance of each listed customer need. Customer importance is usually based on a scale of 1 to 5 with 5 being the highest priority. This information is solicited from customer sources, but unanimity in ranking by the customers is unlikely, so the team has to do its best to evaluate and assign priorities as they believe the aggregate of customers would. These importance rankings are entered

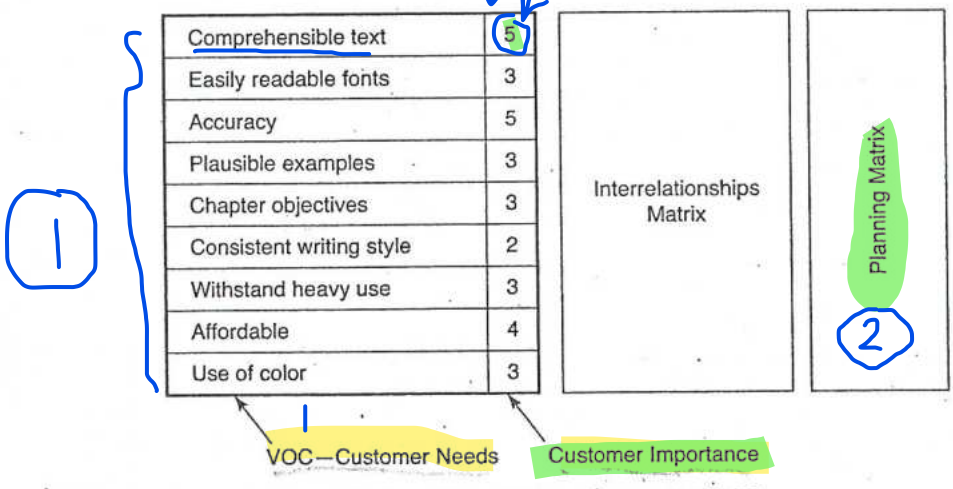


FIGURE 4 Customer Needs (WHATs) and Customer Importance Applied to the HOQ

in the *Customer Importance* column to the right of the *Needs* entries, as shown in Figure 4.

PLANNING THE IMPROVEMENT STRATEGY: HOUSE OF QUALITY MATRIX NUMBER 2

Competitive Benchmarking

Next we must gather and analyze customer satisfaction data relative to our product and competing products, develop a planned satisfaction rating target for our forthcoming product, and calculate improvement factors and sales points.

First we are going to engage in some competitive benchmarking between our existing product and its competition. We are interested in customer satisfaction ratings of competing products because they will come into play in determining what we have to do to make our products more appealing than those of our competitors. In order to obtain that information, we might use a focus group to compare our product against its competition. We could also send questionnaires to customers who use competing products and to those who use ours. In both situations, participants will be asked to rate the products on each of the characteristics listed in the customer needs matrix, using the familiar 1 to 5 scale (5 being most favorable).

Our publisher collects this information for its own existing books, and for competing books of two prime competitors. The information is plotted on the planning matrix as shown in Figure 5.

Planned Customer Satisfaction Performance

Also plotted on the planning matrix will be the team's desired customer satisfaction performance for the new product for each of the customer needs. The same 1 to 5 scale is used. One might ask, why wouldn't the team desire the best rating (5) for every need? The reason the company has to back off perfection is money. The practical objective is to produce a textbook that will satisfy customers while not pricing itself out of the market. That is not to say that improvements should not be made if they can be done without putting the book out of reach of its prospective customers or making the book uncompetitive for cost reasons in the market. The publisher would like to be the competitive leader, but not necessarily the most expensive producer.

The team works out a target customer satisfaction goal for each of the customer needs. These are also plotted on Figure 5.

Improvement Factor

The team next calculates the improvement factor for each need for the new product. The equation for Improvement Factor with a 1 to 5 scale is:

$$\text{Improvement factor} = \{(\text{Planned CS Rating} - \text{Existing CS Rating})0.2\} + 1$$

where *CS* is *Customer Satisfaction*

For example, if a planned CS rating is a "4" and our CS rating for our existing product is a "3," then the Improvement

Customer Needs	CI	Interrelationships	Planning Matrix							
			CS Rating Our Textbooks	CS Rating Competitor A	CS Rating Competitor B	Our Planned CS Rating	Improvement Factor	Sales Point	Overall Weighting	% of Total Weight
Comprehensible text	5		4	5	4	5	1.2	1.1	6.6	13
Easily readable fonts	3		3	5	5	5	1.4	1.0	4.2	8
Accuracy	5		4	4	5	5	1.2	1.5	9.0	18
Plausible examples	3		2	3	4	4	1.4	1.2	5.0	10
Chapter objectives	3		2	4	2	4	1.4	1.3	5.5	11
Consistent writing style	2		4	3	4	4	1.0	1.0	2.0	4
Withstand heavy use	3		3	5	3	4	1.2	1.3	4.7	9
Affordable	4		1	2	2	3	1.4	1.5	8.4	16
Use of color	3		1	3	4	3	1.4	1.4	6.9	12

Customer Importance

(Note: CS is Customer Satisfaction)

FIGURE 5 Competitive Benchmark Data Applied to the HOQ

Factor is:

$$\{(4-3)\times 0.2\}+1=1.2$$

These data are also plotted in the Planning Matrix, as shown in Figure 5.

Sales Point A strategic marketing factor, sometimes called a *Sales Point*, may also be placed in the Planning Matrix. Sales point is a number from 1 to 1.5 that is used to place emphasis on the customer needs. It is an estimate of the marketing importance of the need in the promotion of the new product, and is therefore used, along with customer importance and improvement factor, in the calculation for overall weighting of the customer needs. A sales point of 1 results in no change in the overall weighting, whereas a 1.5 sales point increases the overall weighting half again beyond that indicated by the customer importance of the need and its improvement factor. The team develops the sales point data, and places it in the planning matrix.

Overall Weighting The team next calculates the overall weighting for the individual needs using the formula:

$$\text{Overall Weighting} = \text{Customer Importance} \times \text{Improvement Factor} \times \text{Sales Point}$$

For example, the Comprehensible Text need has a Customer Importance rating of 5, an Improvement Factor of 1.2, and a Sales Point of 1.1. Therefore, the overall weighting is:

$$5\times 1.2\times 1.1=6.6$$

The calculated overall weightings are entered into the planning matrix as shown on Figure 5.

Percentage of Total Weighting Next, we convert the overall weightings to percentages in order to better understand how much of the design or improvement effort should be placed on each of the customer needs. The percentage of total weighting is calculated by the following equation:

$$\%\text{ of Total Weighting} = (\text{Overall Weighting} \div \text{Sum of Overall Weightings}) \times 100$$

For example, the sum of the overall weightings in Figure 5 is 51.3. The Comprehensible Text need has an overall weighting of 6.6. Therefore, the percentage of overall weighting for the Comprehensible Text need is:

$$(6.6 \div 51.3)\times 100 = 13$$

Percent data are entered in the final column of the planning matrix. See Figure 5.

From the planning matrix then, you can see that considering together *customer importance* (how critical is this need to the customer), *improvement factor* (how much of an improvement do we have to make in our product for this need), and *sales point* (importance of this need from the marketing point of view) leads to an *overall weighting* for the need. That in turn tells us through the *percent of total weighting* roughly how our resources need to be allocated across the total design or improvement project. For example, the need for *accuracy* has the highest overall weighting and percent of total weight. It is very important that the publisher achieves its *planned rating* of 5 for accuracy. Affordability comes in a close second, with comprehensibility of text third.

Before we move on to the next matrix, we want to leave you with a caution. We do not recommend that the company allocate the work of improving the product or service strictly or solely by these numbers. They are, after all is said and done, the result of a lot of opinion and estimating all the way from the customer, through the team's deliberations and discussions. The math is going to produce numbers accurately reflecting the various ratings and factors—but the source data for those numbers should not be considered to be absolutely accurate. Remember, it evolved from opinion and estimates. Our best advice is to consider it to be guidance rather than absolute. It seems to work well in most situations, but if the *customer needs* input is faulty, the organization can do the HOQ matrix work perfectly, deploy its resources in accordance with the matrices, and end up designing the wrong product that no one wants. Keep your sensors wide open for information that may warn you of problems.

SELECTING THE TECHNICAL REQUIREMENTS (HOWs): HOUSE OF QUALITY MATRIX NUMBER 3

The Technical Requirements room of the HOQ states *how* the company intends to respond to each of the *Customer Needs*. It is sometimes referred to as the *voice of the company*. We must state at the outset that the technical requirements are *not* the design specifications of the product or service. Rather, they are characteristics and features of a product that is perceived as meeting the customer needs. They are measurable in terms of satisfactory achievement. Some may be measured by weight, strength, speed, and so on. Others by a simple yes or no, for example a desired feature, appearance, test, or material is or is not incorporated. The other side of the coin is that the technical requirements must not be limiting, but must be flexible enough to allow the company to consider every creative possibility in its attempts to satisfy the need.

The technical requirements are generated by the QFD team through discussion and consultation with the *Customer Needs* and *Planning* matrices used as guidance. The team may use affinity or tree diagrams to develop, sort, and rank the requirements, similar to the Customer Needs development process. The difference here is that the input is from within the company rather than from external customers.

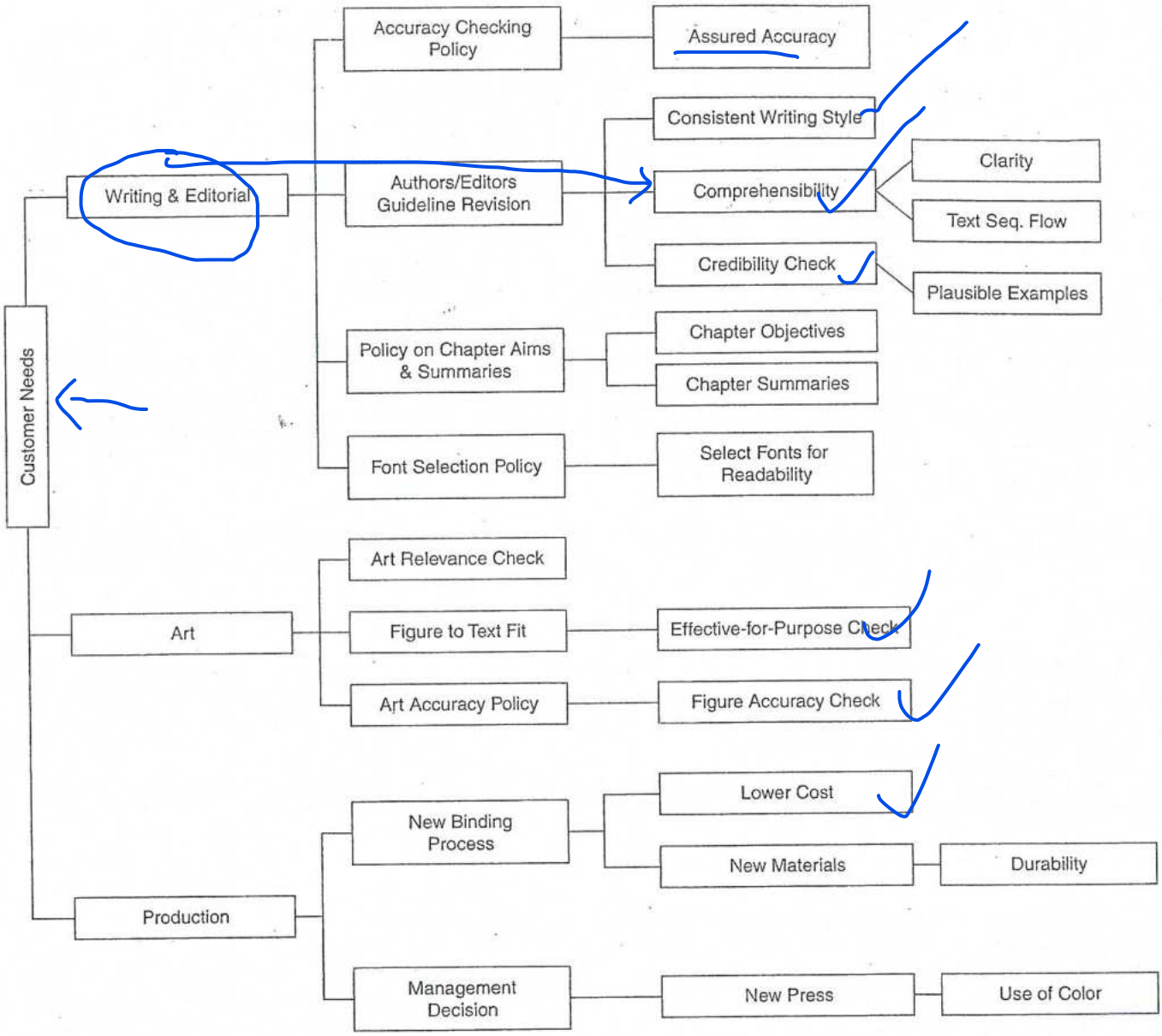


FIGURE 6 Tree Diagram for Developing Technical Requirements

The use of an affinity diagram or tree diagram will help the team focus on the textbook characteristics and features, procedures, and production processes likely to achieve the planned improvement. Our publisher's team developed the tree diagram of Figure 6. They categorized the diagram in three elements, listing the points considered most likely to produce customer acceptance. For example, under the first category, *Writing and Editorial*, cards for four issues are displayed:

- Accuracy checking policy
- Revision to the *Authors/Editors Guideline* manual
- Policy on Chapter Aims and Summaries
- Font Selection Policy

This is carried down through successive tree diagram nodes until the technical requirements are developed. For example, the *Authors/Editors Guideline Revision* node branches into a triple node consisting of relevant items to be addressed in the revised Guidelines:

- Consistent Writing Style
- Comprehensibility
- Credibility Check

This general tree development pattern is repeated for the remaining categories to form the list of items from which the Technical Requirements to be placed in the HOWs room of the HOQ are finally selected by the QFD team.

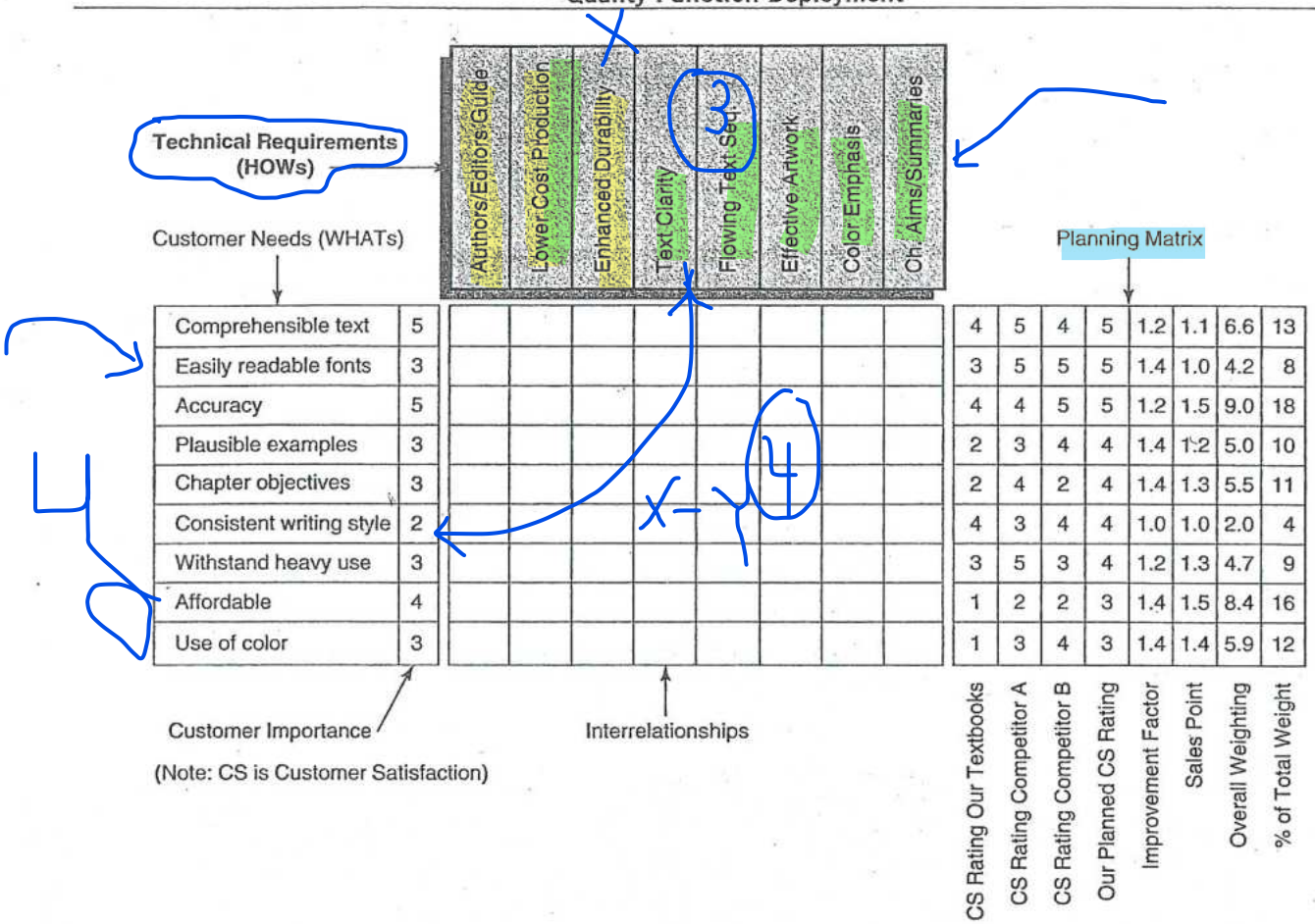


FIGURE 7 Technical Requirements (HOWs) Applied to the HOQ

Refer to Figure 7 to see the eight technical requirements that were developed.

EVALUATING INTERRELATIONSHIPS BETWEEN WHATs AND HOWs: HOUSE OF QUALITY MATRIX NUMBER 4

Now that we have the QFD team's technical requirements (HOWs) in the HOQ, the next step is to examine how they relate to the WHATs of the Customer Needs. The results will be shown in the *Interrelationships* matrix, which links the HOWs and the WHATs. At each intersection cell of the interrelationship matrix the team must assess the degree of relationship between the WHAT and the corresponding HOW. This is usually done using scales of significance of 1 to 5 or 1 to 9, with the higher number indicating a stronger relationship. Sometimes these numbers are entered, but often symbols are used. For our example we will use symbols as follows:

- ◎ = 9 (strongest relationship)
- ○ = 3 (medium relationship)
- △ = 1 (weak relationship)
- Blank cell indicates No relationship

Let's see how this works. Refer to Figure 7, and consider the first customer need, *Comprehensible text*. Now look at each of the intersections on that row to see which HOWs have a relationship with *Comprehensible text*. *Authors/Editors Guide* seems to offer a relationship. Certainly the publisher's guidance to the author, and the level and effectiveness of the editing process will impact the quality and comprehensibility of the text. We have identified an interrelationship, but how strong is it? The team has to decide, and the result may not be very exact, but rather is a well-discussed estimate. Let's say that the strength is *high*. We should enter either a "9" or the double-circle symbol in that cell. The next *Comprehensible Text* relationship cell appears to be under *Text Clarity*. The interrelationship between this WHAT and HOW is strong, so a 9 or the double-circle symbol is entered. All cells must be checked for interrelationships, and when such exists, the strength of the relationship must be evaluated.

As we have mentioned, either numbers or symbols may be used. If you use numbers, use only 1, 3, and 5 or 1, 3, and 9 rather than 1, 2, 3, 4, 5, and so on. Remember, we are only estimating the interrelationship's strength: Is it strong, medium, weak, or nonexistent? There is little to be gained by trying to be precise in an area where the result is a best guess or an estimate.

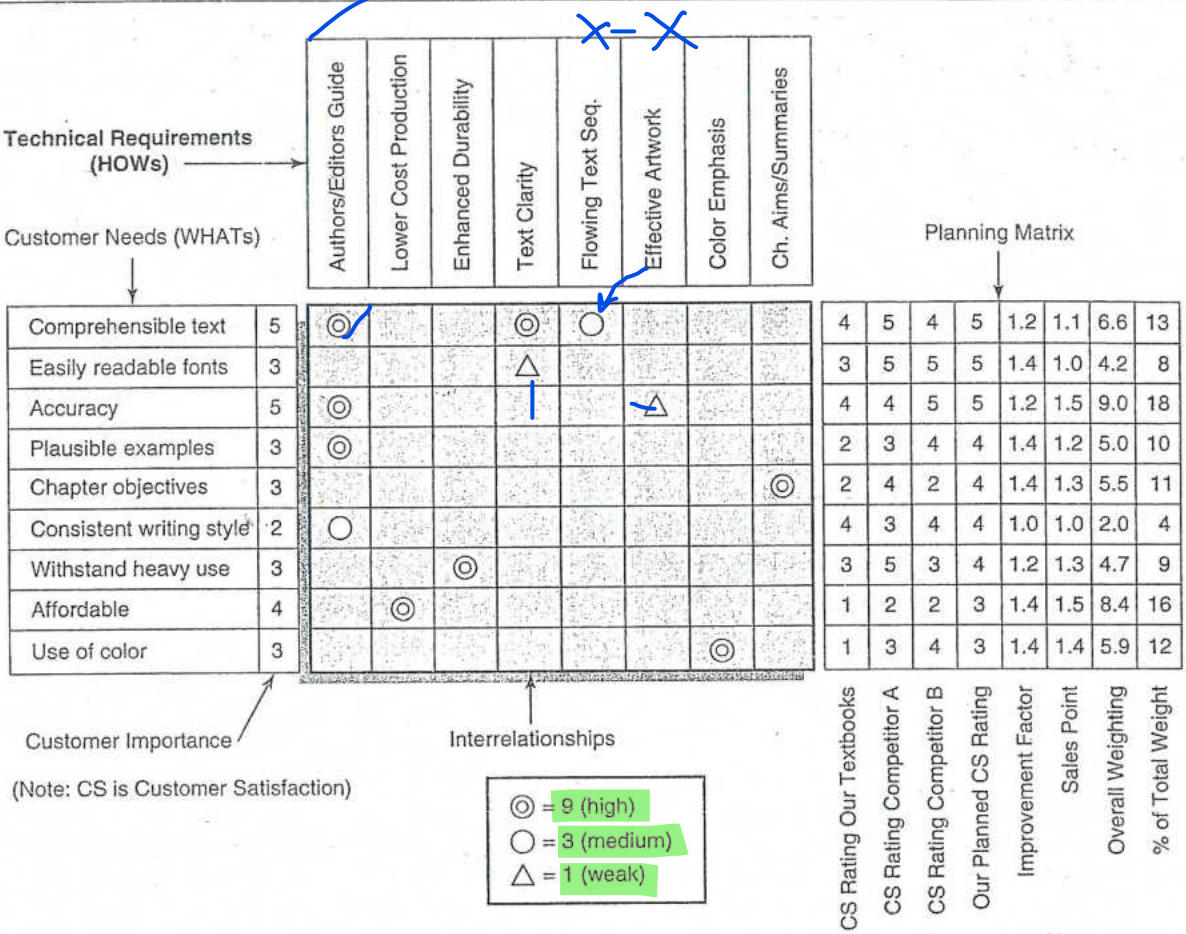


FIGURE 8 Interrelationships between WHATs and HOWs

There is a rule of thumb in QFD that only about 15% of the interrelationship cells will show a relationship between WHATs and HOWs. So don't be concerned when your matrix appears a bit empty. There is, however, one firm rule with the interrelationship matrix—*every row and every column must have at least one entry*. An empty *column* means that the HOW (a technical requirement) is not delivering value to the customer-needs. For example, if Figure 8 had a technical requirement to make the books smaller we would find that it does not relate to any of the figure's customer needs, and the column would be empty. To expend any effort to reduce the book's size would be a waste of resources since the customers will not find value in a smaller book. On the other hand, a horizontal *row* with all cells blank indicates that the WHAT (a customer need) is not being addressed. For example, if Figure 8 showed a customer need for an e-book version for an electronic book reader, that row would have no cell entry because that need is not addressed by any of the technical requirements. Just remember that all the listed customer needs must be addressed in the technical requirements, and any technical requirement that does not address a customer need probably shouldn't be there. Figure 8 shows the interrelationship matrix completed.

EVALUATING THE DIRECTION OF CORRELATION BETWEEN HOWs: HOUSE OF QUALITY MATRIX NUMBER 5

As a product or service is being designed there will inevitably be some technical requirements that tend to benefit one another and some that tend to work against one another. Those that benefit each other are said to have a supportive or positive correlation. Those working against each other have an impeding, or negative correlation. It is always helpful to know what kind of correlation exists in order to take advantage of the supportive correlations, and to contrive tradeoffs for those that impede. Failure to know this may result in a product that does not meet requirements, or one that requires expensive redesign in order to conform to customer requirements. Getting it right the first time is the purpose of the Correlation Matrix or Roof of the HOQ. One might say that getting it right the first time is the purpose of the entire QFD process.

The correlation matrix is constructed by drawing a triangle (looking like a roof) over the Technical Requirements section of the HOQ. Refer to Figure 9. Intersecting diagonal columns are drawn within the triangle from the top of each technical requirement column. Next the correlation

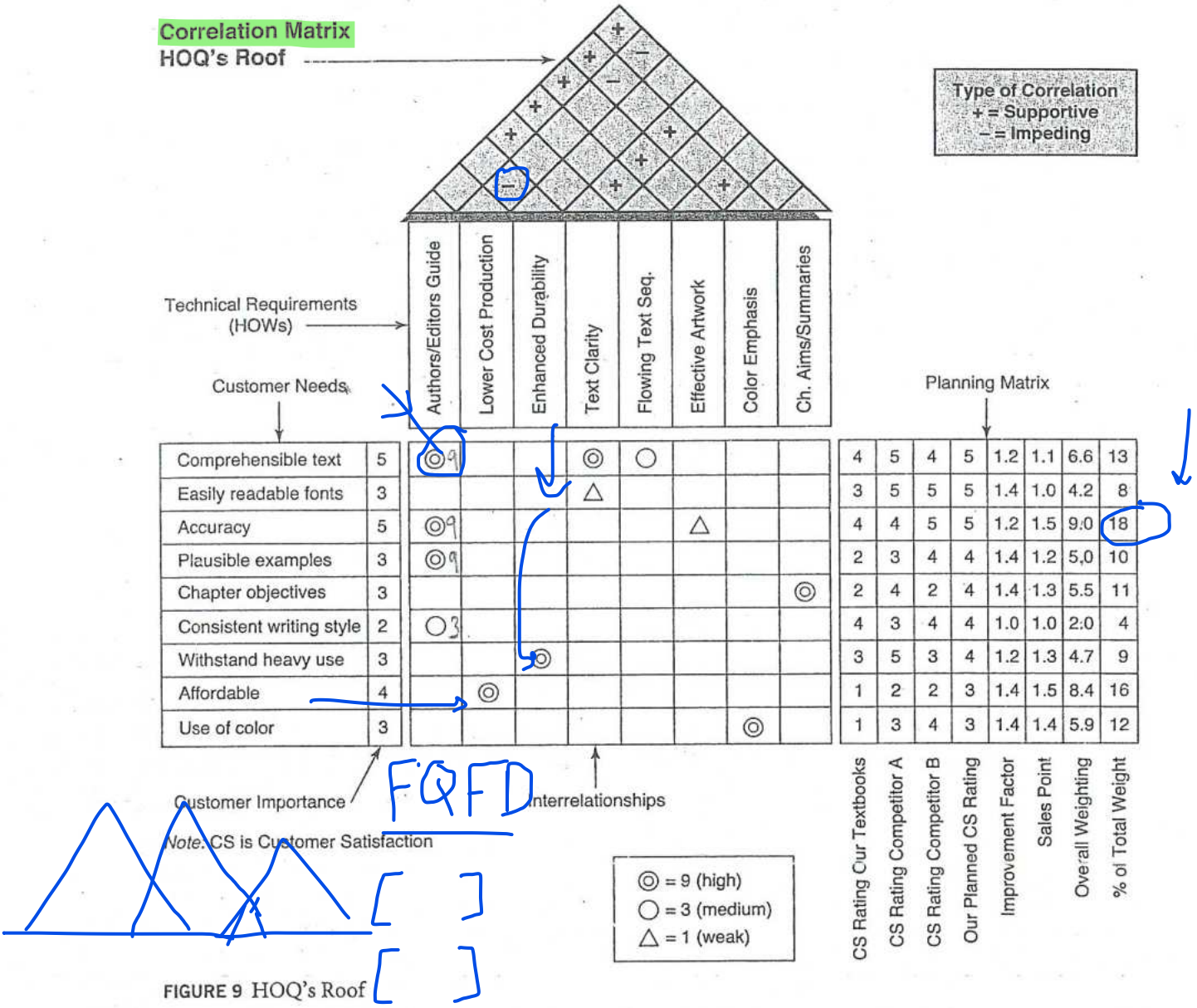


FIGURE 9 HOQ's Roof

type, whether *supportive*, *impeding*, or having *no correlation* is determined for each of the technical requirements against all other technical requirements. A supportive correlation is indicated by a plus sign (+) at the intersecting columns of the two technical requirements under consideration. A negative correlation is indicated by the use of the minus sign (−). If there appears to be no significant correlation, that intersection cell is left blank. Should it be beneficial, the *Supportive* and *Impeding* classifications may be expanded to *Strongly Supportive*, *Supportive*, *Impeding* and *Strongly Impeding*.

In practice, the QFD team asks some variation of this question, "Does improving this technical requirement result in the other's improvement, or does it result in degradation of the other?" If neither improvement nor degradation is indicated, there is apparently no correlation between the two.

In our example, the QFD team will first ask the question, "Will employing a better *Authors/Editors Guide* support or impede *Lower Cost Production*?" It might impede lower cost production if the new-and-improved Guide significantly increased the work for the authors and editors, but the team doesn't think that will be so, so the intersection cell for those two columns is left blank. Next, the team will look for correlation between *Authors/Editors Guide* and the technical requirement for *Enhanced Durability*. Clearly there is no correlation there. The next correlation check is between *Authors/Editors Guide* and the technical requirement for *Text Clarity*. The better the guide, the better the text clarity should be, so this represents a supportive correlation. A plus sign will be placed in the intersecting cell of the technical requirements of *Authors/Editors Guide* and *Text Clarity*. There are four more correlation checks for the *Authors/Editors Guide* technical requirement, and all

turn out to be supportive. Next, we will examine the possible remaining correlations for the *Low Cost Production* requirement. The first will be with *Enhanced Durability*. In this case the correlation is impeding, because making the product more durable would be expected to directly increase the cost of production, not lower it. The intersecting cell will get a minus sign. This means that during the design process, either some tradeoffs must be made between the needs for *lower cost* and *enhanced durability*, or better yet, that some process must be discovered to improve the book's durability while holding or reducing cost. This examination is repeated for all remaining correlation cells, and the correlation matrix you see in Figure 9 is complete.

For an HOQ with eight technical requirements such as our example, there are 28 possible correlations. Adding one more technical requirement expands that number to 36, adding two more results in 45, and so on. Real world HOQ diagrams are often much larger than ours, suggesting that a lot of time and effort must be expended before the team has it completed. The bigger and more complex they become, however, the greater the need for the power of the HOQ. The HOQ's information presentation makes it easier to work through complex situations with assurance that all important factors have been considered and evaluated. That should make it much more likely that our new product will be successful with our customers.

SELECTING THE DESIGN TARGETS (VALUES) OF THE HOWS: HOUSE OF QUALITY MATRIX NUMBER 6

The HOQ is almost complete, needing only a final section called *Design Targets*. If the *customer requirements* describe WHAT the customer needs, and the *design requirements* tell HOW the company is going provide the product characteristics necessary to address those needs, then the *design targets* specify HOW MUCH of the characteristic needs to be provided. For example, in our HOQ the customer has said he wants our books to withstand heavy use without having the binding fall apart. In our design requirements we said we needed to enhance the binding's durability. Now in the *Design Targets* matrix we need to determine HOW MUCH more durable the binding must be. That will be determined by the data that we have already entered into the HOQ, along with data from benchmarking and testing as required. This section summarizes the conclusions of the QFD process and translates them into product specifications.

The Design Targets section is completed in three sections:

- Technical Priorities (from data already in the HOQ)
- Technical Benchmarking (newly developed data)
- Design Target Values (developed from the previous two)

Technical Priorities

To determine the relative importance, or priorities, of each of the stated *Technical Requirements* (HOWs) in meeting the *Customer Needs* (WANTs), the QFD team simply multiplies each of the interrelationship ratings of the technical requirement (0, 1, 3, or 9) from the *Interrelationship* matrix, times the corresponding customer need's *Overall Weighting* value in the *Planning* matrix; and then sums the columns. All of the data for these calculations are already in the HOQ of Figure 9. Starting with the technical requirement for a new and responsive set of *Authoring/Editing Guidelines*, we find that its relationship to the customer need for a *Comprehensible Text* was indicated in the *Interrelationship* matrix as a 9. Looking across the row to the *Overall Weighting* column of the *Planning* matrix we find a value of 6.6. Multiplying them gives us a value of 59.4

There are three more Interrelationship values for the *Authors/Editors Guide* technical requirement, so a total of four multiplications must be done and then summed.

For the *Comprehensible Text* need $9 \times 6.6 = 59.4$
For the *Accuracy need*, $9 \times 9 = 81.0$
For the *Plausible Examples* need, $9 \times 5 = 45.0$
For the *Consistent Writing Style* need, $3 \times 2 = 6.0$
Authors/Editors Guide Technical Priority $= 191.4$

The value of 191.4 is entered in the *Technical Priorities* row of the *Technical Targets* matrix under the column for the *Authors/Editors Guide*. See Figure 10. The technical priorities row is completed by repeating the process for each of the other *Technical Requirements*.

The meaning of the resulting technical priorities numbers like 191.4 and 42.3 does not jump out at you like a percentage does. For that reason, some QFD users translate the priority values into a percentage scale. This is done, of course, by dividing the individual technical priority values by the sum of all the priority values, and multiplying by 100.

$$\%\ \text{total priority} = (\text{Technical Requirement Priority} \div \Sigma\ \text{Technical Priorities}) \times 100$$

In the case of the Authors/Editors Guide technical requirement,

$$\begin{aligned}\%\ \text{of total priority} &= [191.4 \div (191.4 + 75.6 + 42.3 + 63.6 + 19.8 + 9 + 53.1 + 49.5)] \times 100 \\ &= (191.4 \div 504.3) \times 100 \\ &= 38\end{aligned}$$

The rest of the *% of Total Priority* values are calculated, and placed in a row just below the Technical Priorities. See Figure 10. Except for small errors for rounding, the row's sum should equal 100.

With 38% of the total priorities, and with the next highest at 15%, and decreasing from there, that means that in meeting the customer's needs, the new *Authors/Editors Guide* is by far the most important technical requirement. That this technical requirement has a much higher percent

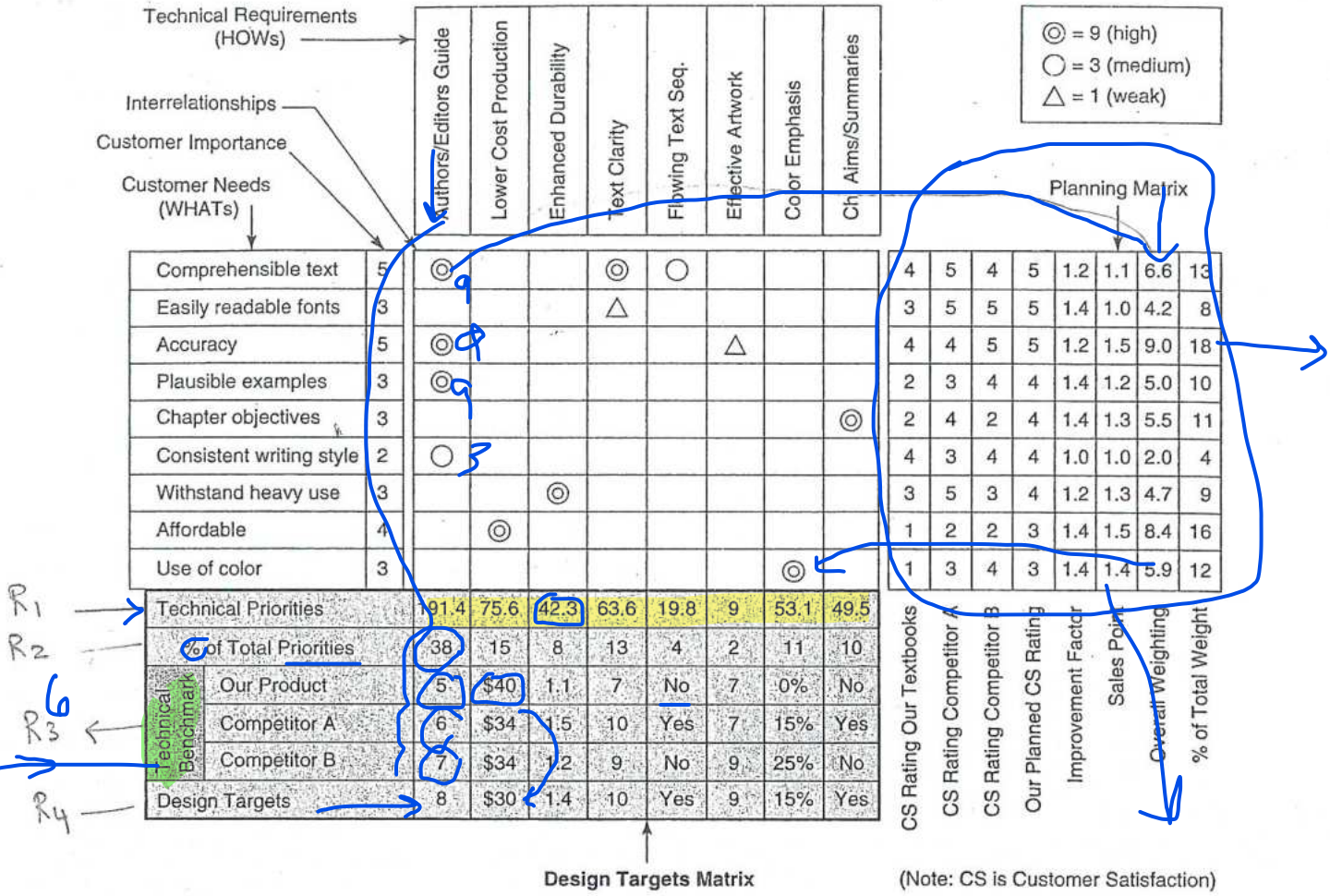


FIGURE 10 HOQ's Adding the Design Targets Matrix

of total priorities than the others seems reasonable since it impacts four customer needs while the others only relate directly to one or two. This information is used by the organization as guidance for the appropriate deployment of limited resources for the project.

Technical Benchmarking

The next section of the Design Targets matrix involves comparing the organization's *intended* product with competing products, in our case from same competitors A and B that we used in the *Planning* Matrix. In *HOQ Matrix 3* the team identified the technical requirements—how they plan to meet the customer needs. The *Technical Benchmarking* section is intended to provide specific information on where the organization's current product (assuming there is one) stands relative to competing products, with respect to each of the *technical requirements*. The source of information for the competing products may come from customers, focus groups, the press, by actual testing and measurement of those products, and so on. Usually it is dredged from a combination of all possible sources. The team starts by gathering the data on its own existing product for each of the technical requirements.

Authoring/Editing Guidelines. This proposed new set of guidelines is intended to respond to several elements where the publisher's books are a bit weak: namely comprehensibility of text, accuracy, plausible examples, and consistent writing style. The team grades those elements for the publisher's current books, and sets the overall score at 5 on a 1 to 10 scale, with 10 being best.

Lower Cost Production. This one is easy. What does the book cost to produce? The answer on average for the current books is $40, so that is the score.

Enhanced Durability. The publisher's books have had a tendency to come apart more often than its competitors do. Testing suggests that the binding process and the materials used could be better. Destructive testing yields a relative strength (the ratio of pull strength to binding stress) of 1.1 for current products.

Text Clarity. This is related to two customer needs: comprehensible text and easily readable fonts. Upon evaluation the team assigned a 1 to 10 based score of 7 for the current books.

Flowing Text Sequence. In this case, rather than trying to determine a score, the team used a YES-NO system. If the text seemed to flow in a logical, orderly sequence it was graded YES. If the flow jumped back and forth from subject to subject, it was given a NO. The publisher's books tended toward the latter, and got the NO.

Effective Artwork. The purpose of artwork, that is the figures, drawings, and illustrations, is to clarify and illuminate the text. The team used a 1 to 10 scale to grade how effectively the books' artwork accomplished those goals. They gave the current versions a 7.

Color Emphasis. Color can be used not only in the artwork, but also in the text to make something more interesting, eye-catching, and hopefully more memorable. The team concluded that a telling rating would be the percentage of pages having color. It was easy to grade the publisher's current books because no color was used except on the covers. Score 0%.

Chapter Aims and Summaries. This is another YES-NO category. A book either uses them or it does not. The current books mostly did not, so they got a NO score.

These scores were entered in the *Our Product* row of the *Technical Benchmark* section. See Figure 10.

Next, the same data were developed by the team for the books of competitors A and B. You will find that data in the next two rows of Figure 10's Technical Benchmark section. The data shows that this publisher's books come off second or third-best of the three. Good reason for low market share, the issue that prompted the company to get involved with QFD in the first place.

If you compare these ratings with those of the planning matrix, you should notice that the rankings of this publisher's books versus those of its competitors are very much in agreement. If that does not turn out to be the case, then something is wrong, and should be discovered before proceeding. Was the customer understood correctly? Was the data reliable? Have we put our emphasis on the wrong thing?

Design Targets

The objective of the design targets is to establish specific objectives for the design team. For example, the QFD team determined that through the application of, and adherence to an improved set of guidelines for all the people involved in authoring and editing the books, increasing the score to an eight would better the competition, and should be possible. Similarly, setting a target of $30 per book (on average) for production cost will beat the competition by $4 per book. However, that represents a 25% reduction from the present situation, and the publisher is also asking to markedly improve the durability of its books. This is the kind of situation where one must consider a radical change that can achieve both goals, and that is what the QFD team is counting on. They expect a complete change in the materials and processes used in binding the books.

A measurement of book durability is relative strength. That is the ratio of pull strength divided by binding stress. The publisher's current products have a relative strength of 1.1, while the competitors A and B score 1.5 (much better) and 1.2 (somewhat better). By investing enough, the publisher can equal Competitor A's 1.5, but is that necessary? Competitor B's books have a relative strength of 1.2, and the books seem quite durable. This becomes a tradeoff. The publisher can switch its current binding process to new modern processes and materials making the bindings more robust than most customers would ever need, or the company can scale the improvement back a bit in the interest of economy, and still have adequate durability while simultaneously achieving lower production costs. The QFD team sets the target at 1.4.

Our books scored 7 out of a possible 10 for clarity of text, against the competitors' scores of 10 and 9. The QFD team sets the design target value at 10—there is no reason to publish anything lacking clarity, and the competition proves it.

In similar fashion, the team sets *YES* for the design objective for text sequence flow. If the authors can't manage it, the editors must.

The design goal for having artwork that is effective in clarifying and illuminating the text was elevated from the current level of 7 to a 9, the same as leading Competitor B. The target for color emphasis was set at having 15% of the pages with some use of color. That is much less than Competitor B, but in line with the customer's needs. And finally, the team determined that the publisher must include chapter aims or objectives and chapter summaries in its books. This is indicated as a *YES*. See Figure 10 for all the inputs to the Design Targets matrix.

At this point the HOQ is complete. See Figure 11. What happens next? That depends on the situation. HOQ is often used at this level to guide all departments in their efforts to design and produce the product. The HOQ will help the organization ensure that all aspects of the product's design adheres to the customer's needs, that extraneous bells and whistles are prevented, and that all relevant activities of the company are involved and participating.

In some cases, depending on the application, an HOQ like the one we have just developed will be just the starting point, with lower level HOQs being developed for the various organizational functions. For example, subordinate HOQs may be utilized for the actual design of the product, procurement of parts and materials, gearing up to manufacture the product, and so on. It is important to understand that QFD is appropriate for services as well as for tangible products. Our development of an HOQ involved a tangible product, but we could as easily have addressed the improvement or development of a service instead. Our objective here has been to acquaint you with the purpose of QFD, and its language, layout, processes, and functions.

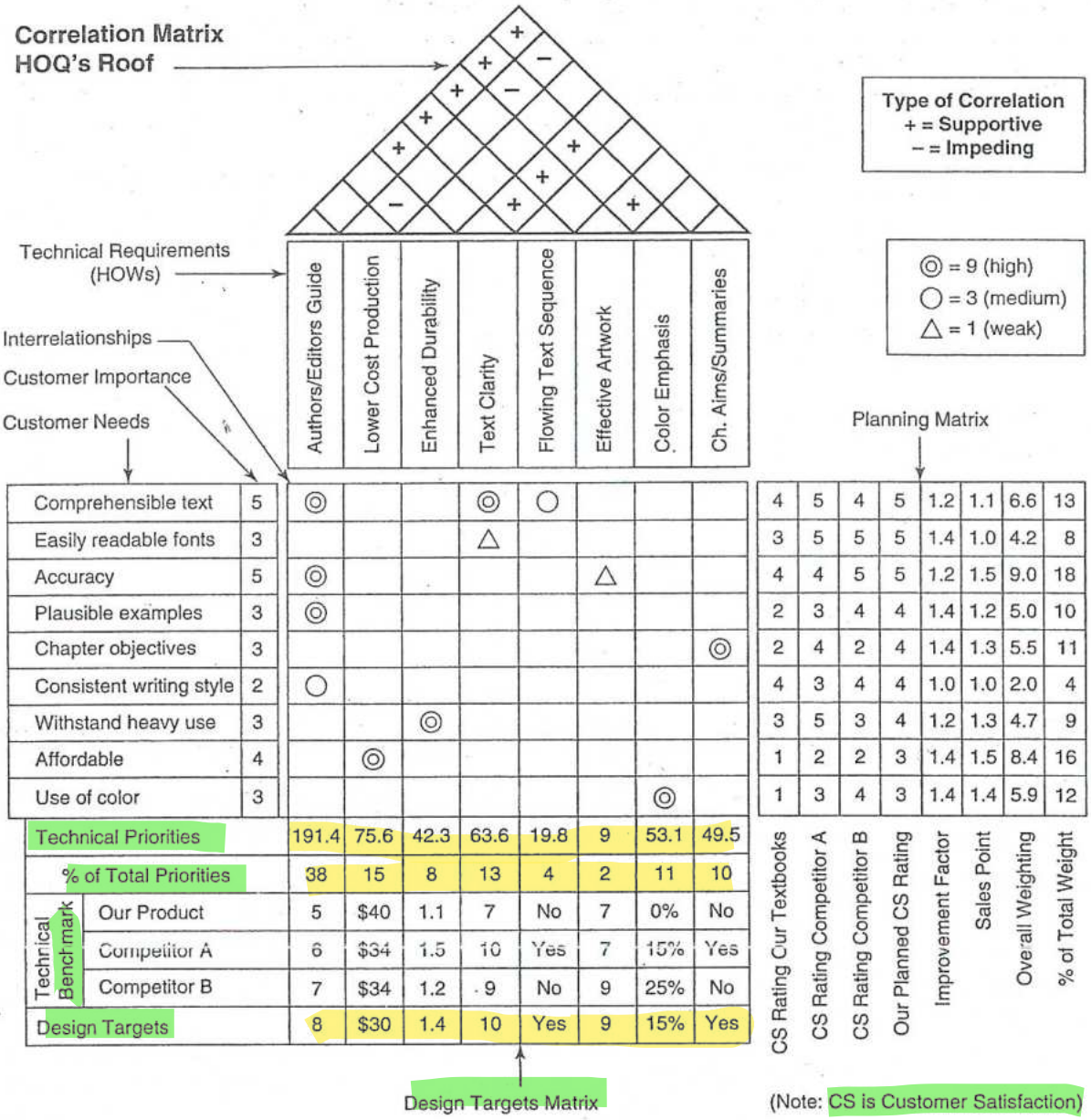


FIGURE 11 The Completed HOQ

SUMMARY

1. Quality Function Deployment (QFD) is an approach to product/service design and continual improvement that brings customers into the design process. It is used to translate what the customer wants into what the organization produces.
2. QFD was originally developed by Dr. Yoji Akao in 1966, combining quality strategies with features of value engineering.
3. QFD requires the involvement of all functional departments of the organization at the start of, and throughout the project. This is also a primary objective of TQM.
4. There are many examples of products being brought to market only to be rejected because they did not satisfy customer wants/needs. An objective of QFD is to avoid that fiasco.
5. The House of Quality (HOQ) employs six attached submatrices.
6. QFD requires the organization to collect and analyze inputs from customers regarding attributes they would like in a product.
7. Some tools used in QFD include affinity diagrams and tree diagrams.
8. QFD requires competitive benchmarking to compare customer satisfaction with the company's *current* prod-

uct versus competing products, and technical benchmarking comparing how the *intended* product will rate against that competition.

9. A QFD rule of thumb is that only about 15% of the Interrelationship matrix cells will be filled.
10. A QFD rule requires that all interrelationship rows and columns must have at least one entry.
11. The Correlation Matrix (roof) indicates which technical requirements support another, which impede another, and which do neither.
12. *Customer Needs* define *what* the customers want, *Technical Requirements* define *how* the organization plans to provide the product characteristics the customers need, and *Design Targets* define *how much* of the characteristics must be provided.

KEY TERMS AND CONCEPTS

Affinity Diagram
Competitive Benchmarking
Correlation Matrix
Cross-Functional QFD Team
Customer Importance
Customer Needs (WHATs)
Design Targets
House of Quality (HOQ)
Impeding Correlation
Improvement Factor
Interrelationships
Planning Matrix
Quality Function Deployment (QFD)
Sales Point
Supportive Correlation
Technical Benchmarking
Technical Priorities
Technical Requirements (HOWs)
Tree Diagram
Value Engineering
Voice of the Customer (VOC)

FACTUAL REVIEW QUESTIONS

1. Define Quality Function Deployment.
2. Describe the basic structure of the QFD House of Quality.
3. Explain the rationale for QFD.
4. List the principle benefits of QFD.
5. Explain the need for the QFD team to be cross-functional.
6. Describe the function of an affinity diagram as used in QFD.
7. Describe the function of the Sales Point.
8. Explain why it is not advantageous to use more precise rating/ranking scales.
9. Describe the function of the HOQ's roof.
10. Describe the fundamental purpose of the Design Targets.

CRITICAL THINKING ACTIVITY

Customer Demands versus Organizational Capabilities

"I don't know why we keep collecting all this customer input and feedback. It's clear they want a better product than our processes can produce," said Derrick Kramer, CEO of Ronkel Inc.

"That's true," said Linda Carver, Ronkel's director of quality. "But we are going to lose our customers if we don't improve our processes. We need to do more than collect customer feedback. We need to use it to keep our processes up-to-date."

Clearly, Ronkel needs to translate customer demands into process improvements. Explain how QFD could be used to help this company. How should Kramer and Carver proceed if they choose to apply QFD?

BENCHMARKING

People seldom improve when they have no other model but themselves to copy after.
—Oliver Goldsmith

MAJOR TOPICS

- Benchmarking Defined
- Benchmarking versus Reengineering
- Rationale for Benchmarking
- Prerequisites to Benchmarking
- Obstacles to Successful Benchmarking
- Role of Management in Benchmarking
- Benchmarking Approach and Process
- Making Full Use of Benchmarking Data
- Perpetual Benchmarking
- Benchmarking Resources

Benchmarking has become a popular tool among companies trying to become more competitive and striving for world-class performance. The majority of them are actively engaged in benchmarking. Benchmarking is a part of the total quality process, and anyone involved in total quality should have a solid understanding of this subject. This chapter is intended to help readers understand what benchmarking is all about, its benefits, and its pitfalls. The chapter includes sufficient information to enable any enterprise to make rational decisions concerning benchmarking, including whether or not to do it and how to go about it.

Benchmarking was brought to our awareness through Robert C. Camp's 1989 landmark book.[1] In the 20 odd years since then a number of variations have been developed on the benchmarking theme. We have *benchmarking studies*, in which there is no contact with an outside firm—information gained is strictly from the public domain. There is no question that this technique can be useful. It is something that the organization should be doing anyway. Sometimes third-party firms specializing in benchmarking studies are contracted for that work. There is considerable doubt that this is really benchmarking, however.

We also have *competitive benchmarking*, in which a competitor's operation is studied from a distance *without* the cooperation of the target firm. The aim is to learn something that can help improve process or product quality. Competitive benchmarking uses publicly available data, and once again, it is possible to contract this work to specialist third-party firms. This approach, however, doesn't fit our definition of benchmarking.

Also in use are the unstructured plant visits, during which the visitor firm intends to learn something that will help with its processes or products. This is often called benchmarking but has more aptly been named *industrial tourism*. Such visits have some value, but they do not comprise benchmarking.

Many other variations exist, but the form of benchmarking addressed here is what has been called *cooperative benchmarking*, *best practices benchmarking*, or *process benchmarking*, in which the focus is radical improvement of key processes. This involves a cooperative effort by two firms, the benchmarking firm wanting to bring a substandard process up to the world-class level of the partner firm's process.

BENCHMARKING DEFINED

Benchmarking has been around since the early 1980s, but it wasn't until the early 1990s that it became a widely accepted means of improving company performance. In 1985, almost no benchmarking activity existed among the Fortune 500 companies. By 1990, half of the Fortune 500 companies were using this technique. Today companies large and small find benchmarking to be an effective component in their total quality effort. If there is a single most likely reason for the slow rise in benchmarking popularity, it is a misunderstanding of the concept—a misunderstanding of what benchmarking is, what it is not, and how to do it. It helps to begin with an examination of what benchmarking is not.

From Chapter 20 *of Quality Management for Organizational Excellence: Introduction to Total Quality*, 7th Edition. David L. Goetsch, Stanley B. Davis. Copyright © 2013 by Pearson Education, Inc. All rights reserved.

Benchmarking Is Not:	
Cheating	Unethical
Illegal	Industrial espionage
Immoral	

All of these misconceptions about benchmarking assume that one party somehow takes advantage of an unsuspecting competitor by surreptitiously copying the competitor's product or processes. Nothing could be further from the truth. Benchmarking involves two organizations that have agreed to share information about processes or operations. The two organizations both anticipate some gain from the exchange of information. Either organization is free to withhold information that is considered proprietary. In addition, the two companies need not be competitors.

Benchmarking is the process of comparing and measuring an organization's operations or its internal processes against those of a best-in-class performer from inside or outside its industry.

Benchmarking is finding the secrets of success of any given function or process so that a company can learn from the information—and improve on it. It is a process to help a company close the gap with the best-in-class performer without having to "reinvent the wheel."

A distinction exists between benchmarking and competitive analysis. *Competitive analysis* involves comparing a competitor's product against yours. It compares the features and pricing of the product. Consumers perform competitive analysis when they compare competitors' products as they try to determine which brand of high-definition television or automobile to purchase. Benchmarking goes beyond that to comparing how the product is engineered, manufactured, distributed, and supported. Benchmarking is interested not so much in what the product is and what it costs as in the underlying processes used to produce, distribute, and support it.

Finally, and most important, benchmarking is a tool to help establish where improvement resources should be allocated. If, for example, it is discovered that three of five processes are nearly as good as the best-in-class performers, but two are significantly off the best-in-class mark, the most resources should be allocated to these two. The most benefit for the dollars invested will come from changing those processes to conform more nearly to the best-in-class. Relatively little will be gained by drastically changing a process that is already close to the best there is. Key points to remember about benchmarking are as follows:

- Benchmarking is an increasingly popular improvement tool.
- Benchmarking concerns processes and practices.
- Benchmarking is a respected means of identifying processes that require major change.
- Benchmarking is done between consenting companies that may or may not be competitors.
- Benchmarking compares your process or practice with the target company's best-in-class process or practice.
- The goal of benchmarking is to find "secrets of success" and then adapt and improve them for your own application.
- Benchmarking is equally beneficial for both large and small businesses.

BENCHMARKING VERSUS REENGINEERING

Benchmarking involves partnering with the owner of a best-in-class process so that you might adopt or adapt that process in your operation without having to spend the time and energy to try to design a duplicate of the superior process. Process reengineering requires you to do the latter, on your own. Therefore, in our view, process reengineering should be considered only when it is impossible to use benchmarking. That could happen for a number of reasons, including these:

- No known process available for benchmarking (rare)
- Best-in-class not willing to partner
- Best-in-class inaccessible due to geography or expense

If your subject process is unsatisfactory and you cannot benchmark for any of these reasons, you may have to resort to reengineering. You should be careful to consider the reasons the process is unsatisfactory. It may simply be the wrong process for the job, or it may be out of statistical control. Reengineering will not solve either of those problems. Be sure that the process is appropriate and that it is in control first. If it is still not producing the desired results, suggesting that it is simply not capable, then redesigning it through reengineering is a good approach. One disadvantage with process reengineering is that there is no guarantee that after spending the time and resources, you will have a competitive process. That issue does not exist with benchmarking. With benchmarking, you will have observed a competitive process in action.

When we set out to improve our processes, we normally flowchart them to help us understand how each process really works and to give us a visual impression of the steps, people, and functions involved. Improvement typically comes about by changing or eliminating activity in the process that does not add value or consumes too much time or resources, and so on. There is an alternative way to go about this, and that is to abandon the current process and replace it with a brand new process that provides the same functionality but better, faster, or cheaper. That is process reengineering.

Here is something to think about: if an organization could achieve the same results by either one of these two routes, which one would offer the best chance for success in the workplace? We believe the former—let's call it the continual improvement route—would be more readily accepted by the workforce and would be, therefore, more likely to succeed. Usually, the people most closely related to the process have major input to any continual improvement initiative, and it will not be perceived as something being forced on them by some person or group that fails to understand the process anyway. Whether justified or not, that is the way process reengineering has come across to

workers. It tends to be radical and sudden, and seldom is consideration given to the human issues. Many times it is seen as a management tool for laying off workers. It does not have to be that way, but that is, we think, the way process reengineering is widely perceived today.

We say this to lead into our final thoughts on process reengineering. If you find process reengineering to be the approach for one of your processes, never let it be a surprise to your employees. In keeping with the philosophy we promote throughout this text, it only makes sense to involve the process owners and their internal suppliers and customers, along with other appropriate employees, in your process reengineering project. Take advantage of their collective brainpower and diverse perspectives, and in the doing, their buy-in will be ensured.

In summary, if you have a very good process to begin with, use continual improvement techniques to make it better. On the other hand, if the process is clearly inferior to some used by other firms, try benchmarking. When you cannot achieve the kind of improvement you need from either of those methods, then process reengineering may be required. But no matter which way you go, be sure to get your people involved.

RATIONALE FOR BENCHMARKING

Never was Yogi Berra's comment, "The future ain't what it used to be," as relevant as it is to modern industry. The future for companies today seems far different from what it seemed in the twentieth century. The first real questions regarding the future and the ability of the United States to sustain its industrial leadership seem to have resulted from the oil crisis of 1974. By then, the United States had lost much of the commercial electronics business to Sony, Hitachi, and Panasonic, but the most important industry in the United States, the automobile industry, seemed secure. However, when the oil embargo struck, Americans quickly traded their big domestic cars for small, more fuel-efficient Japanese models. When the embargo ended, Americans continued buying Japanese cars because consumers found them better than their American counterparts. The Japanese quickly claimed about 30% of the U.S. automobile market (and possibly could have gained much more except for voluntary restraints adopted out of fear that severe trade restrictions would be imposed by Washington). Following these events, North America finally started to wake up to the fact that the world was changing. Whole industries were moving from one part of the world to another, and most of that movement was to Japan. There was good reason to look at the Japanese to see what they were doing differently that allowed them to accomplish this.

What was learned, of course, was that by following the teachings of Deming, Juran, Ishikawa, Taguchi, Ohno, and other quality pioneers, Japan had developed vastly superior practices and processes. These resulted in superior manufactured goods at competitive prices—everything from motorcycles, to cars, to cameras, to electronics of all kinds, and even to ships. It took several years of looking at Japan to realize fully what had happened. For a long time, Western leaders rationalized that Japan's success was due to low labor costs, the Japanese work ethic versus that of Detroit, lifetime employment, and other factors. Such rationalizations simply clouded the real issue: the superiority of the Japanese practices and processes. Now that industrial leaders worldwide are aware that better practices and processes can enhance competitiveness, it makes good business sense to determine where an organization stands relative to world-class standards and what must be done to perform at that level. That is what benchmarking is designed to do.

Twenty years ago, benchmarking was a case of comparing North American industry with that of the Japanese. Today benchmarking is a case of comparing your company with the best in the world. The best in the world for a given comparison may be in Japan or Korea, or it may be next door. It may be your direct competition, or it may be in a completely different industry. In addition to companies all over the world emulating the Japanese, customers all over the world are demanding the highest quality in the products they buy. Business as usual is no longer sufficient. Organizations must be improving always and forever, or they will be out of business soon and forever.

The rationale for benchmarking is that it makes no sense to stay locked in an isolated laboratory trying to invent a new process that will improve the product, or reduce cost, when that process already exists. If one company has a process that is four times as efficient, the logical thing for other companies to do is to adopt that process. An organization can make incremental improvements to its process through continual improvement, but it might take years to make a 4× improvement, and by then, the competition would probably be at 6× or better. Benchmarking is used to show which processes are candidates for continual (incremental) improvement and which require major (one-shot) changes. Benchmarking offers the fastest route to significant performance improvement. It can focus an entire organization on the issues that really count.

Some factors that drive companies to benchmark are commitment to total quality, customer focus, product-to-market time, manufacturing cycle time, and financial performance at the bottom line. Every company that has won the Malcolm Baldrige Award endorses benchmarking (see Discussion Assignment 20–1 later in this chapter). Key points to remember about benchmarking as it relates to continual improvement are as follows:

- Today's competitive world does not allow time for gradual improvement in areas in which a company lags far behind.
- Benchmarking can tell a firm where it stands relative to best-in-class practices and processes and which processes must be changed.
- Benchmarking provides a best-in-class model to be adopted or even improved on.
- Modern customers are better informed and demand the highest quality and lowest prices. Companies have a choice to either perform with the best or go out of business.
- Benchmarking supports total quality by providing the best means for rapid, significant process or practice improvement.

QUALITY TIP

Look Far and Wide

When you look for best-in-class process owners as possible benchmarking partners, don't restrict your search to your own industry. For example, when Southwest Airlines was looking for a faster way to offload passengers and cargo and get the planes ready for their next flights, it benchmarked Indianapolis 500 pit crews. When Xerox needed major improvements in its warehousing operations, it benchmarked L. L. Bean, one of the world's best catalog sales organizations. IBM studied Las Vegas casinos to find ways to reduce employee theft.

Source: David L. Goetsch and Stanley B. Davis.

PREREQUISITES TO BENCHMARKING

Before getting involved in benchmarking, an organization should check the prerequisites—those philosophical and attitudinal mind-sets, skills, and necessary preliminary tasks that must precede any benchmarking efforts.

Will and Commitment

Without the will and commitment to benchmark, an organization cannot proceed. Don't waste time or the time of a benchmarking partner in the absence of a commitment and a will to benchmark on the part of the company's top management.

Vision and Strategic Objective Link

Benchmarking requires a strong focus, or it can go off in numerous different directions as benchmarkers get carried away in their enthusiasm. Before benchmarking is started, its objectives must be linked to the company's vision and strategic objectives, providing specific direction and focus for the effort. Failure to do this will almost certainly result in wasted resources and frustration.

Goal to Become the Best—Not Simply Improved

Nothing is wrong with incremental improvement—unless current performance is far below world class. If an organization is not near the world-class level, incremental improvement may only ensure that it remains inferior to the best-in-class forever. Benchmarking requires that the goal be to leap to the head of the field in one radical change, not just to be a few percentage points better than last year.

Openness to New Ideas

If a company is imbued with the "Not-invented-here" Syndrome, it will have a problem with benchmarking. The chief symptom of that affliction is a shortsighted mind-set that is characterized by a reluctance to consider other ways of doing things. Although few will admit it, many people are reluctant to consider ideas or approaches that are not their own. Organizations can be like individuals in this regard. Because the essence of benchmarking is capitalizing on the work and ideas of others, a company must be open to new ideas for benchmarking to provide any value. The benchmarking process may help bring about more receptivity to new ideas by demonstrating that they really work.

Identifying Key Business Processes

Since the organization must devote significant capital and human resources to any benchmarking initiative, it is important that the effort makes a difference and pays dividends. That will only happen if the processes selected for benchmarking activity are those considered to be among your key business processes. Therefore, it is essential that those processes that are critical to your mission be identified. Key business processes are defined as those having maximum impact on the success of the organization. They enable the organization to produce its products or services, effectively monitor the organization's performance, and establish its objectives and plans for the future. Organizations usually have 10 to 15 key business processes. Identifying them is best done by the organization in brainstorming sessions employing the following four steps:

1. Identify the organizations' Critical Success Factors (CSFs). These are the handful of characteristics, functions, capabilities, or limitations that are critical to the success and viability of the organization.
2. Identify the metrics for measuring CSFs. These metrics are called Key Performance Indicators (KPIs), and may include production output and sales data, and supporting management performance data.
3. Identify the processes that drive the CSFs. There will typically be 15 or more processes in this category.
4. Some of these processes may be grouped together, and others ungrouped (if they are completely independent of each other). These are your key business processes. It is from the list of key business processes that you will select your candidates for process benchmarking.

Understanding of Existing Processes, Products, Services, Practices, and Customer Needs

It is mandatory that an organization thoroughly understand its own processes, products, services, and practices and the requirements of its customers so that it can determine what needs to be benchmarked. In addition, it is necessary to have a solid understanding of your process in order to make meaningful measurements against that of the partner.

Processes Documented

It is not enough to understand the processes; they must be completely documented, for three reasons:

- All people associated with the process should have a common understanding of it, and that can come only from documentation.
- A documented starting point is needed against which to measure performance improvement after benchmarking changes have been implemented.
- Your organization will be dealing with people (the partners) who are not familiar with your processes. Process documentation will help the partner understand your organization's processes. With an understanding of where the benchmarking organization is, the partner will be better able to help.

Process Analysis Skills

To achieve an understanding of your own processes, products, and services and to document those processes, you must have people with the skills to characterize and document processes. These same people will be needed to analyze the benchmarking partners' processes and to help adapt those processes to the organization's needs. Ideally, they should be employees, but it is possible to use consultants in this role.

Research, Communication, and Team-Building Skills

Additional skills required include research, communication, and team building. Research is required to identify the best-in-class process owners. Communication and team building are required to carry out the benchmarking both on an internal basis and with the partners.

OBSTACLES TO SUCCESSFUL BENCHMARKING

Like most human endeavors, benchmarking can fail. Failure in any activity usually means that the participant failed to prepare adequately for the venture—failed to learn enough about the requirements, the rules, and the pitfalls. So it can be with benchmarking. In this section, some of the common obstacles to successful benchmarking as drawn from the experiences of dozens of companies are explained.

Internal Focus

For benchmarking to produce the desired results, you have to know that someone out there has a far better process. If a company is internally focused (as many are), it may not even be aware that its process is 80% less efficient than the best-in-class. An internal focus limits vision. Is another firm better? Which is it? Such organizations don't even ask the question. This is complacency—and it can destroy a company.

Benchmarking Objective Too Broad

An overly broad benchmarking objective such as "Improve the bottom-line performance" can guarantee failure. This may well be the reason for benchmarking, but the team will need something more specific and oriented not to the *what* but to the *how*. A team could struggle with the bottom line forever without knowing with certainty that it achieved success or failure. The team needs a narrower target: for example, "Refine or replace the invoicing process to reduce errors by 50%." That gives team members something they can go after.

Unrealistic Timetables

Benchmarking is an involved process that cannot be compressed into a few weeks. Consider 4 to 6 months the shortest schedule for an experienced team, with 6 to 8 months the norm. Trying to do it in less time than that will force the team to cut corners, which can lead to failure. If you want to take advantage of benchmarking, be patient. On the other hand, any project that goes on for more than a year should be assessed; the team is probably floundering.

Poor Team Composition

When a process is benchmarked, those who own the process, the people who use it day in and day out, must be involved. These people may be production line operators or clerks. Management may be reluctant to take up valuable team slots with these personnel when the positions could otherwise be occupied by engineers or supervisors. Engineers and supervisors should certainly be involved but not to the exclusion of process owners. The process owners are the ones who know the most about how the process really operates, and they will be the ones who can most readily detect the often subtle differences between your process and that of the benchmarking partner. Teams should usually be six to eight people, so be sure the first members assigned are the operators. There will still be room for engineers and supervisors.

Settling for "OK-in-Class"

Too often organizations choose benchmarking partners who are not best-in-class, for one of three reasons:

- The best-in-class is not interested in participating.
- Research identified the wrong partner.
- The benchmarking company got lazy and picked a handy partner.

Organizations get involved in benchmarking when they decide that one or more of their processes is much inferior to the best-in-class. The intention is to examine that best-in-class process and adapt it to local needs, quickly bringing your organization up to world-class standards in that process area. It makes no sense to link with a partner whose process is just good. It may be better than yours, but if adopted, it still leaves your organization far below best-in-class. For the

same amount of effort, an organization could have made it to the top. Organizations should identify the best and go for it. Only if the absolute best will not participate can taking second-best be justified. Second-best should be used only if it is significantly superior to the process in question.

Improper Emphasis

A frequent cause of failure in benchmarking is that teams get bogged down in collecting endless data and put too much emphasis on the numbers. Both data collection and the actual numbers are important, of course, but the most important issue is the process itself. Take enough data to understand your partner's process on paper, and analyze the numbers sufficiently to be certain that your results can be significantly improved by implementing the new process. Unless the team has been deeply involved in the process, the practical knowledge to successfully adapt and implement it back home may be lacking. Keep the emphasis on the process, with data and numbers supporting that emphasis.

Insensitivity to Partners

Nothing will break up a benchmarking partnership quicker than insensitivity. Remember that a partner is doing your organization a favor by giving access to its process. You are taking valuable time from the partner's key people, and at best, you are disrupting the routine of daily business. If you fail to observe protocol and common courtesy in all transactions, your organization runs the risk of being cut off.

Limited Top-Management Support

This issue keeps coming up because it is so critical to success at all stages of the benchmarking activity. Unwavering support from the top is required to get benchmarking started, to carry it through the preparation phase, and finally to secure the promised gains.

ROLE OF MANAGEMENT IN BENCHMARKING

Management plays a crucial role in the benchmarking process. In fact, without the approval and commitment of top management, benchmarking is not possible. Benchmarking is not something that can occur from the grassroots up without management's direct involvement. Several benchmarking considerations require management's approval before the process can start: commitment to change, funding, human resources, disclosure, and involvement.

Commitment to Change

Benchmarking is a serious undertaking for both benchmarking partners. Unless a firm commitment to change exists—unless the organization fully intends to radically improve its processes to come up to best-in-class standards—benchmarking should not be considered. Unfortunately, too many companies jump into benchmarking without that commitment, with the result that money and personnel are wasted by both parties. In addition, the hopes and expectations of employees are raised, only to be disappointed when nothing comes of it. To obtain any real benefit from benchmarking, an organization must resolve that when a best-in-class process is found, it will do what is necessary to incorporate it as a replacement (or radical improvement) model for its inferior process. That, after all, is what benchmarking is about.

Funding

Only management can authorize the expenditure of funds for benchmarking. These funds will support travel for teams visiting the organizations with best-in-class processes. Teams are usually composed of five to eight people. Visits may last from 2 days to 2 weeks. Travel destinations are inflexible, dictated by the location of the best-in-class firms. Clearly, travel expenses can be high. Management must make the funds available if benchmarking is to be carried out.

Human Resources

In similar fashion to funding, management must make the necessary human resources available for the benchmarking tasks. Although the costs for the human resources are usually far higher than for travel, the availability of personnel is seldom an issue except for the target company.

Disclosure

It may not be immediately obvious, but both companies—the benchmarker and the target—disclose information about their processes and practices. Management may be understandably hesitant to disclose such information to competitors, but what about the case of the noncompetitor benchmarking partner? Even there, management may be reluctant because there can be no ironclad guarantee that information divulged to a noncompetitor will not find its way to the competition. The other side of the coin is that few processes or practices remain secret very long anyway. But if the organization has some unique process that gives it a competitive advantage, the process should be treated as proprietary and not be subjected to benchmarking. In any event, only management can make the decision to disclose information.

Involvement

Management must be actively and visibly involved in every aspect of the benchmarking process. Management should be involved in determining which processes are to be benchmarked and selecting benchmarking partner candidates. Management is in a unique position to establish the communication channels between the companies because top managers tend to affiliate through professional organizations. Dialogue among top-level managers should be encouraged.

It is important for management to stay abreast of benchmarking events and to make certain that the effort supports

the objectives and vision of the company. Management's ability to do this is greatly enhanced when it is directly involved. In addition, subordinates will recognize the importance placed on benchmarking by the degree to which management is visible in the process. With management active, all levels will be more productive in their benchmarking activities.

BENCHMARKING APPROACH AND PROCESS

The benchmarking process is relatively straightforward, but steps must flow in a sequence. A number of variations are possible, but the process should follow this general sequence:

1. Obtain management commitment.
2. Baseline your own processes.
3. Identify your strong and weak processes and document them.
4. Select processes to be benchmarked.
5. Form benchmarking teams.
6. Research the best-in-class.
7. Select candidate best-in-class benchmarking partners.
8. Form agreements with benchmarking partners.
9. Collect data.
10. Analyze data and establish the gap.
11. Plan action to close the gap or surpass.
12. Implement change to the process.
13. Monitor results.
14. Update benchmarks: continue the cycle.

These 14 implementation steps are explained in the following sections. Figure 2 is provided to help maintain perspective and afford clarity.

Step 1: Obtain Management Commitment

Benchmarking is not something one approaches casually. It requires a great deal of time from key people, and money must be available for travel to the benchmarking partners' facilities. Both of those require management's approval. You expect to gain information from your benchmarking partner for which it will expect payment in kind: namely, information from you about your processes. This can be authorized only by management. Finally, the object of benchmarking is to discover processes to replace yours or at least to make major changes to them. Such changes cannot be made without management's approval. Without a mandate from top management, there is no point in attempting to benchmark. That is why the requirement for management commitment is at the top of the list. If you cannot secure that commitment, proceed no further.

Step 2: Baseline Your Own Processes

When a process is baselined, it establishes the starting point for process improvement. The process baseline documents the current state of the process, its steps, and capabilities. A baselined process will have complete documentation of its inputs and outputs, all of its steps and supporting information, together with process capability data. This is often called process characterization. Process flow diagrams are a key element of baselining, and provide a graphical picture of how the process works, who is involved, and the sequence of activity and of decision points, and so on. Process capability provides information on what can be expected from the process under optimal conditions.

If your company is involved in total quality, chances are good that you have already done some baselining of processes because before continual improvement can be used effectively, and certainly before statistical process control can be applied, the processes in question must be understood. That is, the processes must be characterized in terms of process capability, their flowcharts, and other aspects. If this has not been done before, it must be done now. It is critical that you understand your own processes thoroughly before attempting to compare them with someone else's processes. Most organizations think they know their processes well, but that is rarely the case unless a deliberate process characterization has recently been done. It is also important that an organization's processes be completely and accurately documented, not just for its own use but also for the benefit of everyone associated with the process in any way.

Step 3: Identify and Document Both Strong and Weak Processes

Selection of processes or functions to benchmark would seem to be a straightforward decision but is in fact one that gives many would-be benchmarkers a great deal of trouble. If you keep in mind that the purpose of benchmarking is to make a radical improvement in the performance of a process—more improvement than could be made quickly through continual improvement techniques—it follows that most concern should be focused on the weakest processes and the functions that operate them. The processes that are the weakest are the ones that are most detrimental to competitiveness. They offer the most room for dramatic improvement, perhaps many times over. This is where the benchmarking effort should be focused because incremental improvement would not be sufficient to bring them up to the necessary level in the time frame required.

It can be difficult to categorize an organization's processes as weak or strong. A process that creates 50% scrap is an obvious choice for the benchmarking list. On the other hand, a process may be doing what is expected of it and, as a result, be classified as strong. However, it could be that expectations for that process are not high enough. It is possible that someone else has a process that is much more efficient, but you just don't know about it. Never consider a process to be above benchmarking, no matter how highly it is rated. Concentrate on the weak ones, but keep an open mind about the rest. If research identifies a better process, add it to the list.

Above all, document all processes fully—even the strong ones. Keep in mind that as you are looking at one of your benchmarking partner's processes because it is superior to yours, your partner may look at your strong processes for the same reason. If the processes are not well-documented, it will be very difficult to help your partner. It is impossible to compare two processes for benchmarking if both are not fully documented.

Step 4: Select Processes to Be Benchmarked

When you have a good understanding of your own processes and your expectations of them, decide which ones to benchmark. An important point to remember is this: never benchmark a process that you do not wish to change. There is no point in it. Benchmarking is not something you engage in simply to satisfy curiosity. The processes that are put on a benchmark list should be those that you know to be inferior and that you intend to change. Leave the others for incremental change through continual improvement—at least for the time being.

Step 5: Form Benchmarking Teams

The teams that will do the actual benchmarking should include people who operate the process, those who have input to the process, and those who take output from it. These people are in the best position to recognize the differences between your process and that of your benchmarking partner. The team must include someone with research capability because it will have to identify a benchmarking partner, and that will require research. Every team should have management representation, not only to keep management informed but also to build the support from management that is necessary for radical change.

Step 6: Research the Best-in-Class

It is important that a benchmarking partner be selected on the basis of being best-in-class for the process being benchmarked. In practical terms, it comes down to finding the best-in-class-you-can-find-who-is-willing. Because benchmarking is accomplished by process, best-in-class may be in a completely different industry. For example, say that an organization manufactures copy machines. It might consider potential benchmarking partners who are leaders in the copying industry. But if it is a warehousing process that is to be benchmarked, the company might get better results by looking at catalog companies that have world-class warehousing operations. If the process to be benchmarked is accounts receivable, then perhaps a credit card company would be a good partner.

Processes are shared across many industries, so don't limit research to like industries or you might miss the best opportunities for benchmarking. Remember that best-in-class does not mean best-in-your-industry, but best regardless of industry for the process in question. If team members stay up-to-date with trade journals, they should be able to compile a good list of potential benchmarking partners. Research should cover trade literature, suppliers and customers, Baldrige Award winners, and professional associations. The Internet offers a seemingly endless stream of benchmarking information. Team members will find that the best-in-class processes become well-known very fast.

Step 7: Select Candidate Best-in-Class Benchmarking Partners

When the best-in-class have been identified, the team must decide with which among them it would prefer to work. Consideration must be given to location and to whether the best-in-class is a competitor (remember, the team will have to share information with its partner). The best benchmarking partnerships provide some benefit for both parties. If the team can find a way to benefit its potential partner, the linkage between the two companies will be easier to achieve. Even without that, most companies with best-in-class processes are willing, often eager, to share their insights and experience with others, even if they gain nothing in return. Indeed, Baldrige Award winners are expected to share information with other U.S. organizations.

Step 8: Form Agreements with Benchmarking Partners

After the team has selected the candidate, it contacts the potential partner to form an agreement covering benchmarking activities. It can be useful to have an executive contact an executive of the target company, especially if there is an existing relationship or some other common ground. Often the most difficult part of the process is identifying the right person in the potential partnering company. Professional associations can sometimes provide leads to help the team contact someone in the right position with the necessary authority.

After such a contact has been made, the first order of business is to determine the company's willingness to participate. If it is not willing, the team must find another candidate. When a company is willing to participate, an agreement can usually be forged without difficulty. The terms will include visit arrangements to both companies, limits of disclosure, and points of contact. In most cases, these are informal. Even so, care must be exercised not to burden the benchmarking partner with excessive obligations. Make the partnership as unobtrusive as possible.

Step 9: Collect Data

The team has already agreed to discuss a specific process (or processes). Observe, collect, and document everything about the partner's process. In addition, try to determine the underlying factors, practices, and processes: what is it that makes the company successful in this area? For example, does it employ total productive maintenance, continual improvement, employee involvement, statistics, or various other approaches? Optimally, your process operators should talk directly with your partner's operators. It is important to come away with a good understanding of what its process is (flowchart) and its

support requirements, timing, and control. The team should also try to gain some understanding of the preceding and succeeding processes because if you change one, the others may require change as well. If the team knows enough when it leaves the partner's plant to implement its process back home, then it has learned most of what is needed. Anything less than this, and the team has more work to do.

While you are in a partner's plant, try to get a feel for its culture and how it operates. Be open-minded and receptive to new ideas that are not directly associated with the process in question. Observing a different plant culture can offer a wealth of ideas worth pursuing.

Step 10: Analyze the Data; Establish the Gap

With the data in hand, the team must analyze them thoroughly in comparison with the data taken from its own process. In most cases, the team will be able to establish the *performance gap* (the performance difference between the two processes) numerically—for example, 200 pieces per hour versus 110 pieces, 2% scrap versus 20%, or errors in parts per million rather than parts per thousand.

After the team concludes that there is no doubt that the partner's process is superior, other questions arise: Can its process replace ours? What will it cost, and can we afford it? What impact will it have on adjacent processes? Can we support it? Only by answering these questions can the team conclude that implementation is possible.

Step 11: Plan Action to Close the Gap or Surpass

Assume the team concluded that the change to the new process is desirable, affordable, and supportable and that the team wants to adopt the process. In most cases, implementation will require some planning to minimize disruption while the change is being made and while the operators are getting used to the new process. It is very important to approach implementation deliberately and with great care. In some cases, it may be wise to try the new process in a pilot model. This is not the time for haste. Consider all conceivable contingencies and plan to avoid them, or at least be prepared for them. Physical implementation may be accompanied by training for the process operators, suppliers, or customers. Only after thorough preparation and training should an organization implement the change to the new process.

A second aspect of benchmarking should be kept in mind. The objective is to put in place a process that is best-in-class. If the team merely transplants the partner company's process, it will not achieve the objective, although improvements may occur. To achieve best-in-class, an organization must surpass the performance of the benchmark process. It may not be possible to do this at the outset, but the team's initial planning should provide for the development work necessary to achieve it in a specified period of time (see Figure 1).

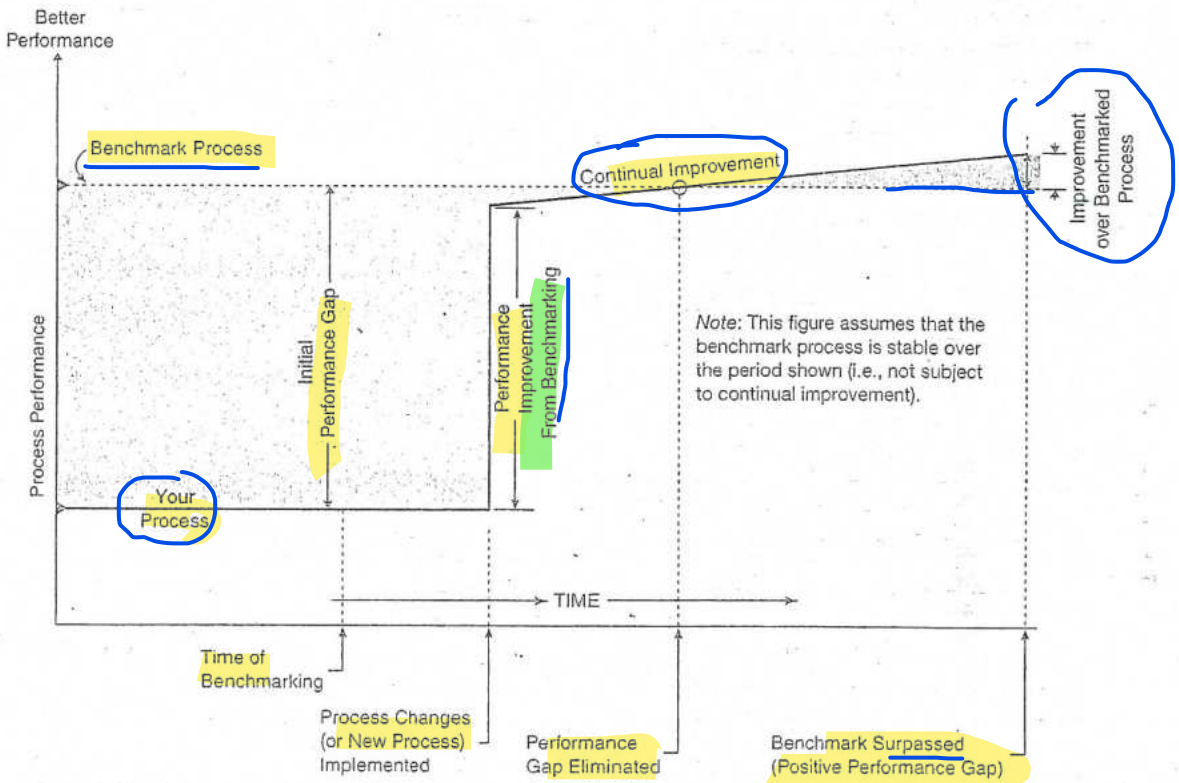


FIGURE 1 Effect of Benchmarking Process Change Followed by Continual Improvement

Step 12: Implement Change to the Process

The easiest step of all may be the actual implementation, assuming that the team's planning has been thorough and that execution adheres to the plan. New equipment may or may not be involved, there may be new people, or there may be more or fewer people—but there will certainly be new procedures that will take time to become routine. Therefore, it should not be a surprise if initial performance falls below the benchmark. After people get used to the changes and initial problems get worked out, performance should be close to the benchmark. If it is not, an important factor was overlooked, and another visit to the benchmarking partner may be necessary to determine what it is.

Step 13: Monitor Results

After the process is installed and running, performance should come up to the benchmark quickly. Before long, continual improvement should enable the organization to surpass the benchmark. None of this is likely to happen without constant attention and monitoring. Never install a new process, get it on line and performing to expectations, and then forget about it. All processes need constant attention in the form of monitoring. Statistical process control can be an invaluable tool for this purpose, as can other types of charting.

Step 14: Update Benchmarks; Continue the Cycle

As was explained in Step 11, the intent of benchmarking is not only to catch up with the best-in-class but also to surpass, thereby becoming best-in-class. This is a formidable undertaking because those with best-in-class processes are probably not resting on their laurels. They too will constantly strive for continually better performance. However, you are now applying new eyes and brains to their processes, and fresh ideas may well yield a unique improvement, vaulting your organization ahead of the benchmarking partner. Should that happen, your organization will be sought out as a best-in-class benchmarking partner by others who are trying to bootstrap their performance. Whether that happens or whether the benchmark is actually surpassed, the important thing is to maintain the goal of achieving best-in-class. Benchmarks must be updated periodically. Stay in touch with the best-in-class. Continue the process. Never be content with a given level of performance.

An important consideration, as you either achieve best-in-class or get close, is that limited resources have to be diverted to those processes that remain lowest in performance relative to their benchmarks. Let continual improvement take over for the best processes, and concentrate benchmarking on the ones that remain weak.

QUALITY TIP

Continual Process Improvement Has No End

Any process that is "good enough" today will be inadequate tomorrow.

Source: David L. Goetsch and Stanley B. Davis.

Three Phases of Benchmarking

The 14-step sequence introduced above represents the three phases of benchmarking: preparation, execution, and postexecution. Figure 2 illustrates the benchmarking process or sequence by phase and indicates action responsibility for each step. Figure 2 also makes it clear that the final step (14) causes the cycle to start over again at Step 2, confirming the never-ending nature of the benchmarking process for companies that want to achieve or maintain leadership positions. Key points relating to the 14-step sequence of steps for implementing benchmarking are as follows:

- Benchmarking requires top management's commitment, participation, and backing.
- It is necessary that an organization thoroughly understand its own processes before attempting to benchmark.
- The processes that should be benchmarked are those that most need improvement.
- Benchmarking teams must include process operators.
- Benchmark best-in-class, not best-in-the-industry.
- Do not rush into new processes or major changes without thorough, thoughtful planning.
- Do not be satisfied with a zero gap—aim to surpass.
- Carefully monitor new processes or major process changes.
- Benchmarking is not a one-shot process; continue it forever.

MAKING FULL USE OF BENCHMARKING DATA

At the conclusion of the benchmarking project with your partner, data analysis will have produced both quantitative and qualitative information. The quantitative information is effectively the "stake driven into the ground" as the point from which future progress is measured. It is also used as the basis for improvement objectives. Qualitative information covers such matters as personnel policies, training, management styles and hierarchy, total quality maturity, and so on. This information provides insights on how the benchmarking partner got to be best-in-class.

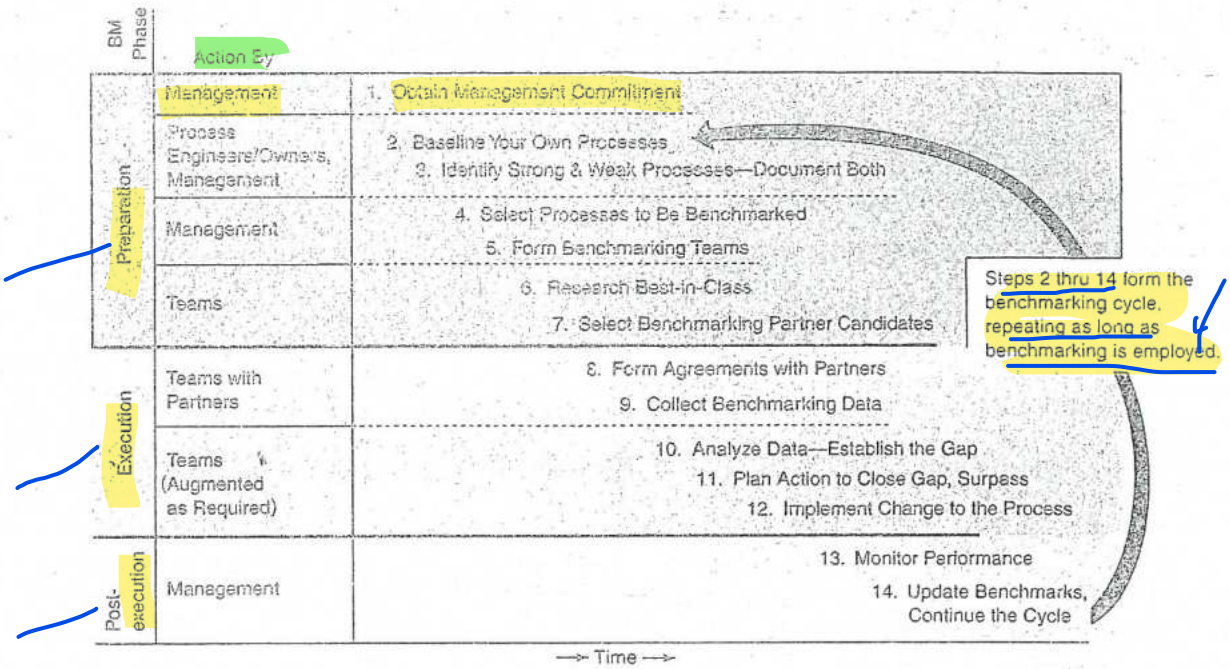


FIGURE 2 The Benchmarking Process or Sequence

The quantitative data are clearly the information sought and are always used. However, there may be more value in the qualitative information. It describes the atmosphere and environment in which best-in-class can be developed and sustained. Do not ignore it. Take it very seriously. Study it, discuss it in staff meetings, and explore the possibilities of introducing these changes into your culture.

PERPETUAL BENCHMARKING

If you have been through a series of benchmarking activities and have implemented changes that have significantly improved processes, your organization may develop a tendency to leave benchmarking. After all, there are other things that need attention and resources. But this can be a costly mistake. At this point, the organization not only has greatly improved its processes but also developed some valuable benchmarking experience. Keep in mind that best-in-class continues to be a dynamic and ever-changing mosaic. Processes are constantly being improved and altered. In a relatively short time, an organization can fall behind again. To prevent that from happening, the organization must take advantage of hard-won benchmarking experience and keep the effort moving. This means staying up-to-date with the best-in-class through all the means at your disposal, staying current with your own processes as they are continually improved, and benchmarking the weaker processes. This is a never-ending process.

BENCHMARKING RESOURCES

A number of sources of information can help organizations with their benchmarking efforts. These cover the spectrum from nonprofit associations to cooperative affiliations to for-profit organizations that sell information. In addition, of course, there are consulting firms with expertise and databases covering all aspects of benchmarking.

One of the most promising ventures is the American Productivity and Quality Center (APQC) Benchmarking Clearinghouse (123 N. Post Oak Lane, Houston, TX 77024; phone, [800] 776-9676 or [713] 681-4020; and on the Web at www.apqc.org). The APQC Benchmarking Clearinghouse has been set up to assist companies, nonprofit organizations, and government in the process of benchmarking. It works with affiliated organizations to collect and disseminate best practices through databases, case studies, publications, seminars, conferences, videos, and other media.

A wide range of benchmarking information is available on the Internet. Just ask your search engine to find "benchmarking" or "process benchmarking," and you will probably be rewarded with more information than you can use. This ranges from articles on the subject to promotions for books and consultants. Colleges list the contents of their libraries that are related to benchmarking. We would suggest a word of caution, however. Anyone can put anything on the Internet without verification, so it is always a good idea to approach material from unfa-

miliar sources with a degree of skepticism. In spite of this, we consider the Internet to be a valuable benchmarking resource center.

Excellent sources of information for benchmarking are trade and professional groups. They can often direct organizations to best-in-class practices, provide contacts, and offer valuable advice. Baldrige Award winners are committed to sharing information with other U.S. companies, and they hold periodic seminars for this purpose.

The trade literature publishes a wealth of relevant information, including lists of companies with best-in-class processes and practices. *Industry Week* is one example of an excellent source of benchmarking information. Dun and Bradstreet maintains a database of potential benchmarking partners and will share it for a fee.

Consultants and universities that are engaged in benchmarking can help organizations get started by providing initial training, offering advice and guidance, and directing organizations to benchmarking partner candidates.

Again, be cautious, and ensure that any information obtained is current. The very nature of benchmarking makes yesterday's data obsolete. To achieve maximum benefit, organizations must be sure that they are operating on current information.

SUMMARY

1. Benchmarking is a process for comparing an organization's operations or processes with those of a best-in-class performer.
2. The objective of benchmarking is major performance improvement achieved quickly.
3. Benchmarking focuses on processes and practices, not products.
4. Benchmarking is done between consenting organizations.
5. Benchmarking partners are frequently from different industries.
6. Benchmarking is a component of total quality.
7. Benchmarking must be approached in an organized, planned manner, with the approval and participation of top management.
8. Benchmarking teams must include those who operate the processes.
9. Benchmarking is not restricted within industry boundaries, but only to best-in-class processes.
10. It is necessary for the benchmarker to understand its own process before comparing it with another.
11. Because best-in-class is dynamic, benchmarking should be seen as a never-ending process.
12. Management has a key role in the benchmarking process, including commitment to change, making funds available, authorizing human resources, being actively involved, and determining the appropriate level of disclosure.
13. The goal of benchmarking is to become best-in-class, not simply improved.
14. The intent of benchmarking is to replace an inferior process with one rated best-in-class or to radically improve a process, bringing it up to best-in-class performance—and then to surpass best-in-class.
15. A number of obstacles to successful benchmarking exist, including internal focus, overly broad or undefined objectives, unrealistic timetables, improper team composition, failure to aim at best-in-class, diverted team emphasis, insensitivity toward the partner, and wavering support by top management.

KEY TERMS AND CONCEPTS

Benchmarking
Benchmarking partner
Best-in-class
Continual improvement
Customer focus
Internal focus
Key business process
Malcolm Baldrige Award
Performance gap
Process baselining
Process capability
Process characterization
Process flow diagram
Qualitative information
Quantitative information

FACTUAL REVIEW QUESTIONS

1. Define benchmarking.
2. Explain the difference in objectives for continual improvement and benchmarking.
3. List five factors that lead organizations to benchmarking.
4. On which processes should an organization concentrate for benchmarking?
5. Why is it necessary that top management be committed as a prerequisite to benchmarking?
6. What are the reasons for characterizing and documenting an organization's processes before benchmarking?
7. Identify the critical members of the benchmarking team.

8. Explain why it is not enough to simply clone the benchmarking partner's process.
9. Explain the importance of linking the benchmarking objectives with the organization's strategic objectives.
10. Explain how the "Not-invented-here" Syndrome can be a hindrance to benchmarking effectiveness.
11. List and discuss the eight obstacles to successful benchmarking.

CRITICAL THINKING ACTIVITY

A Competitive Crisis

Note: This is a purely fictitious case study in terms of both the company and the numbers.

Empire Communications Products is a company of 420 employees engaged in designing and producing telephone equipment for the wireless telephone industry. It originally spun out of a large communications company several years ago as the wireless phone market began its rapid expansion. Today its major competition is from the North American, European, and Japanese telecom giants, all of which have now recognized the market potential and are competing furiously. Empire Communications has been a respected and successful niche market player, even selling some proprietary products to its big competitors. However, the pressure on profits has become extreme, and the company is searching for ways to cut its costs.

The CEO has had her management steering committee looking into benchmarking as a possible means of making processes more efficient. It has concluded that the company has five key business process areas, each with its own set of processes. The five key business process areas are as follows:

Key Process Area	12-Month Expense	Primary Processes
Engineering (45 employees)	$1,000,000	Research & development
	6,005,000	Design
	300,000	Product improvement
	7,305,000	
Finance (12 employees)	500,000	Accounting
	100,000	Accounts payable
	130,000	Accounts receivable
	730,000	
Human Resources (5 employees)	300,000	Recruiting/hiring
	60,000	Compensation
	260,000	Employee development
	620,000	
Production (350 employees)	1,000,000	Procurement
	30,000,000	Materials
	3,000,000	Warehousing
	3,500,000	Material control
	550,000	Materials preparation
	3,800,000	Production control
	11,100,000	Assembly
	2,050,000	Integration and test
	55,000,000	
Quality Assurance (8 employees)	275,000	Incoming inspection
	500,000	In-process inspection
	150,000	Supplier auditing
	200,000	Internal auditing
	1,125,000	
Total Annual Expenses	$64,780,000	

The steering committee did some research to compare similar expenses with a typical firm in the industry. It found that the company's engineering expenses were close to the average. The same was true of the finance department. Human resources was on average except for expenses for employee development, where it was clear that Empire was spending less for training than the industry at large. What the committee found in the production and quality assurance areas was a major surprise. Empire spent far more than the industry average for warehousing, material control, materials preparation, production control, and even assembly. In quality assurance, Empire's costs were way above the average for inspection. On the other hand, Empire spent significantly less than the average for its materials, integration and test, and supplier audits and internal audits. The comparative data are given here:

Process	Industry Avg.	Empire	Difference
Employee development	450,000	260,000	−190,000
Materials	31,000,000	30,000,000	−1,000,000
Warehousing	975,000	3,000,000	+2,025,000
Material control	180,000	3,500,000	+3,320,000
Materials preparation	85,000	550,000	+465,000
Production control	725,000	3,800,000	+3,075,000
Assembly	10,000,000	11,100,000	+1,100,000
Integration & test	3,060,000	2,050,000	−1,010,000
Incoming inspection	75,000	275,000	+200,000
In-process inspection	200,000	500,000	+300,000
Supplier auditing	1,250,000	150,000	−1,100,000
Internal auditing	2,800,000	200,000	−2,600,000
	$50,800,000	$55,385,000	+$4,585,000

In total, Empire's costs were about $4.6 million above the annual average for its peers. If it could find a way to eliminate the excess cost, the $4.6 million would be added to before-tax profit, virtually doubling its current profit status. That would certainly be welcomed.

Exercise Questions

1. You are a benchmarking consultant. Empire staff has shared this information with you, and it wants to know why you think benchmarking is an appropriate course for it to follow. Is benchmarking likely to help Empire Communications? What will you tell it?
2. Does the pattern of spending more than the average in some areas and under the average in others suggest anything to you? How will this influence any benchmarking strategy?
3. How would you determine the best process areas for benchmarking?
4. Given the fact that the telecom industry is extremely competitive, is it likely that Empire will find willing benchmarking partners among its competitors? If not, what would you do?
5. Develop a recommendation for Empire Communications for how you propose to lead it through the benchmarking activity and what it should expect to gain from it.

Author's Comments on the Empire Communications Exercise

Question 1. It seems clear that other companies are doing things much differently and, overall, much less expensively than Empire, so benchmarking would seem to be a good avenue for quick, major improvement.

Question 2. Spending less for training *may* mean that some of Empire's employees are not as well-trained as they should be. That will have to be investigated in more depth. Beyond that there seems to be a pattern of over- and underspending that suggests Empire is not doing business like the average firms in production and quality assurance.

The gross differences in warehousing, material control, and production control are probably the result of Empire's use of the traditional manufacturing techniques rather than the lean just-in-time approach, which can be a huge cost saver. If that is the case there will be lots of possibilities for benchmarking.

Empire spends 6.5 times the average for materials preparation. Perhaps it is doing it all in-house rather than having its supplier do it more efficiently. We need to find out exactly what Empire is doing and then look to see where there is a better process to be benchmarked.

Integration and test looks, on the surface, to be a winner. Find out why, and if it turns out to be a superior

process, it can be used as an enticement for a prospective benchmarking partner.

Empire appears to have lower materials purchasing expense, but if that is coupled with overspending on incoming inspection and underspending in supplier audits, one gets the impression that Empire is still trying to sort defective materials out at its plant rather than having its suppliers do so before the materials ever get to Empire. That could also help explain why Empire's assembly costs are higher than average (rework due to defective materials).

Almost certainly benchmarking will show Empire new, more efficient ways to do things, but we need to fully understand how Empire works before we go benchmarking.

Question 3. Look for the production processes that indicate the biggest undesirable expense gap and then try to determine which will be easiest to benchmark and implement. Always take the easiest-to-benchmark, financially critical process first.

Question 4. The chances are slim that an outright competitor would become a benchmarking partner, although that does happen. Empire should look at the entire electronics industry (it competes only in telecom), and even outside it if appropriate for the process. Remember, it is best-in-class, not just best-among-competitors, in which we are interested.

Question 5. Your proposal should outline the work to be done internal to Empire: namely, checking out the issues raised by Question 2 and determining where best to start regarding Question 3. After comparing what Empire is doing against what the competition is apparently doing, do the research to find a best-in-class partner. Be sure to tell Empire that any process that is to be benchmarked will have to be thoroughly flowcharted and understood. (It would also be a good idea to point out that even those critical processes that are not on the benchmarking list at present should also be characterized as a first step in an internal continual improvement program.) You will need to talk about the benchmarking team composition, training, and the actual visit to the partner's site. Also, you will need to explain the process of adopting or adapting the new process to the Empire Communications environment and culture. It would be a good idea to go through each of the 14 steps with Empire's Steering Committee.

DISCUSSION ASSIGNMENT 1

Benchmarking at Motorola

Motorola, one of the original Malcolm Baldrige Award winners, has found that even after achieving best-in-class, there is much to be gained through continued benchmarking. Every new program, every new product, and every new improvement effort at Motorola is preceded by a search for the best-in-class. In this way, Motorola ensures that every new process introduced will be world class.

DISCUSSION QUESTION

Discuss the following question in class or outside of class with your fellow students:

1. What do you think motivates Motorola to invest in benchmarking?

DISCUSSION ASSIGNMENT 2

Benchmarking at Xerox

By the late 1970s, Xerox was losing significant market share to its Japanese competitors. Not only were the Japanese products excellent, but also, to Xerox's dismay, they were sold for less than Xerox could manufacture them. Xerox found that it had nine times as many suppliers as the Japanese companies and made seven times as many manufacturing defects. Lead times for new products were twice as long, and production setup times were five times as long as the competitors'.

Xerox introduced benchmarking in 1980. Its processes and practices were benchmarked against the best in and out of its industry. As a result of these efforts, Xerox saved itself. Today, Xerox is a world-class competitor, capable of holding its own in terms of technology, price, service, and customer satisfaction against any competition. Benchmarking at Xerox has reached into every facet of the company and remains a primary feature of the corporation.

DISCUSSION QUESTION

Discuss the following question in class or outside of class with your fellow students:

1. Using public domain information, such as that available on the Internet, determine where Xerox stands relative to its competitors today.

ENDNOTE

1. Robert C. Camp, *Benchmarking: The Search for Industry Best Practices That Lead to Superior Performance* (Milwaukee, WI: Quality Press/Quality Resources, 1989).

CONTINUAL IMPROVEMENT METHODS WITH SIX SIGMA, LEAN, LEAN SIX SIGMA, AND MORE

Even if you're on the right track, you'll get run over if you just sit there.
—Will Rogers

MAJOR TOPICS

- Rationale for Continual Improvement
- Management's Role in Continual Improvement
- Essential Improvement Activities
- Structure for Quality Improvement
- The Scientific Approach
- Identification of Improvement Needs
- Development of Improvement Plans
- Common Improvement Strategies
- Additional Improvement Strategies
- The Kaizen Approach
- The CEDAC[1] Approach
- The Lean Approach
- The Six Sigma Approach
- The Lean Six Sigma Approach
- The Theory of Constraints (TOC) and Integrated TOC, Lean, Six Sigma (iTLS) Approach

One of the most fundamental elements of total quality is continual improvement. The concept applies to processes and the people who operate them as well as to the products resulting from the processes. A fundamental total quality philosophy is that all three—processes, people, and products—must be continually improved. This chapter provides the information needed to make continual improvements to the processes and products.

RATIONALE FOR CONTINUAL IMPROVEMENT

Continual improvement is fundamental to success in the global marketplace. A company that is just maintaining the status quo in such key areas as quality, new product development, adoption of new technologies, and process performance is like a runner who is standing still in a race. Competing in the global marketplace is like competing in the Olympics. Last year's records are sure to be broken this year. Athletes who don't improve continually are not likely to remain long in the winner's circle. The same is true of companies that must compete globally.

Customer needs are not static; they change continually. A special product feature that is considered innovative today will be considered just routine tomorrow. A product cost that is considered a bargain today will be too high to compete tomorrow. A good case in point in this regard is the ever-falling price for each new feature introduced in the personal computer. The only way a company can hope to compete in the modern marketplace is to improve continually.

MANAGEMENT'S ROLE IN CONTINUAL IMPROVEMENT

In his book *Juran on Leadership for Quality*, Joseph Juran writes:

> The picture of a company reaping big rewards through quality improvement is incomplete unless it includes some realities that have been unwelcome to most upper managers. Chief among these realities is the fact that the upper managers must participate personally and extensively in the effort. It is not enough to establish policies, create awareness, and then leave all else to subordinates. That has been tried, over and over again, with disappointing results.[2]

Management can play the necessary leadership role—and that essentially is its role—in continual improvement by doing the following:

- Establishing an organization-wide quality council and serving on it.
- Working with the quality council to establish specific quality improvement goals with timetables and target dates.
- Providing the necessary moral and physical support. Moral support manifests itself as commitment. Physical

From Chapter 19 *of Quality Management for Organizational Excellence: Introduction to Total Quality,* 7th Edition. David L. Goetsch, Stanley B. Davis. Copyright © 2013 by Pearson Education, Inc. All rights reserved.

support comes in the form of the resources needed to accomplish the quality improvement objectives.

- Scheduling periodic progress reviews and giving recognition where it is deserved.
- Building continual quality improvement into the regular reward system, including promotions and pay increases.

ESSENTIAL IMPROVEMENT ACTIVITIES

Continual improvement is not about solving isolated problems as they occur. Such an approach is viewed as "putting out fires" by advocates of total quality. Solving a problem without correcting the fault that caused it—in other words, simply putting out the fire—just means the problem will occur again. Quality expert Peter R. Scholtes and his colleagues recommend the following five activities, which he sees as crucial to continual improvement (see Figure 1):[3]

- ***Maintain communication.*** Communication is essential to continual improvement. This cannot be overemphasized. Communication within improvement teams and among teams is a must. It is important to share information before, during, and after attempting to make improvements. All people involved, as well as any person or unit that might be impacted by a planned improvement, should know what is being done, why, and how it might affect them.
- ***Correct obvious problems.*** Often process problems are not obvious, and a great deal of study is required to isolate them and find solutions. This is the typical case, and it is why the scientific approach is so important in a total quality setting. However, sometimes a process or product problem will be obvious. In such cases, the problem should be corrected immediately. Spending days studying a problem for which the solution is obvious just so that the scientific approach is used will result in $10 solutions to 10-cent problems.
- ***Look upstream.*** Look for causes, not symptoms. This is a difficult point to make with people who are used to taking a cursory glance at a situation and putting out the fire as quickly as possible without taking the time to determine what caused it.
- ***Document problems and progress.*** Take the time to write it down. It is not uncommon for an organization to continue solving the same problem over and over again because nobody took the time to document the problems that have been dealt with and how they were solved. A fundamental rule for any improvement project team is "document, document, document."
- ***Monitor changes.*** Regardless of how well studied a problem is, the solution eventually put in place may not solve it or may only partially solve it, or it may produce unintended consequences. For this reason, it is important to monitor the performance of a process after changes have been implemented. It is also important to ensure that pride of ownership on the part of those who recommended the changes do not interfere with objective monitoring of the changes. These activities are essential regardless of how the improvement effort is structured.

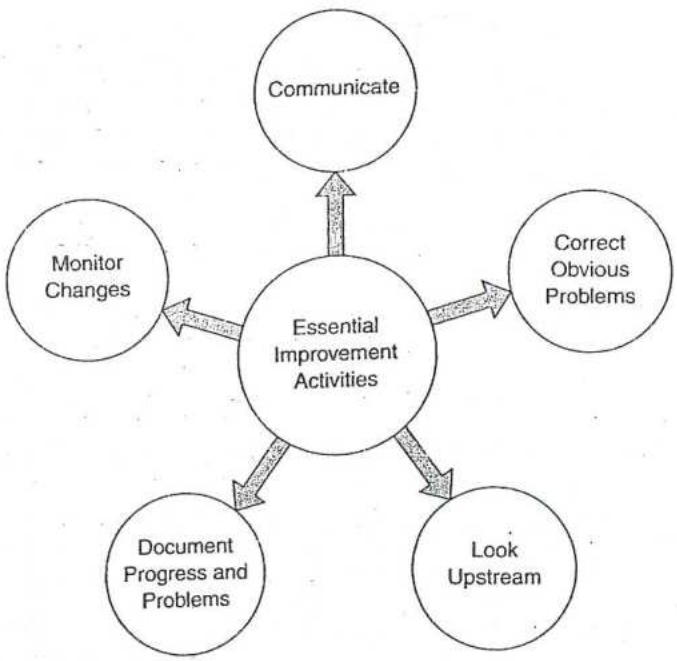


FIGURE 1 Essential Improvement Activities

Improvement Must Be Continual

"Improve constantly and forever the system of production and service. Improvement is not a one-time effort. Management is obligated to continually look for ways to reduce waste and improve quality."

Source: W. Edwards Deming, Cited In Mary Walton, *The Deming Management Method* (New York: Putnam, 1986), 35.

Improvement Is Not Putting Out Fires

W. Edwards Deming said, "Putting out fires is not improvement. Finding a point out of control, finding the special cause and removing it is only putting the process back to where it was in the first place. It is not improvement of the process. [Deming attributed this conclusion to Joseph M. Juran, many years ago.]

"You are in a hotel. You hear someone yell fire. He runs for the fire extinguisher and pulls the alarm to call the fire department. We all get out. Extinguishing the fire does not improve the hotel.

"That is not improvement of quality. That is putting out fires."

Source: W. Edwards Deming, Cited In Mary Walton, *The Deming Management Method* (New York: Putnam, 1986), 67.

STRUCTURE FOR QUALITY IMPROVEMENT

Quality improvement doesn't just happen. It must be undertaken in a systematic, step-by-step manner. For an organization to make continual improvements, it must be structured appropriately and Quality pioneer Juran calls this "mobilizing for quality improvement."[4] It involves the following three steps:[5]

- ***Establish a quality council.*** The quality council has overall responsibility for continual improvement. According to Juran, "The basic responsibility of this council is to launch, coordinate, and 'institutionalize' annual quality improvement."[6] It is essential that the membership include executive-level decision makers.
- ***Develop a statement of responsibilities.*** All members of the quality council, as well as employees who are not currently members, must understand the council's responsibilities. One of the first priorities of the council is to develop and distribute a statement of responsibilities bearing the signature of the organization's CEO. Responsibilities that should be stated include the following: (a) formulating policy as it relates to quality; (b) setting the benchmarks and dimensions (cost of poor quality, etc.); (c) establishing the team and project selection processes; (d) providing the necessary resources (training, time away from job duties to serve on a project team, etc.); (e) launching quality improvement projects; (f) establishing quality measures for monitoring progress and undertaking monitoring efforts; and (g) implementing an appropriate reward and recognition program.
- ***Establish the necessary infrastructure.*** The quality council constitutes the foundation of an organization's quality effort. However, there is more to the quality infrastructure than just the council. The remainder of the quality infrastructure consists of subcommittees of the council that are assigned responsibility for specific duties, project improvement teams, quality improvement managers, a quality training program, and a structured improvement process.

THE SCIENTIFIC APPROACH

The scientific approach is one of the fundamental concepts that separates the total quality approach from other ways of doing business. Scholtes and his colleagues describe the scientific approach as "making decisions based on data, looking for root causes of problems, and seeking permanent solutions instead of relying on quick fixes."[7]

For putting the scientific approach to work in a total quality setting, Scholtes developed four strategies which are as follows:[8]

- Collect meaningful data.
- Identify root causes of problems.
- Develop appropriate solutions.
- Plan and make changes.

Collect Meaningful Data

Meaningful data are free from errors of measurement or procedure, and they have direct application to the issue in question.[9] It is not uncommon for an organization or a unit within it to collect meaningless data or to make a procedural error that results in the collection of erroneous data. In fact, in the age of computers, this is quite common. Decisions based on meaningless or erroneous data are bound to lead to failure. Before collecting data, decide exactly what data are needed, how they can best be collected, where the data exist, how they will be measured, and how you will know the data are accurate.

Identify Root Causes of Problems

The strategy of identifying root causes is important.[10] Too many resources are wasted by organizations attempting to solve symptoms rather than problems. The total quality tools are helpful in separating problems from causes.

Develop Appropriate Solutions

With the scientific approach, solutions are not assumed.[11] Collect the relevant data, make sure they are accurate, identify root causes, and then develop a solution that is appropriate. Too many teams and too many people begin with "I know what the problem is. All we have to do to solve it is . . . ." When the scientific approach is applied, the problem identified is often much different from what would have been suspected if acting on a hunch or an intuition. Correspondingly, the solution is also different.

Plan and Make Changes

Too many decision makers use what is sometimes called the "Ready, fire, aim" approach rather than engaging in careful, deliberate planning.[12] Planning forces you to look ahead, anticipate needs and what resources will be available to satisfy them, and anticipate problems and consider how they should be handled.

Much of the scientific approach has to do with establishing reliable performance indicators and using them to measure actual performance. In his book *Total Manufacturing Management*, Giorgio Merli lists the following examples of useful performance indicators:[13]

Importance of Statistical Thinking

"Statistical thinking is critical to improvement of a system. Only by use of properly interpreted data can intelligent decisions be made."

Source: W. Edwards Deming, Cited In Mary Walton, *The Deming Management Method* (New York: Putnam, 1986), 57.

- Number of errors or defects
- Number of or level of need for repetitions of work tasks
- Efficiency indicators (units per hour, items per person)
- Number of delays
- Duration of a given procedure or activity
- Response time or cycle
- Useability/cost ratio
- Amount of overtime required
- Changes in workload
- Vulnerability of the system
- Level of criticalness
- Level of standardization
- Number of unfinished documents

This is not a complete list. Many other indicators could be added. Those actually used vary widely from organization to organization. However, such indicators, regardless of which ones are actually used, are an important aspect of the scientific approach.

IDENTIFICATION OF IMPROVEMENT NEEDS

Even the most competitive, most successful organizations have limited resources. Therefore, it is important to optimize those resources and use them in ways that will yield the most benefit. One of the ways to do this is to carefully select the areas of improvement to which time, energy, and other resources will be devoted. If there are 10 processes that might be improved, which will yield the most benefit if improved? These are the processes that should be worked on first.

Methodologies for identification of improvement needs include Pareto and the Toyota Practical Problem-Solving model. Another approach is offered by Scholtes and his colleagues. They recommend the following four strategies for identifying improvement needs:[14]

- ***Apply multivoting.*** Multivoting involves using brainstorming to develop a list of potential improvement projects. Team members vote several times—hence the name—to decide which project or projects to work on first. Suppose the original list contains 15 potential projects. Team members vote and cut the list to 10. They vote again and cut it to 5. The next vote cuts the list to 3, and so on until only 1 or 2 projects remain. These are the first projects that will be undertaken.
- ***Identify customer needs.*** An excellent way to identify an improvement project is to give the customer a voice in the process. Identify pressing customer needs and use them as projects for improvement.
- ***Study the use of time.*** A good way to identify an improvement project is to study how employees spend their time. Is an excessive amount of time devoted to a given process, problem, or work situation? This could signal a trouble spot. If so, study it carefully to determine the root causes.
- ***Localize problems.*** Localizing a problem means pinpointing specifically where, when, and how often it happens. It is important to localize a problem before trying to solve it. Problems tend to be like roof leaks in that they often show up at a location far removed from the source.

DEVELOPMENT OF IMPROVEMENT PLANS

After a project has been selected, a project improvement team is established. The team should consist of representatives from the units most closely associated with the problem in question, including the process operator. It must include a representative from every unit that will have to be involved in carrying out improvement strategies. The project improvement team should begin by developing an improvement plan. This is to make sure the team does not take the "Ready, fire, aim" approach mentioned earlier.

The first step is to develop a mission statement for the team. This statement should clearly define the team's purpose and should be approved by the organization's governing board for quality (executive steering committee, quality council, or whatever the group is called). After this has been accomplished, the plan can be developed. Scholtes and his colleagues recommend five stages for developing the plan:

1. ***Understand the process.*** Before attempting to improve a process, make sure every team member thoroughly understands it. How does it work? (This usually requires the development of a process flowchart.) What is it supposed to do? Why is that step necessary? What are the best practices known pertaining to the process? The team should ask these questions and others, and pursue the answers together. This will give all team members a common understanding, eliminate ambiguity and inconsistencies, and shine light on any obvious problems that must be dealt with before proceeding to the next stage of planning.
2. ***Eliminate errors.*** In analyzing the process, the team may identify obvious errors, or potential errors, that can be quickly eliminated. These should be eradicated before proceeding to the next stage. This stage is sometimes referred to as "error-proofing" the process.
3. ***Remove slack.*** This stage involves analyzing all of the steps in the process to determine whether they serve any purpose and, if so, what purpose they serve. In any organization, processes exist that have grown over the years with people continuing to follow them without giving any thought to why things are done a certain way, whether they could be done better another way, or whether they need to be done at all. Few processes cannot be streamlined.
4. ***Reduce variation.*** Variation in a process results from either common causes or special causes. Common

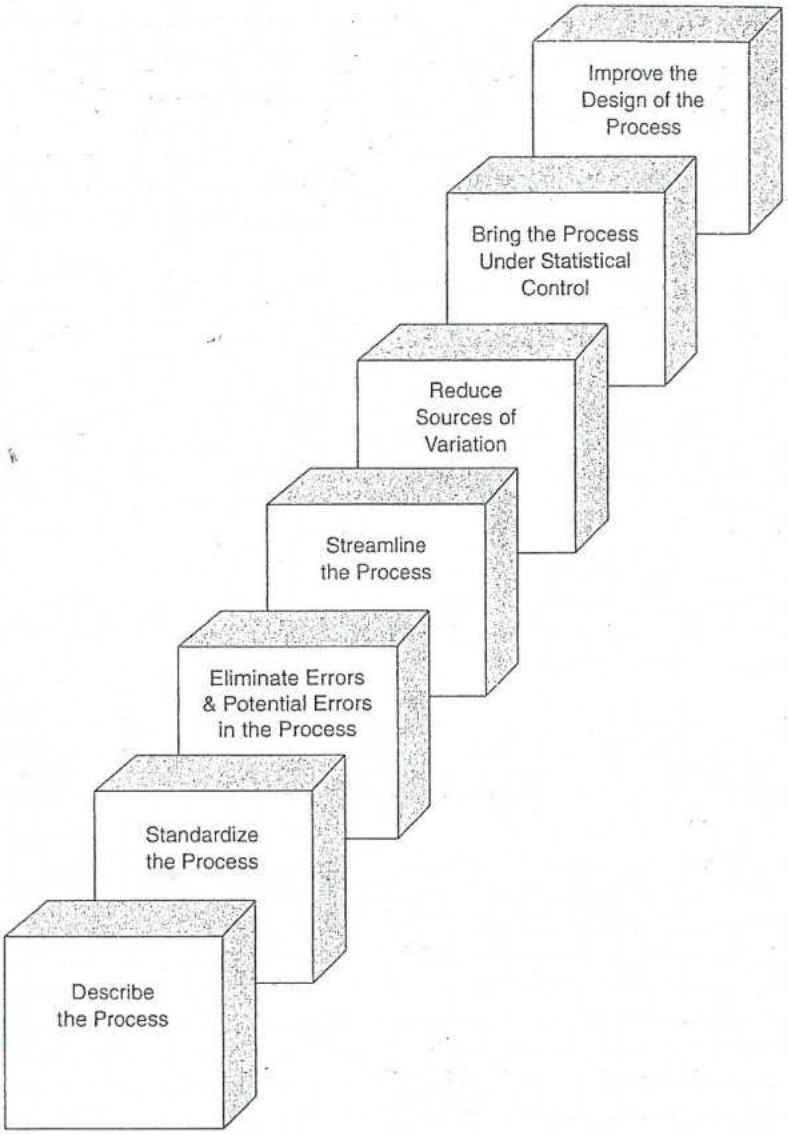


FIGURE 2 Standard Process Improvement Strategies

causes result in slight variations and are always present. Special causes typically result in greater variations in performance and may not always be present. Strategies for identifying and eliminating sources of variation are discussed in the next section.

5. ***Plan for continual improvement.*** By the time this step has been reached, the process in question should be in good shape. The key now is to incorporate the types of improvements made on a continuous basis so that continual improvement becomes a normal part of doing business. The Plan–Do–Check–Adjust cycle applies here. With this cycle, each time a problem or potential improvement is identified, an improvement plan is developed (Plan), implemented (Do), monitored (Check), and refined as needed (Adjust).

COMMON IMPROVEMENT STRATEGIES

Numerous different processes are used in business and industry; consequently, there is no single road map to follow when improving processes. However, a number of standard strategies can be used as a menu from which improvement strategies can be selected as appropriate. Figure 2 shows several standard strategies that can be used to improve processes on a continual basis. These strategies are explained in the following sections.[15]

Describe the Process

The strategy of describing the process is used to make sure that everyone involved in improving a process has a detailed knowledge of the process. Usually, this requires some inves-

Localizing a Problem

"A vehicle repair operation repeatedly found trucks with rusted fuel pumps. Before they could know what caused the rust, they had to localize the occurrence of the problem. They used stratification analysis of data they collected to localize the problem and found that:

- the problem occurred in vehicles using diesel fuel.
- and of those vehicles, only in ones that operated in a certain geographical area.
- and of those, only ones that got fuel from a specific fueling station.

"This information allowed them to zero in on the fueling site, and they discovered a small hole in a pipe feeding the underground tank. Rain water could seep into the tank through the hole. Repairing the leak and preventing its recurrence solved the problem of rusted fuel pumps."

Source: Joseph M. Juran, *Juran on Leadership for Quality: An Executive Handbook* (New York: Free Press, 1989), 28–29.

tigation and study. The steps involved are as follows:

1. Establish boundaries for the process.
2. Flowchart the process (as it is, not as it should be).
3. Make a diagram of how the work flows.
4. Verify your work.
5. Correct immediately any obvious problems identified.

Standardize the Process

To continually improve a process, all people involved in its operation must be using the same procedures. Often this is not the case. Employee X may use different procedures than Employee Y. It is important to ensure that all employees are using the best, most effective, most efficient procedures known. The steps involved in standardizing a process are as follows:

1. Identify the currently known best practices for the process and write them down.
2. Test the best practices to determine whether they are in fact the best, and improve them if there is room for improvement (these improved practices then become the final best practices that are recorded).
3. Make sure that everyone is using the newly standardized process.

Streamline by Reducing Inventory and Lot Sizes

"Large inventories of work-in-process cause many problems. They slow response time to customers, and are usually costly to maintain, and most deadly of all, hide other problems in the process. One cause of large inventories is slow changeovers from job to job, which also cause large lot sizes. This is true of both manufacturing and nonmanufacturing processes."

Source: Peter R. Scholtes, Barbara J. Streibel, and Brian L. Joiner, *The Team Handbook*, 3rd ed. (Madison, WI: Joiner Associates, 1992), 5–61.

4. Keep records of process performance, update them continually, and use them to identify ways to improve the process even further on a continual basis.

Eliminate Errors and Potential Errors in the Process

The strategy of eliminating errors in the process involves identifying errors that are commonly made or which could be made (potential) in the operation of the process and then getting rid of them. This strategy helps delete steps, procedures, and practices that are being done a certain way simply because that is the way they have always been addressed; and those that could be done incorrectly due to ambiguous or incomplete process procedures; or even faulty process design. Whatever measures can be taken to eliminate such errors are carried out as a part of this strategy.

Streamline the Process

The strategy of streamlining the process is used to take the slack out of the process. This can be done by reducing inventory, reducing cycle times, and eliminating unnecessary steps. After a process has been streamlined, every step in it has significance, contributes to the desired end, and adds value.

Reduce Sources of Variation

The first step in the strategy of reducing sources of variation is identifying sources of variation. Such sources can often be traced to differences among people, machines, measurement instruments, material, sources of material, operating conditions, and times of day. Differences among people can be attributed to levels of capability, training, education, experience, and motivation. Differences among machines can be attributed to age, design, and maintenance. Regardless of the source of variation, after a source has been identified, this information should be used to reduce the amount of variation to the absolute minimum. For example, if the source of variation is a difference in the levels of training completed by various operators, those who need more training should receive it. If one set of measurement instruments is not as finely calibrated as another, they should be equally calibrated.

Bring the Process Under Statistical Control

For this discussion, it is necessary to know only that a control chart is planned, data are collected and charted, special causes are eliminated, and a plan for continual improvement is developed.

Improve the Design of the Process

There are many different ways to design and lay out a process. Most designs can be improved on. The best way to improve the design of a process is through an active program

of experimentation. To produce the best results, an experiment must be properly designed, using the following steps:

1. Define the objectives of the experiment. (What factors do you want to improve? What specifically do you want to learn from the experiment?)
2. Decide which factors are going to be measured (cycle time, yield, finish, or something else).
3. Design an experiment that will measure the critical factors and answer the relevant questions.
4. Set up the experiment.
5. Conduct the experiment.
6. Analyze the results.
7. Act on the results.

ADDITIONAL IMPROVEMENT STRATEGIES

In his book *Total Manufacturing Management*, Merli lists 20 strategies for continual improvement that he calls "The Twenty Organizing Points of Total Manufacturing Management."[16] Eighteen of these strategies are still valid (see Figure 3), and are explained in the following paragraphs:[17]

- ***Reduced lead time.*** Raw materials sitting in a storeroom are not adding value to a product. Efficient management of the flow of materials is essential to competitiveness. Lead time can be reduced by evaluating the following factors: order processing time, waiting time prior to production, manufacturing lead time, storage time, and shipping time.
- ***Flow production.*** Traditionally, production has been a stop-and-go or hurry-up-and-wait enterprise. *Flow production* means production that runs smoothly and steadily without interruption. An example illustrates this point. A large manufacturer of metal containers had its shop floor arranged by type of machine (cutting, turning, milling, etc.). All cutting machines were grouped together, all turning machines were grouped together, and all milling machines were grouped together. However, this isn't how the flow of work went. Work flowed from cutting to turning, back to cutting, and on to milling. Arranging machines by type caused a great many interruptions and unnecessary material handling. To improve production efficiency, the machines were rearranged according to work flow. This is often referred to as cellular production. Flow production smoothed out the rough spots and made work flow more smoothly.
- ***Group technology.*** Traditional production lines are straight. With group technology, processes are arranged so that work flows in a U-shaped configuration. This can yield the following benefits: shorter lead times, greater flexibility, less time in material handling, minimum work in progress, flexibility with regard to volume, less floor space used, and less need for direct coordination.
- ***Level production.*** This involves breaking large lots into smaller lots and producing them on a constant basis over a given period of time. For example, rather than producing 60 units per month in one large lot, production might be leveled to produce 3 units per day (based on 20 workdays per month). This strategy can yield the added benefit of eliminating the need to store the materials needed for large lots. This, in turn, makes it easier to implement just-in-time manufacturing.
- ***Synchronized production.*** Synchronized production involves synchronizing the needs of the production line with suppliers of the materials needed on the line. For example, assume that a line produces computers in a variety of different internal configurations. The difference among the configurations is in the capacity of the hard drive installed. Such information as what type of hard drive is needed, in what quantities, at what time, and at what point on the line must be communicated to the hard-drive supplier. The supplier must, in turn, deliver the correct type of hard drive in the correct quantity at the correct time to the correct place on the line. When this happens, synchronized production results.
- ***Overlapped/parallel production.*** This strategy involves dismantling long production lines with large lot capacities and replacing them with production cells that turn out smaller lots. This allows production of different configurations of the same product to be overlapped or run parallel, that is, concurrently.
- ***Flexible schedules.*** Production cells and the ability to overlap production or run it parallel allow for a great deal of flexibility in scheduling. The more options available to production schedulers, the more flexible they can be in developing schedules.
- ***Pull control.*** Pull control is a concept applied to eliminate idle time between scheduling points in a production process, the need to maintain oversized inventories to offset operational imbalances, and the need to plan all target points within a process. With good pull control, work moves through a process uninterrupted by long waiting periods between steps.
- ***Visual control.*** Visual control is an important aspect of just-in-time manufacturing. It is an information dissemination system that allows abnormalities in a process to be identified visually as they occur. This, in turn, allows problems to be solved as they occur rather than after the fact.
- ***Stockless production.*** Stockless production is an approach to work handling, inventory, lead time planning, process balancing, capacity utilization, and schedule cycling that cuts down on work in progress. With stockless production, it is necessary to eliminate process bottlenecks, balance the process, and have an even work flow that eliminates or at least minimizes work in progress. Stockless production and just-in-time go hand-in-hand.

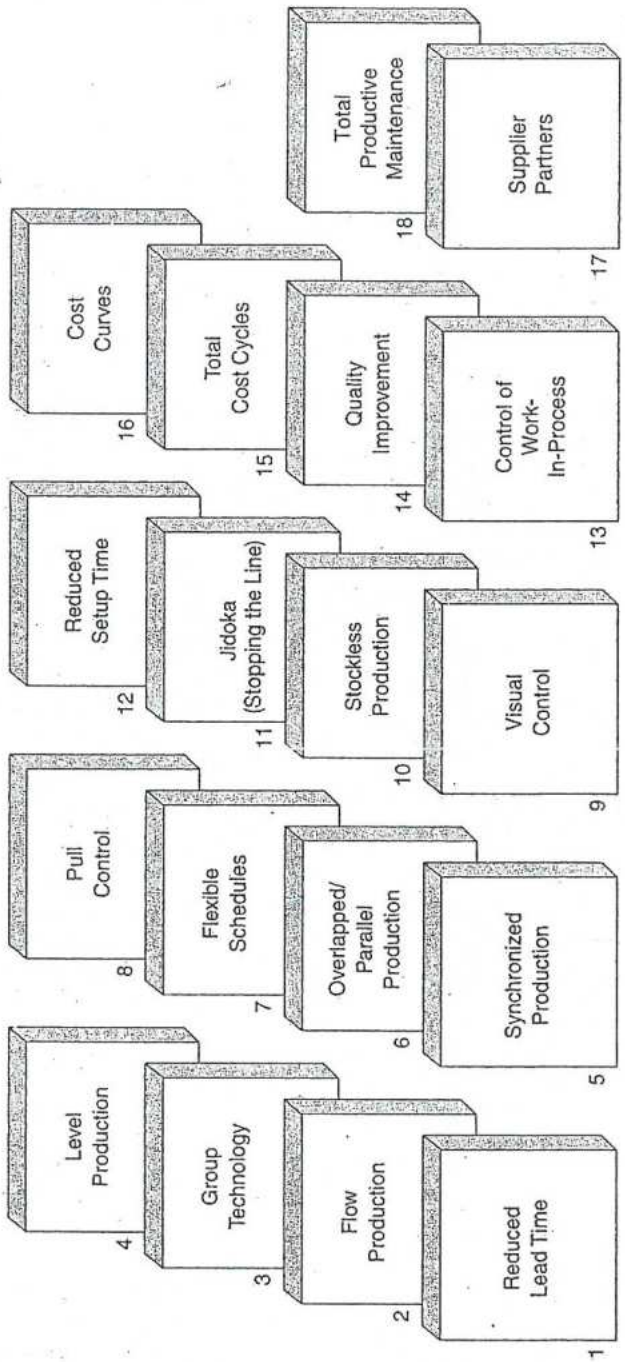


FIGURE 3 Strategies for Continual Improvement

- *Jidoka.* *Jidoka* means halting an entire process when a defect is discovered so that it won't cause additional problems further down the line. *Jidoka* can be accomplished manually, or the line can be programmed to stop automatically, or both.
- ***Reduced setup time.*** This strategy consists of any activity that can reduce the amount of time required to break down a process and set it up again for a different production run. Such things as quick changeovers of tools and dies are common with this strategy.
- ***Control of work-in-process.*** Work-in-process (WIP) often means work that is sitting idle waiting to be processed. Controlling the amount of idle WIP involves organizing for a smoother flow, small lot sizes, process flexibility, pull control, and rapid breakdown and setup.
- ***Quality improvement.*** In addition to improving productivity using the various strategies discussed in this chapter, it is important simultaneously to improve quality. This book is devoted to an approach for continually improving quality. An important point is that productivity and quality improvements are reciprocally supportive.
- ***Total cost cycles.*** This strategy involves basing decisions on the total cost cycle rather than isolated pieces of it. It is not uncommon for decisions to be based on reducing the costs associated with part of a process, although another part of the process may have its cost increased by the decision. True improvements have not been accomplished unless overall costs have been reduced.
- ***Cost curves.*** A cost curve is a graphic representation of a time-based process wherein manufacturing costs accumulate relative to billing. Two types of costs are shown on a cost curve: materials and conversion costs. A cost curve shows graphically how much cost accumulates until the customer is billed for the product. It is a tool to help managers set the optimal point of production.
- ***Supplier partners.*** This strategy amounts to involving suppliers as partners in all phases of product development rather than keeping them in the dark and revealing your activities to them only through the low-bid process. If tested and trusted suppliers know what you are trying to do, they will be better able to maximize their resources in helping you do it.
- ***Total productive maintenance.*** Total productive maintenance (TPM) means maintaining all systems and equipment continually and promptly all of the time. In a rushed workplace, one of the most common occurrences is slacking off on machine and system maintenance. This is unfortunate because a poorly maintained system cannot achieve the quality and productivity needed to be competitive. Poor maintenance can result in the following problems: shutdowns from unexpected damage, increased setup and adjustment time, unused uptime, speeds below the optimum, increased variations, increased waste from defects, and production losses.

THE KAIZEN APPROACH

Kaizen is the name given by the Japanese to the concept of continual incremental improvement. *Kai* means "change" and *zen* means "good." *Kaizen*, therefore, means making changes for the better on a continual, never-ending basis. The improvement aspect of Kaizen refers to people, processes, and products.

If the Kaizen philosophy is in place, all aspects of an organization should be improving all the time. People, processes, management practices, and products should improve continually: "good enough" is never good enough. In his landmark book *KAIZEN: The Key to Japan's Competitive Success*, Masaaki Imai gives an overview of the concept that is summarized in the following paragraphs:[18]

- ***Kaizen value system.*** The underlying value system of Kaizen can be summarized as continual improvement of all things, at all levels, all the time, forever. All of the strategies for achieving this fall under the Kaizen umbrella (see Figure 4). Executive managers, middle managers, supervisors, and line employees all play key roles in implementing Kaizen (see Figure 5).

QUALITY TIP ▼

DENSO Manufacturing Tennessee and Kaizen

DENSO Manufacturing, located in Maryville, Tennessee, is part of a larger global company that produces advanced technologies, systems, and components for the automotive industry. The quality standard for DENSO Tennessee is ISO/TS 16949. In addition, the company has achieved ISO 14001 registration and has been recognized for its commitment to recycling and pollution control. The foundation of DENSO Tennessee's quality program is Kaizen. Kaizen is Japanese for good change ("Kai" = change and "Zen" = good). The good change is continual and it involves all personnel—executives, managers, and employees. The company is also committed to the concept of lean manufacturing.

When DENSO Tennessee was awarded the prestigious Shingo Prize for Excellence in Manufacturing, the following accomplishments were noted:

- TS 16949 and ISO 14001 registrations/certifications
- Recycling rate of 95%
- DENSO Global President's Award for Kaizen
- Reduction of the defect rate by 32% during the period considered
- Warranty cost reduction of 60% during the period in question

By applying the principles of total quality, DENSO Tennessee is able to thrive in the global arena in a field that is intensely competitive. By focusing on continual improvement, the company is able to stay ahead of competitors that are, themselves, committed to organizational excellence.

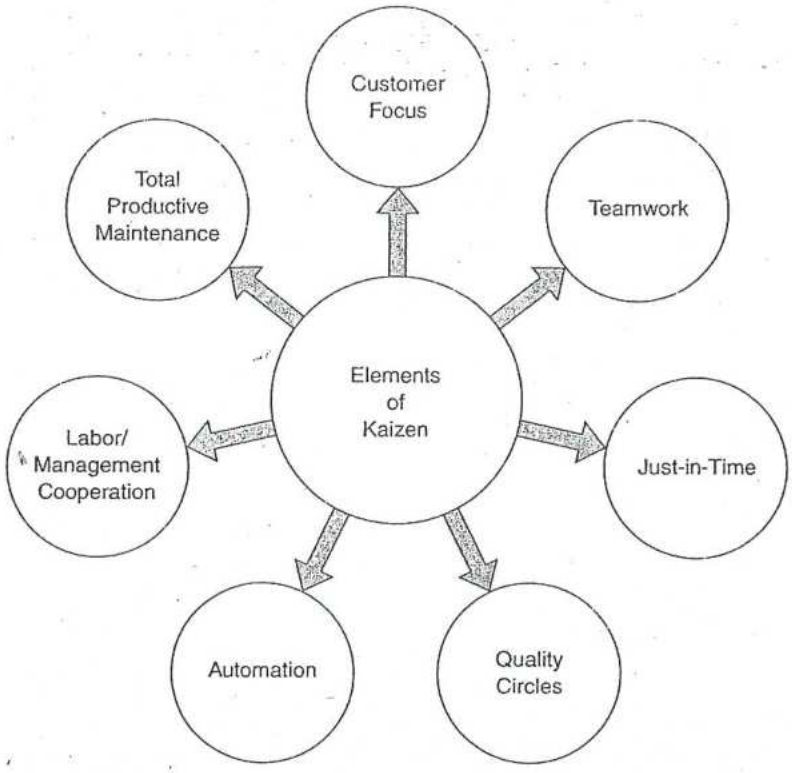


FIGURE 4 Elements of Kaizen

Directions

To promote continual improvement, consider the following factors every day and ask the following question: *"How can this be improved?"*

____ Personnel (at all levels)
____ Work techniques
____ Work methods
____ Work procedures
____ Time
____ Facilities
____ Equipment
____ Systems
____ Software
____ Tools
____ Material
____ Plant layout
____ Production levels
____ Inventory
____ Paradigms (mind-sets)

Comments

_____
_____
_____

FIGURE 5 Kaizen Checklist

- ***Role of executive management.*** Executive managers are responsible for establishing Kaizen as the overriding corporate strategy and communicating this commitment to all levels of the organization; allocating the resources necessary for Kaizen to work; establishing appropriate policies; ensuring full deployment of Kaizen policies; and establishing systems, procedures, and structures that promote Kaizen.
- ***Role of middle managers.*** Middle managers are responsible for implementing the Kaizen policies established by executive management; establishing, maintaining, and improving work standards; ensuring that employees receive the training necessary to understand and implement Kaizen; and ensuring that employees learn how to use all applicable problem-solving tools.
- ***Role of supervisors.*** Supervisors are responsible for applying the Kaizen approach in their functional roles, developing plans for carrying out the Kaizen approach at the functional level, improving communication in the workplace, maintaining morale, providing coaching for teamwork activities, soliciting Kaizen suggestions from employees, and making Kaizen suggestions.
- ***Role of employees.*** Employees are responsible for participating in Kaizen by taking part in teamwork activities, making Kaizen suggestions, engaging in continual self-improvement activities, continually enhancing job skills through education and training, and continually broadening job skills through cross-functional training.
- ***Kaizen and quality.*** In a total quality setting, quality is defined by customers. Regardless of how customers define quality, it can always be improved and it should be, continually. Kaizen is a broad concept that promotes quality from the all-encompassing Big Q perspective.

Kaizen Implementation Tools

Many tools discussed in this text are used in Kaizen. In addition, several are specifically thought of as *Kaizen* implementation tools: *Kaizen* Checklists and the *Kaizen* Five-Step Plan.

Kaizen Checklists

Kaizen is about continual improvement of people, processes, procedures, and any other factors that can affect quality. One of the best ways to identify problems that represent opportunities for improvement is to use a checklist that focuses the attention of employees on those factors that are most likely in need of improvement. These factors include personnel, work techniques, work methods, work procedures, time, facilities, equipment, systems, software, tools, material, plant layout, production levels, inventory, and paradigms (see Figure 5).

Kitchen Kaizen

Illustrating the mind-set of a Kaizen practitioner, a group leader in the weld shop at Toyota's Lexus plant in Cambridge, Ontario, tells this story: He was at a party and needed to dispose of something. To find a disposal site, he went into the expensive new designer kitchen—granite countertops, the latest top-line appliances, and so on. Locating the trash can, he found that the foot-pedal-operated lid stuck open when he released the pedal. The hostess told him that they had just learned to live with it. The Kaizen mind kicked into operation and he had to solve the problem. Before the party was over, he had found that if a certain part of the lid-raising mechanism was turned around, the lid worked perfectly. Kaizen always produces improvement—even in the kitchen.

Source: Lexus magazine, Quarter 1, 2004, 39.

Kaizen Five-Step Plan

The Five-Step Plan is the Japanese approach to implementing Kaizen.[19] Posters bearing the words *seiri, seiton, seiso, seiketsu,* and *shitsuke* can often be found on the walls of Japanese plants. In English, these words mean "straighten up," "put things in order," "clean up," "standardize," and "discipline," respectively.

- ***Step 1: Straighten up.*** This step involves separating the necessary from the unnecessary and getting rid of the unnecessary in such areas as tools, work in process, machinery, products, papers, and documents.
- ***Step 2: Put things in order.*** This step involves putting such things as tools and material in their proper place and keeping things in order so that employees can always find what they need to do the job without wasting time looking.
- ***Step 3: Clean up.*** This step involves keeping the workplace clean so that work can proceed in an efficient manner, free of the problems that can result when the work site is messy.
- ***Step 4: Standardize.*** This step was originally aimed at standardizing how the first three of the Five-S's were implemented and maintained, but since then expanded to include standardizing on best practices. Visual management is also a major component of standardization.
- ***Step 5: Discipline.*** This step involves careful adherence to standardized work procedures. This requires discipline.

Five W's and One H

The Five W's and One H are not just Kaizen tools. They are widely used as management tools in a variety of set-

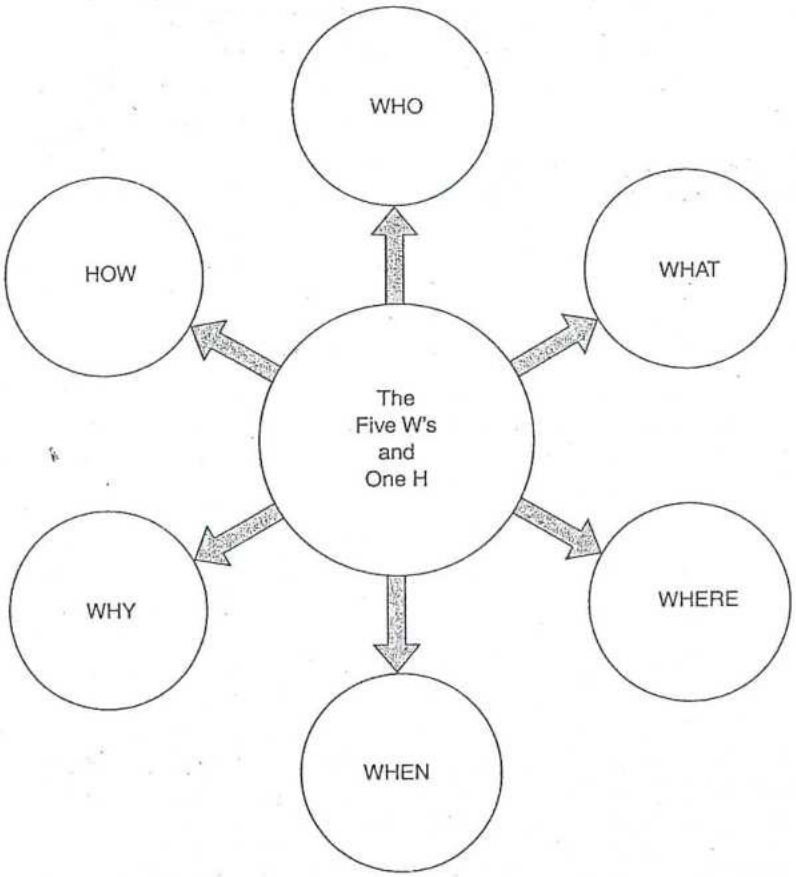


FIGURE 6 The Five W's and One H

tings. The Five W's and one H (see Figure 6) are Who, What, Where, When, Why, and How. Using them encourages employees to look at a process and ask such questions as the following: Who is doing it? Who should be doing it? What is being done? What should be done? Where is it being done? Where should it be done? When is it being done? When should it be done? Why is it being done? Why do it that way? How is it being done? How should it be done?

Five-M Checklist

The Five-M checklist is a tool that focuses attention on five key factors involved in any process.[20] The Five M's are man (operator), machine, material, methods, and measurement (see Figure 7). In any process, improvements can be made by examining these aspects of the process.

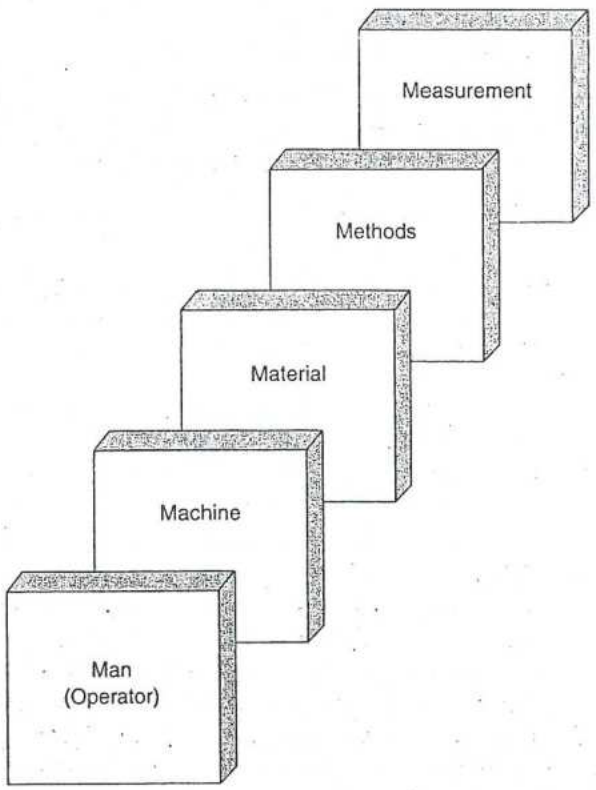


FIGURE 7 The Five M's Of Processes

THE CEDAC APPROACH

CEDAC is an acronym for *cause-and-effect diagram with the addition of cards.*[21] It was originally developed by Dr. Ryuji Fukuda of Sumitomo Electric, a Japanese manufacturing firm. Its purpose is to facilitate continual improvement in the workplace.

$$Density = \frac{Number\ of\ employees\ with\ mastery^*}{Total\ number\ of\ employees}$$

For example:

Employees with mastery = 60
Total number of employees = 100

$$\frac{60}{100} = 60\%\ density$$

*Employees who are skilled at using the improvement system.

FIGURE 8 Calculating the Density of Skilled Employees

CEDAC is based on the supposition that three conditions must exist in order for continual improvement to occur. Fukuda explains these conditions as follows:[22]

- ***A reliable system.*** For continual improvement to occur, there must be a standardized, reliable system. A system that is reliable will yield the same results regardless of who uses it, provided it is applied properly and according to standard procedures.
- ***A favorable environment.*** Continual improvement will not occur unless an environment favorable to it exists. The keys to creating and maintaining an environment favorable to continual improvement are leadership and education. Leadership manifests itself in the form of commitment, both to the concept of continual improvement and to the allocation of the necessary resources. Education is how employees become skilled in the use of the improvement system. The higher the density of employees who are skilled in the use of the improvement system, the better, Density is expressed as a percentage (see Figure 8).
- ***Practicing as teams.*** Like all endeavors requiring skills, continual improvement strategies must be practiced. Because in a total quality setting work is performed by teams of employees, it is important for team members to practice together.

As teams practice, it is important for individual members to understand that improvements may come only in small increments. This is not merely acceptable; it is also desirable. In a competitive situation, the difference between winning and losing is often quite small.

In the United States, instant replay of sports events and big plays broadcast during the sports portion of the nightly news have accustomed people to last-minute game-winning home runs in baseball, desperation baskets just before the buzzer in basketball, and clock-beating 60-yard touchdown passes in football. What the camera does not show is all of the small, incremental improvements that put these teams in a position to win with one dramatic play in the final seconds of the game. This is unfortunate because a home-run mentality can mitigate against an organization's ability to make the small incremental improvements that can mean the difference between winning and losing.

The CEDAC system can be divided into two main parts (see Figure 9). Each part is subdivided into several related activities. In part 1, a problem is identified. Quality tools are used to analyze the problem. Based on

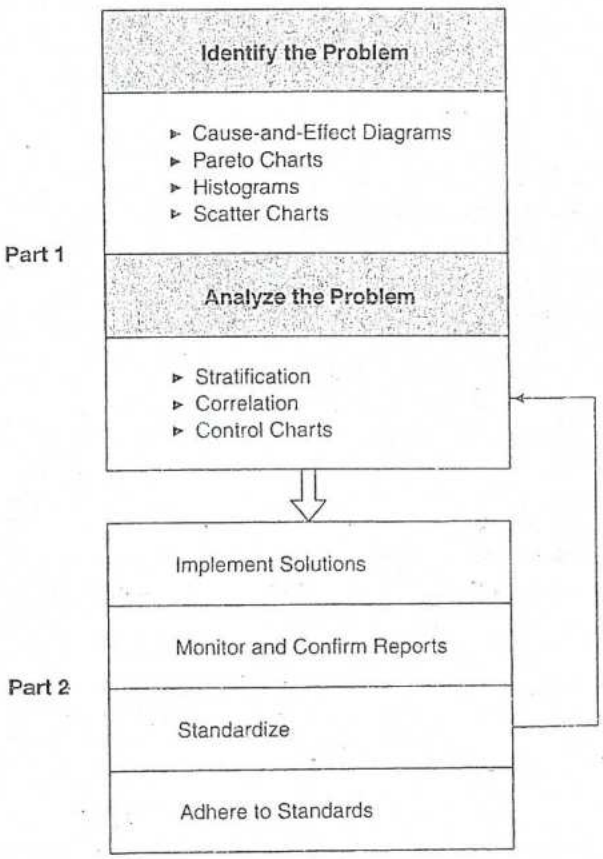


FIGURE 9 CEDAC System

Leadership Means Committing Resources

"[I]t is the higher managers who have the decisive power over the allocation of the necessary resources, such as manpower, material, money, and time. Therefore, one of the crucial ways that leaders demonstrate their commitment is to allocate those resources properly to the company's improvements."

Source: Ryuji Fukuda, *CEDAC: A Tool for Continuous Systematic Improvement* (Cambridge, MA: Productivity Press, 1989), 39.

the analysis, solutions are implemented in part 2. Results are monitored and confirmed. If the results are positive, the procedures that solved the problem are standardized, and these new standard procedures are followed by all employees. If the desired results are not achieved, the team returns to part 1 to analyze the problem again.

Developing a CEDAC Diagram

Figure 10 summarizes the main steps in developing a CEDAC diagram.[23] Instructions for these steps are contained in the following paragraphs:

1. ***Draw the basic diagram.*** The CEDAC diagram should be drawn with the cause side on the left and the effect side on the right. Using CEDAC is a team activity. Consequently, the basic diagram should be large enough to attach to a wall so that it can be reviewed by team members at any point in the process. The cause side is a fishbone diagram with the addition of cards to the left of each spine. The effect side can be any of various tools (e.g., a control chart or a Pareto chart). Figure 11 is an example of a basic diagram laid out but not yet containing any information. Such a diagram might be as large as 4 × 6 feet or even larger.

2. ***Select the focus of improvement efforts.*** What is the focus of the CEDAC project? What problem is to be attacked?

- ✓ 1. Draw the basic diagram.
- ✓ 2. Select the focus of the improvements to be made.
- ✓ 3. Name a project leader.
- ✓ 4. Establish a way to measure improvements on the effect side.
- ✓ 5. Establish the improvement goal and projected date of attainment.
- ✓ 6. Format the effect side of the diagram.
- ✓ 7. Collect fact cards for the cause side of the diagram.
- ✓ 8. Develop improvement cards.
- ✓ 9. Implement proposed improvements, monitor, and measure results.
- ✓ 10. Select the best improvement cards for standardization.

FIGURE 10 Ten-Step Checklist: Developing a CEDAC Program

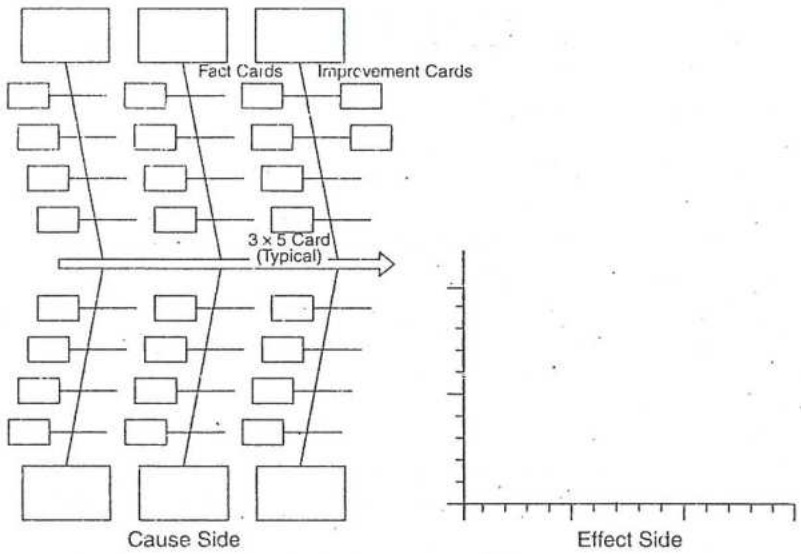


FIGURE 11 CEDAC Diagram

Quality tools can be used to identify the improvement that has the most potential.

3. ***Name a project leader.*** A CEDAC diagram relates to one specific improvement project and should have its own project leader. This is the person responsible for organizing, facilitating, monitoring, and completing the project.

4. ***Establish a measurement method.*** Improvements tried as part of the CEDAC process should result in improvements on the effect side of the diagram. These results must be measurable. Does the improvement decrease waste? Improve throughput? Reduce defects? These are improvements that can be measured. Regardless of the focus of the project, establish measures for documenting success or failure.

5. ***Establish an improvement goal and date.*** The improvement goal and projected target date are established by the project leader. It is important for this person to communicate why the goal and target date are important by relating them to the organization's ability to compete.

6. ***Format the effect side of the diagram.*** The actual format for the effect side of the CEDAC diagram must be decided on at this point. The preliminary chart prepared in the first step must be finalized. It can be a Pareto chart, a histogram, a control chart, or any other type of quality tool. The actual format selected should be the one that best communicates the necessary facts relating to the project. Figure 12 is a format that might be used if the project goal is to reduce throughput time by 50% over a 24-week period or any similar goal.

7. ***Collect fact cards for the cause side.*** The goal is to reduce throughput time by 50% within 24 weeks. All members of the project team should examine the problem and commit their ideas as to why throughput time is as high as it is to cards (e.g., 3 × 5 cards). These cards are known as *fact cards*. The fact cards should be sorted into general categories (material, manpower, methods, etc.). After all cards have been sorted into categories, the spines on the cause side of the CEDAC diagram are labeled to correspond with these categories. Cards in each category are examined and combined where appropriate. Remaining cards are then attached to the left of the horizontal lines along the spines, as shown in Figure 11.

8. ***Collect improvement cards.*** Each fact card attached to the CEDAC diagram contains a description of some factor that contributes to increased throughput time. Each of these factors should be eliminated. To do this, improvement cards are collected from members of the project team. These cards correspond to the fact cards and contain a recommendation for eliminating the factor described on the corresponding fact card. Improvement cards are attached to the right of the horizontal lines along the spines, as shown in Figure 11.

9. ***Implement and test improvement ideas.*** Improvement ideas should be carefully evaluated for credibility before being attached to the CEDAC diagram. However, after an improvement card is attached, the idea it contains should be implemented and the results monitored and recorded on the effect side of the diagram.

10. ***Select cards for standardization.*** Improvement ideas that fail to reduce throughput time (see Figure 12) should be discarded. Those that work best should be written in as standard procedures in the process in question. After an idea is standardized, it should be adhered to strictly by all personnel.

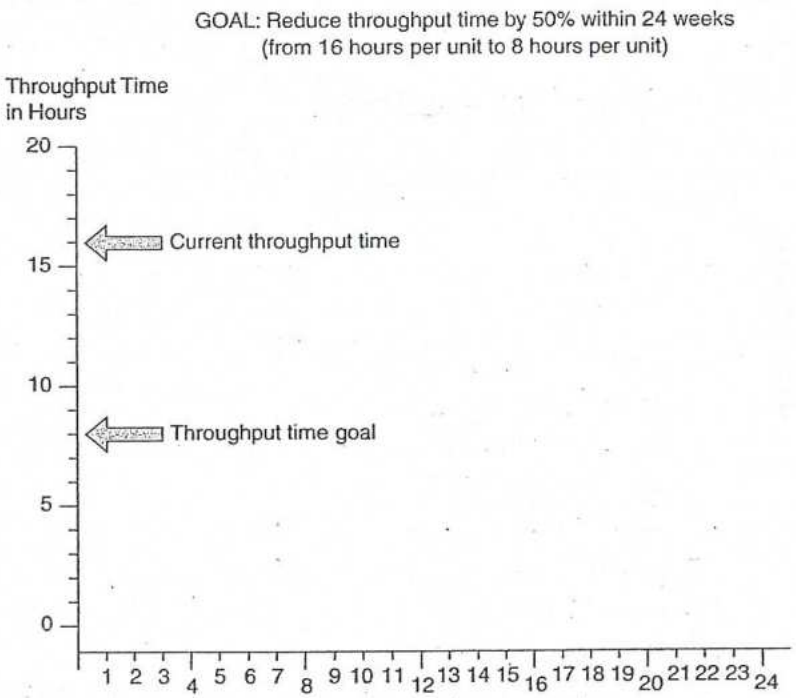


FIGURE 12 CEDAC Diagram: Effect Side

THE LEAN APPROACH

Lean was originally developed as a manufacturing concept and, as such, is often referred to as *lean manufacturing*. However, as has happened with so many quality management–related concepts, the service sector—impressed with the results enjoyed by practitioners of lean manufacturing—began to adopt and adapt the concept to this sector. Consequently, we use the term *Lean* in this text to convey the message that the concept can be applied with good results in the manufacturing and service sectors. The purpose of adopting Lean as a business improvement method is to produce better products or deliver better services using fewer resources. If the concept had a motto, it would be this: *doing more with less and doing it better.*

Lean Defined

Lean as a concept is based on the Just-In-Time Toyota Production System (TPS) developed at Toyota Motor Corporation by Japanese quality pioneer Taiichi Ohno. Ohno's work incorporated the earlier work of Sakichi Toyoda and Kiichiro Toyoda, the latter being the founder of Toyota Motor Corporation. Lean is a somewhat generic version of the TPS.[24] A Lean operation is one in which a better product is developed or a better service is delivered using *less of everything required* (i.e., human, financial, technological, and physical resources). Lean is about being flexible enough to get the right things, to the right place, at the right time, in the right amounts. At the heart of the concept are the reduction of waste and the improvement of work flow.

The reduction of waste approach to Lean implementation grew out of Toyota's desire to eliminate waste in manufacturing processes. Lean focuses on reducing and, ideally, eliminating the following types of waste:[25]

- ***Overproduction waste.*** This amounts to making more of a product or delivering more of a service than is needed or more than is needed at the moment. In a manufacturing setting, this might mean producing 100 parts when only 50 are needed. In a service setting, it might mean pumping 20 gallons of gas for a customer who wanted only 15.
- ***Inventory waste.*** This amounts to carrying more inventory than is needed at a given time. The concept of *just-in-time delivery* has the reduction of inventory as part of its broader purpose. In a manufacturing setting, this might mean having more parts stack up at an assembly station than can be used for a given production run. In a service setting, this could mean a bookstore carrying more copies of a given book than it is likely to sell.
- ***Motion waste.*** This amounts to incorporating unnecessary movement into the production process or into the delivery of services. This was one of the targets of the time and motion studies conducted by Frederick Taylor, who, in 1911, published the classic book *The Principles of Scientific Management.* In a manufacturing setting, this might mean programming too many motions into a CNC milling machine. In a service setting, it might mean having to move around the office several times to obtain everything needed to complete paperwork.
- ***Transportation waste.*** This amounts to excess movement of parts in a manufacturing setting. In a service setting, it typically means excess movement of people. In a manufacturing setting, this might mean that a part is machined at one side of the shop and must be transported all the way to the other side in order to be finished or incorporated as part of an assembly. In a service setting, it might mean having to transport patients to one end of a hospital for a given test and all the way to the other for another type of test.
- ***Overprocessing waste.*** This amounts to going beyond customer requirements in ways that create no additional value when producing a product or doing more than the customer wants in a service setting. A manufacturing example would be holding a given part to tighter tolerances than required in the specifications when the application of the part will not be improved by tighter tolerances. The classic service example is the sales representative who holds up a customer by continuing to talk after already making the sale.
- ***Defects waste.*** This amounts to creating rejected work or causing rework as the result of production or processing errors. In manufacturing, an example of a defect would be a part that is faulty because it does not meet customer specifications. In a service setting, it might mean having to rewrite an insurance policy because of calculation errors in writing the original policy.
- ***Waiting waste.*** This amounts to people, machines, or processes idling because something that is needed is not yet available. In a manufacturing setting, it might involve an expensive machine and its operator sitting idly because the parts they are to work on have not been delivered. In a service setting, the classic example is the airliner idling on the taxiway waiting for clearance to take off.
- ***Underutilization waste.*** This amounts to underuse of the talent, skills, and creativity of people and the capabilities of technology. In a manufacturing setting, it might involve failing to include the people who operate processes in brainstorming sessions aimed at improving the performance of those processes. In a service setting, it might mean using a sophisticated word processing system like it is just a typewriter with a visual display monitor.

Tools and Techniques of Lean

The tools and techniques of Lean will be familiar to students of quality management. However, Lean is not just about the application of these tools. It is also about how they are applied and in what order. The tools and techniques most commonly associated with Lean are as follows:[26]

- *Five-S workplace organization.* The Five-S's come from five Japanese words that translate into English as sort, store, shine, standardize, and sustain. Five-S as a tool is used to ensure a neat, clean, and orderly workplace, one that is conducive to peak performance and continual improvement.
- *Visual workplace systems.* This tool is used to promote ease of communication. It amounts to using visual aids such as signs, lines, labels, and color coding so that no one has to guess where to go or what to do.
- *Layout.* This tool is used to achieve the optimum plant layout so that motion and transportation waste are minimized. The idea is to get work that is input for another process as close as possible to that process to reduce unnecessary motion and transportation.
- *Standardized work (SW).* This tool is used to ensure that processes involving repetitive tasks are being done in the most efficient and productive manner and that all who operate the processes do them in the same way. This prevents the introduction of human and process errors.
- *Point of use storage (POUS).* This tool is used to ensure that the tools and parts needed at a given workstation are stored conveniently near that station. POUS helps minimize movement and transportation waste.
- *Batch size reduction.* This tool is used to achieve efficiency for the entire system rather than for a given process within the system. It helps ensure that work flows smoothly and continuously from one process to the next rather than bunching up at any given workstation or any part of a given process.
- *Quick changeover (QCO).* This tool is used to make process conversions as rapidly as possible. It might involve changing tools quickly in a manufacturing setting or changing a room for a different purpose in a service setting. Regardless, this tool helps eliminate time wasted in making process changes.
- *Poka-yoke.* This tool is used to error-proof a process to the extent possible. It is Lean's answer to that old maxim "Anything that can go wrong will go wrong." Poka-yoke is especially important for situations where there is the potential for human error. It amounts to asking the question "What could go wrong here?" when setting up a process and then finding ways to eliminate or at least minimize the potential errors identified.
- *Self-inspection.* This tool involves having personnel check their own work rather than just passing along errors to the next step in the process. In order to apply this tool, individual employees must be trained, provided with inspection standards, given the necessary inspection equipment, and allowed the time necessary to complete inspections.
- *Autonomation.* The word itself means "automation with a human touch." This tool is used to build automatic alarms/process notifications into the system so that when a problem of any kind arises, a human being is notified and can intervene to solve the problem. For example, a robot that experiences some type of malfunction might shut down, thereby setting off an alarm that will notify a human operator of the need to intervene.
- *Pull systems/kanban.* This tool is used to provide a visual method—*kanban* is the Japanese word for "sign"—that lets one step in the process know that the next step is ready for its output. The sign or other type of notification is the "pull" that asks for the output.
- *Cellular and flow.* This tool is used to ensure a steady and consistent flow of work through the system's cells. When the output of one cell in the process sits idly waiting to be used in the next cell, time is wasted. A steady, continuous flow of work is more efficient. This is the opposite of the old "hurry up and wait" phenomenon.
- *Just-in-time (JIT).* This tool is used to ensure that items are delivered to the next cellular step in the process just in time to be used. JIT is the antidote to work piling up at one station while another station has nothing to work on.
- *Total productive maintenance (TPM).* This tool is used to ensure that all equipment in a system and all parts of all processes that make up the system are in good condition and ready for use when called on. With TPM, equipment maintenance becomes a normal part of the process. TPM uses process operators in many maintenance procedures.
- *Value stream mapping (VSM).* This tool uses symbols to describe a value stream. It is implemented in four steps: (1) identify the process groups (of tasks), (2) develop a map of the current state, (3) develop a map of a desired future state, and (4) develop a plan to achieve the future state map. VSM is a continual process, since every process can and should be improved continually. This is the Japanese concept of *Kaizen*.
- *Change management.* Continual improvement is fundamental to Lean, and improvements do not happen unless changes are made. This tool is used to effectively manage change so that human resistance is minimized. An effective approach to managing change is as follows: (1) create a comprehensive word picture of how things will be different and better after the change (write it from the perspective of the process operators—those who will be affected most by the change and who will have to implement it); (2) communicate the change picture to all stakeholders; (3) give stakeholders opportunities to ask questions, make comments, voice concerns, and vent; (4) ask process operators to identify any roadblocks to successful implementation of the change that you might not have anticipated, and take the steps necessary to eliminate or mitigate these roadblocks; (5) implement, monitor, and adjust; and (6) incorporate

the change into the process so that it becomes the normal approach until it is changed as the result of a subsequent process improvement.

- *Teamwork.* This tool is used to ensure that all other aspects of Lean can be implemented effectively. Lean, like all quality management concepts, is by its nature a team-oriented enterprise. The better teamwork is working in the organization, the better the results of Lean will be.

THE SIX SIGMA APPROACH

In 1981, Robert Galvin, who was the president of Motorola, issued a challenge to his company: *Improve performance tenfold over the next 5 years.* Motorola responded and achieved the goal. That led the company to its next challenge. Galvin, by then versed in some work being done in Motorola's Communications Sector with the goal of Six Sigma quality, called for 10 times improvement in each of the next 2-year periods, and achieving Six Sigma quality throughout the corporation by 1992. That required a staggering 100 times improvement in all operations of the company. It was not achieved by 1992, but by that year it was clear that this was the right thing to do. By 1993, many of Motorola's manufacturing operations were operating at or near Six Sigma.[27]

In the first 10 years following Galvin's Six Sigma Challenge, and as a direct result of the Six Sigma Efforts, Motorola claimed to have saved several billions of dollars which went directly to the bottom line as profit. Sales increased by a factor of five, and profits increased by nearly 20% each year.[28] Other companies that have adopted Six Sigma report similar gains.

As the word of Six Sigma spread, other organizations took up the challenge. CEO Jack Welch committed General Electric to Six Sigma (1995). Allied Signal (1994) and Honeywell (1998)—the two now combined under the name of Honeywell International Inc.—were other very large companies that took on Six Sigma. They were soon followed by Ford (2000) and a host of others. A decade into the twenty-first century, rooted in total quality management, Six Sigma enjoys widespread application across many industrial and service sectors. Applicability of Six Sigma is not limited to manufacturing concerns. Albertsons, and parent supermarket chain Supervalu, figure their Six Sigma savings from 2002 through 2008 in the hundreds of millions of dollars.[29] Six Sigma is even finding application in the military. In 2008, the U.S. Army recorded savings of $2 billion from four Six Sigma initiatives involving such disparate projects as[30]

- More efficient meal scheduling
- Streamlining communications through the chain of command
- Reducing the recruiting process from 32 steps to 11
- Better management of clothing outlet inventory

Six Sigma is one of the most innovative developments to emerge out of the total quality movement. Its purpose is to improve processes to the point where the defect rate is 3.4 per million or less, thereby making the company more competitive, profitable, and successful. Originally designed for use in high-volume production settings, it has nonetheless been found equally suited to service organizations, including the military, hospitality industry, supermarkets, and so on. Its benefits include the following:[31]

- Cost reduction
- Productivity improvement
- Market-share growth
- Customer retention
- Cycle-time reduction
- Culture change
- Product/service development

Modern products and services have many built-in opportunities for defects. In manufacturing, for example, most good companies try to operate in the 3-sigma to 4-sigma region. The number of defects from such a company will range between 63 and 2,700 defects per million. The Six Sigma companies expect just 3.4 defects per million.

Motorola won the Malcolm Baldrige National Quality Award in 1988 for its pioneering efforts in the development of the Six Sigma concept. The central core of the Six Sigma concept is a six-step protocol for process improvement. The six steps are as follows:

1. Identify the product characteristics wanted by customers.
2. Classify the characteristics in terms of their criticality.
3. Determine if the classified characteristics are controlled by part and/or process.
4. Determine the maximum allowable tolerance for each classified characteristic.
5. Determine the process variation for each classified characteristic.
6. Change the design of the product, process, or both to achieve a Six Sigma process performance.

It is important to note that the Six Sigma concept is a subset of the broader concept of total quality. Six Sigma is a strategy within the context of total quality that moves the target to a much higher level of quality than organizations have achieved in the past. It is not a concept that supplants or replaces total quality. Rather, it is an innovative way to pursue a higher level of quality under the broad umbrella of total quality.

Six Sigma Belts, Champions, and Executives

Unlike Total Quality Management (TQM), the Toyota Production System and Lean, Six Sigma has a defined organizational hierarchy of Six Sigma expertise and experience for

the organization implementing practices and operating Six Sigma projects. These hierarchical levels are named as follows:

- *Executive (CEO, Top Management).* Establish Six Sigma vision for the organization. Empower subordinate Six Sigma leaders. Provide necessary resources for the implementation/projects.
- *Champion.* Trained in Six Sigma methodology and selection of Six Sigma projects that are aligned with business objectives. Executive designates Champions from upper management to identify Six Sigma projects, align and integrate them with the organization's goals and vision. Select and mentor Six Sigma project leader "Belts."
- *Master Black Belt.* Identified by Champions to be cross-functional in-house Six Sigma consultants/facilitators/coaches. Assist Champions in identification of Six Sigma projects. Has extensive project management experience, and thorough mastery of Six Sigma methodology and tools. Guides and mentors Black and Green Belts. Usually full-time Six Sigma employees.
- *Black Belt.* Has significant Six Sigma training. Primarily engaged in leading Six Sigma project execution under the Master Black Belts.
- *Green Belt.* Has Six Sigma training. Project leaders engaged in Six Sigma implementation/projects, operating under guidance from the Black Belts.

If this sounds like a martial arts system, it is for a good reason. In the early days of Six Sigma the folks who were involved in implementation of the practices or execution of the projects needed the aura of authority (and maybe with some intimidation thrown in) carried by a martial arts Black Belt. Motorola could have simply set up the same certification levels, calling them Level 1, Level 2, or Master, Journeyman, and so on, but the Belt nomenclature had a more dynamic ring to it, and it has endured. Although there is no central clearing house for Six Sigma certification, Motorola, the American Society for Quality, the Institute of Industrial Engineers, and many other organizations offer individuals Six Sigma certification.

Key Personnel Preparation and Roles in Six Sigma

One of the strengths of Six Sigma is its emphasis on preparation of the key personnel who will be responsible for its deployment and ongoing operation.[32] This preparation, coupled with well-defined roles for personnel, adds to the potential of this continual improvement method. Advocates of Six Sigma take a four-pronged approach to deploying the concept: (1) understand the concept and all of its component elements, (2) train key personnel who will be the organization's Green and Black Belts, (3) make sure that the organization's Green and Black Belts are provided the environment needed for success by key decision makers who serve as Champions of the Six Sigma deployment, and (4) provide Master Black Belts to support, guide, instruct, mentor, and assist the Black Belts.

Green Belts are selected personnel in an organization who have completed basic training in the application of DMAIC Roadmap and the various tools associated with it. Black Belts have completed more advanced training in the application of DMAIC and the associated tools. Master Black Belts are Black Belts who have shown themselves to be self-reliant, self-motivated, and excellent problem solvers and who, as a result, have been allowed to complete additional training. Master Black Belts, as a result of their additional training, have a broader array of tools to apply in solving problems. These additional tools become especially important when an improvement project being run by a Black Belt becomes bogged down or hits a roadblock.

Champions, in the long run, represent the most important component in the deployment of Six Sigma. Champions, as the name implies, are key decision makers in an organization who "champion" the cause of effective Six Sigma deployment. They provide an environment in which Six Sigma can be effectively employed. They support the concept and those tasked with applying it. When problems arise between a Black Belt and anyone else in the organization, Champions step in to defuse the situation before it throws the Six Sigma deployment off track. This is especially important when a Black Belt faces resistance from a manager who is higher in the organization.

Mike Carnell and Scot Shank describe an effective Champion as "a hybrid of Henry Kissinger and Xena, the Warrior Princess."[33] By this, they mean that good Six Sigma Champions are both diplomat and warrior and they know when to be which. In addition, Champions must be proficient in: (1) business and operations interface, (2) project selection, (3) pace mediation, and (4) results implementation.[34]

DMAIC Roadmap

The nucleus of Six Sigma is the Define, Measure, Analyze, Improve, and Control or DMAIC Roadmap. Although the five phases of the roadmap concept are constant, the steps, tools, and outputs of each phase can vary slightly, depending on the type of organization and the exigencies of that organization. An excellent model of a DMAIC Roadmap for Six Sigma was developed by Sigma Breakthrough Technologies Inc. The explanations in the remainder of this section are based on this model roadmap.[35] For each phase, there are steps, associated tools, and outputs. The steps and outputs are summarized in the following paragraphs, along with a sampling of some of the tools that might be used.

Define In this phase of the roadmap, users (1) initiate the project, (2) define the process, (3) determine customer requirements, and (4) define key process output variables. These steps lead to the following outputs: the project charter, the project team, and a list of clear customer requirements. Some of the tools that might be used in this phase include SIPOC maps (see Figure 13), value stream maps,

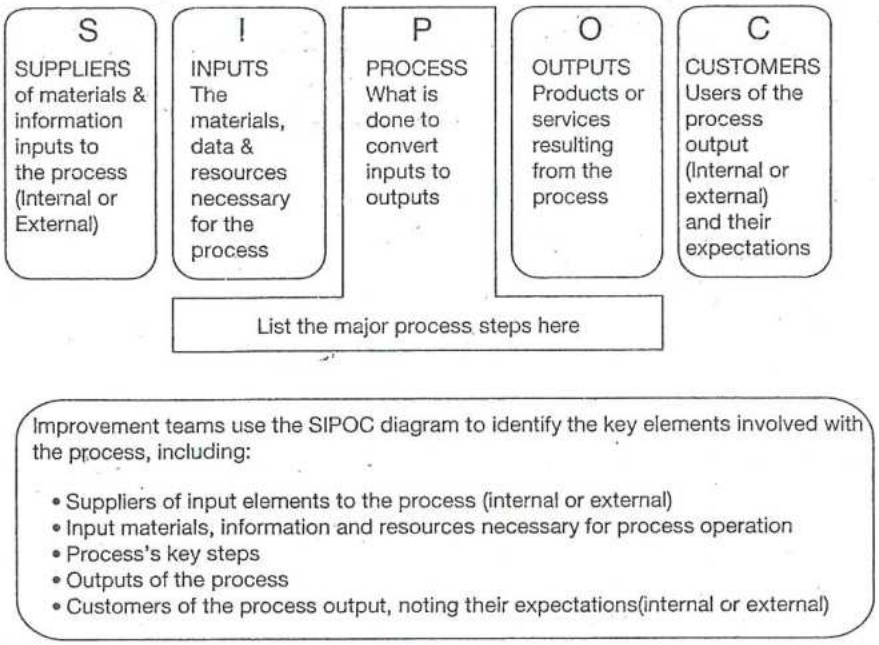


FIGURE 13 SIPOC Diagram

affinity diagrams, brainstorming, Murphy's Analysis, customer requirement trees, and surveys.

Measure In this phase, users (1) understand the process, (2) evaluate risks on process inputs, (3) develop and evaluate measurement systems, and (4) measure current performance. These steps result in the following outputs: current state process maps, identified and measured Xs or Key Process Input Variables (KPIVs), verification of measurement systems, and current capability of Ys or Key Process Output Variables (KPOVs). Some of the tools that might be used in this phase include SIPOC/Value Stream Mapping, input/output analysis, detailed process maps, FMEA, data collection plans, data integrity audits, and C&E matrices.

Analyze In this phase, users (1) analyze data to prioritize key input variables and (2) identify waste. These steps result in the following outputs: root causes of defects that are reduced to the vital few, a prioritized list of potential key inputs, and a list of specific wastes. Some of the tools that might be used in this phase include statistical process control (SPC), T-tests, analysis of variance (ANOVA), nonparametrics, chi square regression, Five-S, and multivariable studies.

Improve In this phase, users (1) verify critical outputs, (2) design improvements, and (3) pilot the new process. These steps result in the following outputs: a final list of KPIVs, an action plan for improvement, future state process maps, FMEA, control plans, new process design/documentation, and a pilot study plan. Some of the tools that might be used in this phase include design of experiments, kanban, mistake-proofing, quick changeover, process mapping, process documentation, training plans, SPC, FMEA, and control plans.

Control In this phase, users (1) finalize the control system and (2) verify long-term capability. These steps result in the following outputs: a control system, improvement validated for the long term, identified continual improvement opportunities, handoff of the new process, and team recognition. Some of the tools that might be used in this phase include control plans, process documentation, training plans, SPC, and process capability.

Six Sigma: The Name

The name Six Sigma comes from the concept of standard deviation, a statistically derived value represented by the lowercase Greek letter sigma (σ). The variation of processes and their output products is typically measured in the number of standard deviations from the mean (usually the ideal point).

The well-controlled processes of most good companies presently operate between 3 and 4 sigma. This means 99.73% of the output of a process will fall between plus and minus three standard deviations at 3 sigma, or 99.9937% at 4 sigma. If the specification (such as a required dimension with a tolerance) for parts produced by the process should correspond to the $\pm 3\sigma$ values, then a 3-sigma process will yield 2,700 defective parts for every 1 million produced. (See Figure 14.)

Let's assume that the specifications describing acceptable product remain constant and that through some improvement we are able to decrease process variation to the point that its new 6-sigma deviation corresponds to the positions of the old 3-sigma values. (See Figure 15.) Now if everything else remains constant, the process will yield 99.9999998% acceptable product, or a mere 0.002 defective parts per million. In this case, the process is performing at a

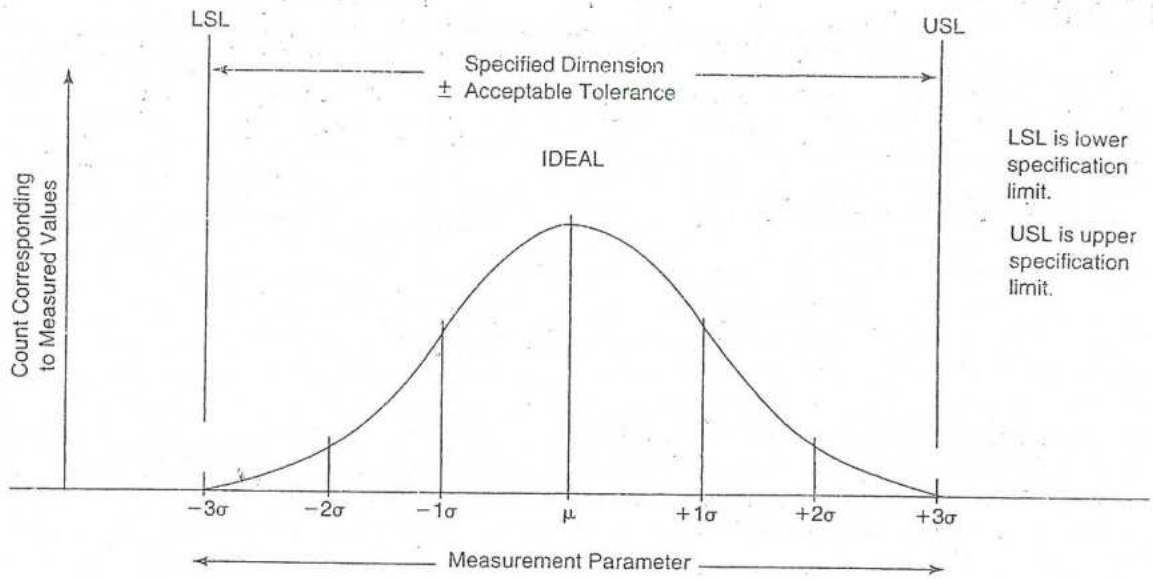


FIGURE 14 Histogram of a 3-Sigma Process

Note: Requirements match ±3σ values; 99.73% of product with fall within the specified limits.

6-sigma level. Note that this corresponds to 1 unacceptable part in 500 million produced.

When Motorola embarked on its journey to break out of the normal quality level associated with 3- or 4-sigma processes, it targeted 6 sigma; hence the name Six Sigma. Eventually, other companies began to adopt the Motorola program, and the name has become part of the quality lexicon.

Relationship of Six Sigma to Total Quality

Six Sigma is an extension of total quality management, which has the aim of taking process and product quality to levels where all customer requirements are met. Depending on which Six Sigma proponent you are listening to, the emphasis may be on improving the bottom line or on meeting customer requirements. Of course, the latter is the best way to accomplish the former. It is important to understand that Six Sigma is not some new field of endeavor separate from the total quality philosophy. Quite the contrary, Six Sigma is a total quality strategy for achieving what all the other total quality strategies attempt to achieve: superior performance that is improved continually, forever.

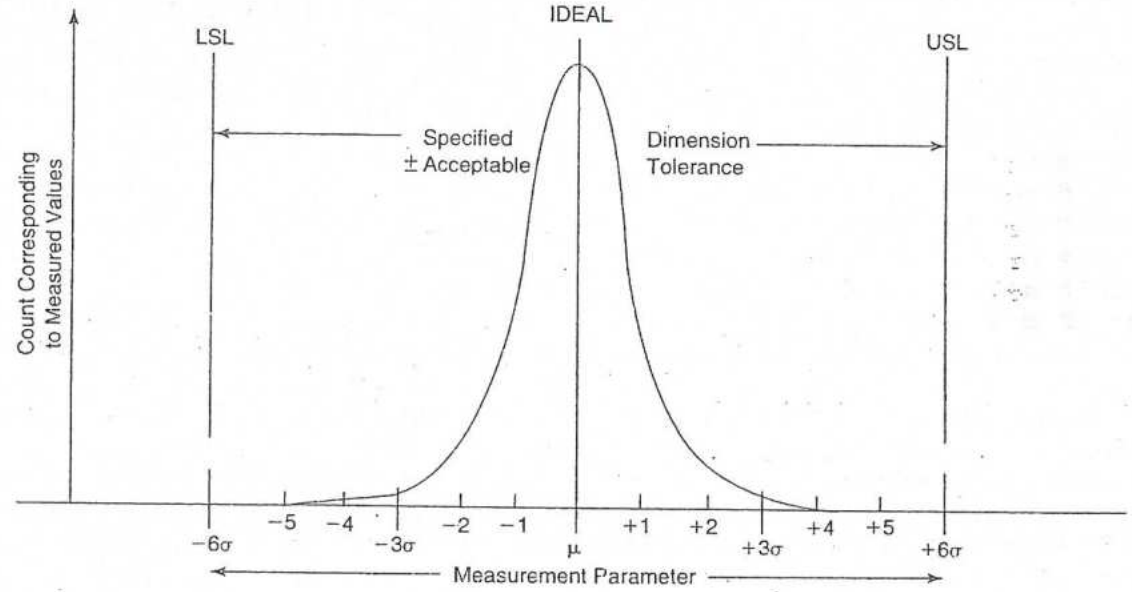


FIGURE 15 Histogram of a 6-Sigma Process

Note: Requirements match ±6σ values. Note that requirements are the same as in Figure 14, but the process is improved; 99.9999998% of product produced will fall within the specified limits.

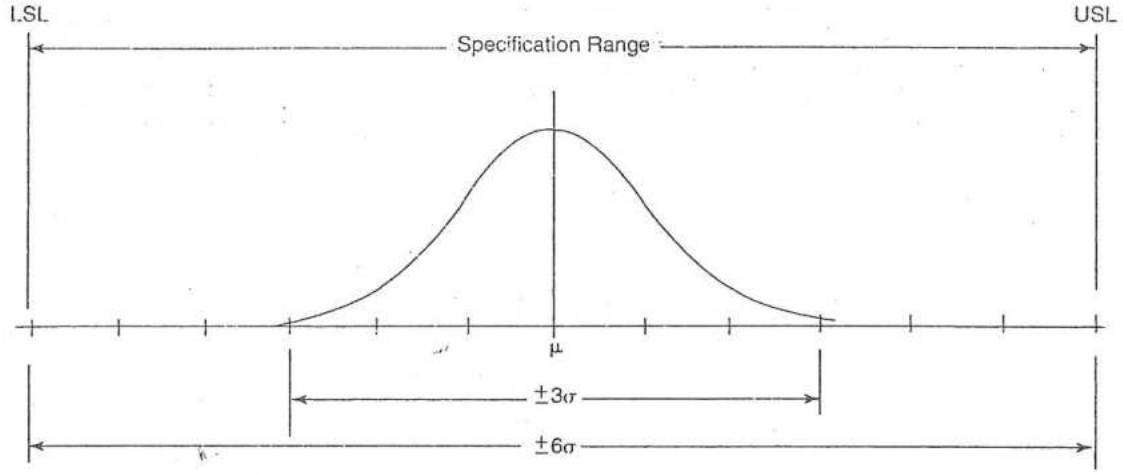


FIGURE 16 This histogram shows a 6-sigma process achieved by broadening the specification range for product acceptability.

How Is Six Sigma Achieved?

Six Sigma can be achieved by improving process performance, but improving processes to this degree can be difficult, and in many cases nearly impossible. On the other hand, Six Sigma can be achieved without improving the process at all if the specification describing acceptable product can be loosened enough to correspond to the original process's $\pm 6\sigma$ points (see Figure 16). Note that in this case the process, which is identical to that of Figure 14, was not changed in any way. Instead, the definition of what is acceptable in terms of process input was changed. The specification range has been increased from the values corresponding to the $\pm 3\sigma$ points to the values corresponding to the $\pm 6\sigma$ points. When we do this, unacceptable product will occur only once in 500 million products.

In order to use this strategy, we must be able to use output that has greater deviation from the ideal value—without sacrificing performance, reliability, or other quality parameters. This is done through engineering processes called *robust design* and *design for manufacture*. Robust design seeks to design products that maintain their reliability, performance, and other quality characteristics even when the component parts of the whole product have great variability of important characteristics. The objective of design for manufacture is to eliminate the possibility of manufacturing errors by simplifying and "error-proofing" the steps required for manufacturing the product. These techniques—improving processes (both incrementally and in giant leaps) and rendering the processes more efficient and foolproof through the use of robust design and design for manufacture—have been around for a long time and are considered by most to be essential elements of TQM. The difference here is that Motorola did something no one else had done: It set the target at Six Sigma.

Is Six Sigma Really Six Sigma?

In this chapter's discussion so far, we have used numbers relating to acceptable product that are quite different from those found in the Six Sigma literature. For example, at 3 sigma, out of 1 million chances for success, there will be 2,700 failures. That is a success rate of 99.73%. At 6 sigma, the prediction is that 0.002 failures will occur out of 1 million chances. That is a success rate of 99.9999998%. However, the most often seen number for failures out of 1 million chances in Six Sigma is 3.4. This is a significant difference. Statistics predict one failure in 500 million chances at 6 sigma. Motorola uses 3.4 out of 1 million or 1,700 times more failures than statistics project. Figure 17

Sigmas	Nonconformances (Statistical)	% Acceptable (Statistical)	Nonconformances (Motorola)	% Acceptable (Motorola)
1	317,400	68.26	697,700	30.23
2	45,400	95.46	308,733	69.1267
3	2,700	99.73	66,803	93.3197
4	63	99.9937	6,200	99.38
5	0.57	99.999943	233	99.9767
6	0.002	99.9999998	3.4	99.99966
7	0.000003	≈ 100	0.019	99.9999981

Nonconformances per Million Opportunities in a Six Sigma Setting

FIGURE 17 Sigma Quality Levels, NPMO

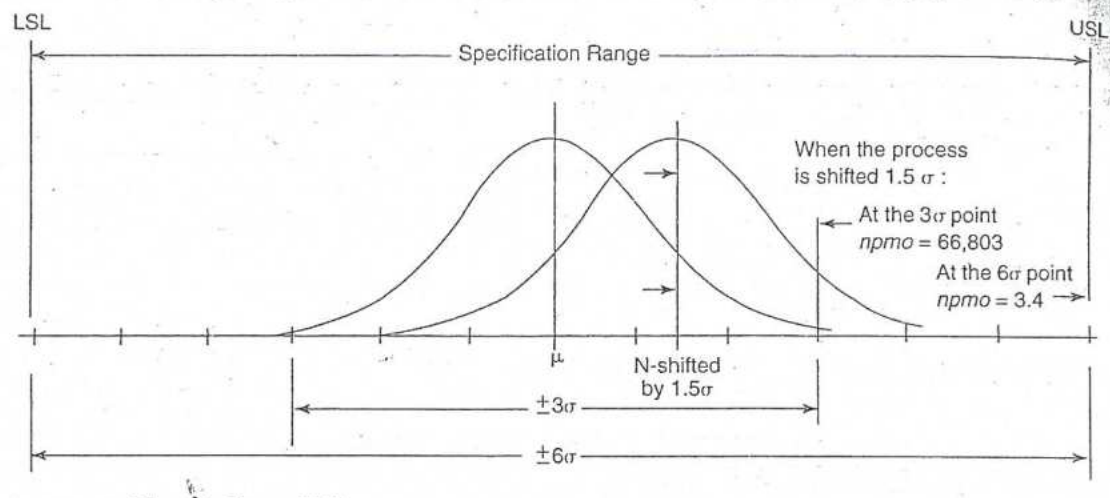


FIGURE 18 The $1^1/_2$ Sigma Shift

Note: The process histogram is shifted $1^1/_2$ sigma from its ideal position to account for long-term variation.

illustrates the difference between straight statistics and the Motorola version.

Clearly, the numbers used by Motorola in its Six Sigma program are significantly different from those derived from straight statistics. Which are correct? The answer is that the straight statistics numbers are correct, but the Motorola numbers are better in a practical sense. What Motorola has done is applied a factor to account for slight changes in environmental conditions, different operators, and so on. The reason Motorola considers this valid is that the sigma values of any process are derived from a statistically valid sample of process operation, necessarily taken over a relatively short period of time. The typical histogram is a snapshot of what is going on at the time the data were collected. Should that period be changed from a few weeks to a few years, one would no doubt encounter new variations resulting from the environment, new operators, and other factors. Motorola believes that the short-term view provides an overly optimistic picture of process variation and, consequently, of the process results at a given sigma level. The company concluded, therefore, that the reality of the long term under which the processes operate should be compensated for. Motorola chose to do this by shifting the process average (μ) from the target, or ideal point, by 1.5 sigma to the right, while leaving the normal 6 sigma field and the upper and lower specification limits as they were. (See Figure 18.)

Such a shift could take place due to environmental changes or other factors. Drifts and shifts of varying magnitude are the norm in the long term, and Motorola is covering that eventuality by accounting for it before the fact. The values for *nonconformances per million opportunities (NPMO)* are then taken from the right tail of the histogram. Notice in Figure 18 that the $+3\sigma$ point intercepts the shifted curve at the equivalent of its $+1.5\sigma$. At 1.5 sigma, there should be 66,803 *NPMO*, which corresponds exactly with Motorola's expectation for 3 sigma. Similarly, the $+6\sigma$ line intercepts the shifted curve at its $+4^1/_2\,\sigma$ point; 4.5 sigma is predicted by statistics to yield 3.4 *NPMO*, the value used in the Motorola Six Sigma program. Whether in real life the process should shift to the left or the right makes no difference, since the same results occur in either direction. Practically speaking, and pragmatically anticipated by Motorola, the process may shift back and forth by varying magnitudes over time. By introducing the 1.5 sigma shift, Motorola has allowed some long-term variation to enter the picture without causing panic.[36]

We hasten to state that we do not disagree with the route Motorola took with the $1^1/_2$ sigma shift. Smart people determined that this was the appropriate thing to do. Still, we are not completely comfortable with the Six Sigma name if it fails to truly represent 6 sigma. But we will not argue with 3.4 nonconformances out of a million opportunities. This is a quality level that is so far beyond the average that we will gladly accept it, name and all.

THE LEAN SIX SIGMA APPROACH

The name Lean Six Sigma has to be understood before we go any further. Failure to do so will lead to a misunderstanding of the concept itself and its purpose. Clarification is best begun by stating what Lean Six Sigma is not. It most definitely is not some kind of a Lite Six Sigma, like an improvement system designed for those who only want a little improvement or who don't want to be bothered by the details of Six Sigma. What we have here is a wedding between two healthy, robust, powerful systems that stood alone in the two previous sections—Lean and Six Sigma. The Six Sigma part of Lean Six Sigma is still the full-bodied, potent improvement system that we have discussed in the previous section. The Lean part of Lean Six Sigma is still the complete, proven Quality Management system found in the Toyota Production System and Just-In-Time.

The two earlier sections explained the concepts of Lean and Six Sigma, respectively. This section explains a concept that combines the two to form Lean Six Sigma. The two comple-

ment each other with their strengths, namely Lean's elimination of waste and Six Sigma's breakthrough methodology for solving performance problems and making improvements, DMAIC, and its infrastructure system of Belts. Lean Six Sigma is nothing more or less than the marriage of Lean and Six Sigma.

Advantages of Lean Six Sigma include:

- Elimination of the Eight Wastes—waiting, overproduction, rework, motion, transportation, processing, inventory, and intellect
- Means of improving process flow whether on the manufacturing floor, in an office, or any other setting
- A structured means for identifying the key factors that determine the performance of all kinds of processes
- Ordered methods for establishing key factors at the best possible level
- Disciplined means of sustaining key factors at the best level
- Synergistic advantage of linking the Lean tools with the Six Sigma tools in a systematic way and in a specified sequence
- Tying all of these to the financial health of the organization

The objective of Lean Six Sigma is to make the organization superior in its day-to-day work and processes, its products and services, and its business results. This has also been the objective of many organizations that have found that Lean alone, or Six Sigma by itself, did not quite provide all the results needed in their quest for a better competitive posture. A lot of those organizations have found that by combining Lean with Six Sigma, significant performance gains relative to processes, products, services, employees, customer satisfaction, and the business bottom line have been realized. Those same organizations would also admit, however great their improvement record has been, that the improvement task is never finished—that continual improvement is a never-ending practice. With technology changing at an ever faster pace and with customer demands and preferences constantly shifting, the need for continually improving processes, employees, products and services will be with us long into the future, if not forever. Given the level of competition in the marketplace of our shrinking world, there will always be the need for improvement of business performance. Lean Six Sigma provides a proven system for achieving continual improvement in every aspect of the organization's business.

THE THEORY OF CONSTRAINTS AND INTEGRATED TOC, LEAN, SIX SIGMA (ITLS) APPROACH

In his 1984 book, *The Goal*, Dr. Eliyahu M. Goldratt introduced a management concept called the Theory of Constraints (TOC). He describes his theory:

> The Theory of Constraints is an intuitive framework for managing an organization. Implicit in the framework is a desire to continually improve performance, and to have a process of ongoing improvement. It starts, as it must, with clearly defining the goal of the organization and establishing measurements to determine the impact of any action on the goal.[37]

All business organizations have at least one goal, and whether stated or not, that is to make a profit today, this year, next year, and in the future. Ordinarily businesses measure their performance by net profit and return on investment (ROI). The TOC is founded on the premise that an organization's performance against the goal can be determined and managed by the variations of three measures:

- Investment (money invested to be in the business)
- Operating Expense (money spent converting investment to throughput)
- Throughput (money from sales)

The premise giving rise to the theory is that every organization faces constraints, at least one of which limits the rate of goal achievement. Goldratt defines a constraint as "anything that limits an organization from achieving higher performance vis-à-vis its goal."[38] Organizations may have tens, or even hundreds of constraints fitting this description, but a core principal within the TOC is that only one, or just a few, really constrain performance. The constraint may be internal to the organization, such as a machine that cannot produce acceptable parts fast enough, employees who lack the necessary skills, or policies and procedures that are unsuitable for the process as implemented. The constraint may also be external, such as lack of customer demand for the product.

It must be noted here that constraints for the purpose of TOC never include breakdowns. Machines that are considered capable of doing what is needed of them do not become constraints when they occasionally breakdown or go out of calibration or adjustment. This is consistent with TQM which holds that repairing a broken machine cannot be considered an improvement, because it merely restores an earlier level of performance.

The TOC is intended to focus the attention and effort of the organization to the constraint within a value-chain, and uses the following five steps to do that:[39]

1. IDENTIFY the constraint (What is the real or major constraint?)
2. Decide how to EXPLOIT the constraint (Turn it into a positive factor, eliminate, or circumvent)
3. SUBORDINATE AND SYNCHRONIZE everything else to the above decisions. (No other activity should have priority because the constraint is inhibiting achievement of the organization's goal.)

Then to improve the performance of that same value-chain, continue:

4. ELEVATE the performance of the constraint (e.g., add capacity)
5. If in any of the steps the constraint has shifted, GO BACK TO STEP 1.

Value-Chain definition: A chain of activities that add value to a product or service as it passes through each of the sequential steps.

The authors have some difficulty with the Theory of Constraints as a standalone system for continual improvement, although many organizations have used TOC as such with good results. As a consequence of the EXPLOIT and SUBORDINATE steps it is often necessary to utilize buffers. These buffers hold materials or work-in-progress to prevent shutting down production whenever a constraining function cannot keep up with demand. Should the constraint fall behind in its output to the next link of the value-chain, the materials or work-in-process stored in the buffer is used to allow the next link to continue operation. This tactic has been proven to be a major deterrent to continual improvement, because having those buffers available hides problems that should be solved. Therefore, rather than being eliminated once and for all, the same problems keep recurring.

As it turns out, the people who are facing the issues everyday on the firing line of the business world have found that better results are achieved by using the Theory of Constraints methodology concurrently with Lean and Six Sigma than by using any of the three systems by itself or in pairs. The Integrated TOC, Lean, Six Sigma (iTLS) model:[40]

- Focuses on the few yet critical elements that limit global performance of the organization by applying Theory of Constraints tools
- Eliminates waste in the form of "hidden factories" [including buffers] with application of Lean tools
- Reduces undesirable variability to ensure process stability with Six Sigma tools

The iTLS model approaches improvement projects in three successive phases.

1. Apply TOC to focus on processes where changes are necessary.
2. Apply Lean to remove waste from the processes.
3. Apply Six Sigma tools to control process performance and variability.

Should your organization be using Lean, Six Sigma, or Lean Six Sigma, you might do well to consider the addition of TOC.

SUMMARY

1. The rationale for continual improvement is that it is necessary in order to compete in the global marketplace. Just maintaining the status quo, even if the status quo is high quality, is like standing still in a race.
2. Management's role in continual improvement is leadership. Executive-level managers must be involved personally and extensively. The responsibility for continual improvement cannot be delegated.
3. Essential improvement activities include the following: maintaining communication, correcting obvious problems, looking upstream, documenting problems and progress, and monitoring change.
4. Structuring for quality improvement involves the following: establishing a quality council, developing a statement of responsibilities, and establishing the necessary infrastructure.
5. Using the scientific approach means collecting meaningful data, identifying root causes of problems, developing appropriate solutions, and planning and making changes.
6. Ways of identifying improvement needs include the following: using multivoting, seeking customer input, studying the use of time, and localizing problems.
7. Developing improvement plans involves the following steps: understanding the process, eliminating obvious errors and potential errors, removing slack from processes, reducing variation in processes, and planning for continual improvement.
8. Commonly used improvement strategies include the following: describing the process, standardizing the process, eliminating errors and potential errors in the process, streamlining the process, reducing sources of variation, bringing the process under statistical control, and improving the design of the process.
9. Additional improvement strategies include the following: reducing lead time, introducing flow production, using group technology, leveling production through smaller lot size, synchronizing production, overlapping production, using flexible scheduling, using pull control, using visual control, using stockless production, using jidoka, reducing setup time, applying control of Work-in-Process, improving quality, applying total cost cycles, using cost curves, use of supplier partners, applying total industrial engineering, and applying total productive maintenance.
10. *Kaizen* is the name given by the Japanese to the concept of continual incremental improvement. It is a broad concept that encompasses all of the many strategies for achieving continual improvement and entails the following five elements: straighten up, put things in order, clean up, standardize, and discipline. Two important Kaizen tools are "Five W's and One H," and the "Five M Checklist."
11. CEDAC is an acronym for *cause-and-effect diagram with the addition of cards.* (This acronym is a registered trademark of Productivity Inc.) With CEDAC, a cause-and-effect diagram is developed, but fact cards about problems and improvement cards containing ideas for solving the problems are used.

12. Lean is a TQM approach originally designed for manufacturing, but since adapted to any kind of organization. It is intended for smoother, more flexible process flow, reducing waste, and improving the organization's competitive posture. The wastes of overproduction, inventory, motion, transportation, overprocessing, defects, waiting, and underutilization are primary targets of Lean. Compared to a non-Lean company, the Lean organization does more and does it better, while using less.
13. Six Sigma is a statistically based approach that targets the defect rate at 3.4 per million or less. Key elements of Six Sigma include the DMAIC roadmap and an infrastructure of Green Belts, Black Belts, Master Black Belts, and Champions. Like other approaches, Six Sigma aims for quality improvement, but goes further to tie these quality improvement initiatives to the financial elements of the organization.
14. Lean Six Sigma is not a low calorie variation, but a linking of Lean and Six Sigma that synergistically combine the benefits of both.
15. Goldratt's Theory of Constraints (TOC) is a management concept designed to provide continual improvement. It focuses on identifying business or process constraints and exploiting the constraints. The basic TOC has evolved into Integrated TOC, Lean, Six Sigma (iTLS) which combines TOC with Lean and Six Sigma.

KEY TERMS AND CONCEPTS

Black Belts
CEDAC
Champions
Communication
Continual improvement
Cost curves
Customer needs
Defects per million
DMAIC roadmap
Five M's
Five W's and One H
Flexible schedules
Flow production
Green Belts
Group technology
Improvement plans
Improvement strategies
Improvement versus "putting out fires"
iTLS
Jidoka
Just-in-time
Kaizen
Kanban
Key Process Input Variables (KPIVs)
Key Process Output Variables (KPOVs)
Lead time
Lean
Lean Six Sigma
Level production
Localize problems
Look upstream
Management's role in continual improvement
Master Black Belts
Multivoting
Necessary infrastructure
Nonconformances per million opportunities (NPMO)
Obvious problems
Plan–Do–Check–Adjust (PDCA) cycle
Pull control
Quality council
Reduced setup time
Return on Investment (ROI)
Root causes
Scientific approach to problem solving
SIPOC
Six Sigma
Slack
Standardizing processes
Statement of responsibilities
Stockless production
Streamlining processes
Supplier Partners
Synchronized production
Theory of constraints
Total cost cycles
Total industrial engineering
Total productive maintenance (TPM)
Value Stream Mapping (VSM)
Value Chain
Variation and sources of variation
Visual control
Work-in-process (WIP)

FACTUAL REVIEW QUESTIONS

1. Explain the rationale for continual improvement.
2. What is management's role in continual improvement?
3. Describe the five essential improvement activities.
4. If you were an executive manager in an organization, how would you structure the organization for quality improvement?
5. What is meant by using the scientific approach?
6. Describe the steps involved in developing an improvement plan.
7. List and explain three widely used improvement strategies.
8. Explain the following improvement strategies:
   a. Group technology
   b. Synchronized production
   c. Jidoka
   d. Supplier Partners
   e. Total productive maintenance
9. Explain the concept of Kaizen.
10. What is CEDAC and how is it used?
11. What are the primary objectives of Lean?
12. Explain the rationale of Six Sigma's target of 3.4 NPMO.
13. How might a SIPOC map be used in a process improvement project?
14. Define Lean Six Sigma.
15. Explain how Theory of Constraints approaches continual improvement, and how it differs from other approaches.

CRITICAL THINKING ACTIVITY

Which Approach Is Best?

Mark Berry, Sandra Griffith, and Juan Carlos are seniors at Florida Tech University, majoring in industrial technology with a quality emphasis. All three hope to be quality directors after graduation.

"I am going to use the Kaizen approach when I graduate and land my first job," said Mark. "It's simple, easy to use, and effective."

"Not me," replied Sandra. "I like the Six Sigma approach."

"I'm not going to use either of them," said Juan. "I'm going to make myself a master list of improvement strategies and use whatever is best for the individual situation."

Join their debate. What approach do you think is best for promoting continual improvement, and why?

ENDNOTES

1. CEDAC is a registered trademark of Productivity Inc.
2. Joseph M. Juran, *Juran on Leadership for Quality: An Executive Handbook* (New York: Free Press, 1989), 72.
3. Peter R. Sholtes, Barbara J. Streibel, and Brian L. Joiner, *The Team Handbook*, 3rd ed. (Madison, WI: Joiner Associates, 2003), 5–9.
4. Juran, *Juran on Leadership*, 35.
5. Ibid., 42–46.
6. Ibid., 43.
7. Sholtes, Streibel, and Joiner, *The Team Handbook*, 5–9.
8. Ibid.
9. This section is based on Scholtes, Streibel, and Joiner, *The Team Handbook*, 5–10.
10. This section is based on Scholtes, Streibel, and Joiner, *The Team Handbook*, 5–10.
11. This section is based on Scholtes, Streibel, and Joiner, *The Team Handbook*, 5–11.
12. This section is based on Scholtes, Streibel, and Joiner, *The Team Handbook*, 5–11.
13. Giorgio Merli, *Total Manufacturing Management* (Cambridge, MA: Productivity Press, 1990), 143.
14. Scholtes, Streibel, and Joiner, *The Team Handbook*, 5–17.
15. Ibid., 5–67.
16. Merli, *Total Manufacturing Management*, 163.
17. Ibid., 153–165.
18. Masaaki Imai, *Kaizen: The Key to Japan's Competitive Success* (New York: McGraw-Hill, 1986), 1–16.
19. This section is based on Imai, *Kaizen*, 233.
20. Ibid., 237.
21. Ryuji Fukuda, *CEDAC: A Tool for Continuous Systematic Improvement* (Cambridge, MA: Productivity Press, 1989), 3.
22. Ibid., 3–10.
23. This section is based on Fukuda, *CEDAC*, 39–51.
24. This section is based on Andy Carlino and Jamie Flinchbaugh, *The Hitchhiker's Guide to Lean* (Dearborn, MI: Society of Manufacturing Engineers, 2005), 28–42.
25. This section is based on Anthony Manos, Mark Sattler, and George Alukal, "Make Healthcare Lean," *Quality Progress* 39, no. 7 (July 2006): 24–25.
26. Ibid., 26–29

CHAPTER 13

Six Sigma Management and Lean Tools

I look at Six Sigma as a foundation on which you can build more innovation.

—Jeffrey R. Immelt, Chairman General Electric

As you can see by the preceding quote, General Electric (GE) places a lot of importance on Six Sigma as a method for improvement. They initiated the Six Sigma program in 1995 with a goal of being a Six Sigma company by 2000.

As evidenced by a quick Internet search, **Six Sigma** is a very popular approach to improving quality. Several distinctions about Six Sigma differentiate it from traditional continuous improvement. First, Six Sigma represents a well-thought-out packaging of quality tools and philosophies in an honest effort to provide rigor and repeatability to quality improvement efforts.

Second, Six Sigma is much more cost-reduction-oriented than traditional continuous improvement. It is this second aspect of Six Sigma that has made it so popular with CEOs. In fact, many quality practitioners are uncomfortable with the focus on results, stating that this approach violates several of Deming's points, especially in setting targets and goals for cost reduction. But proponents of Six Sigma state that this focus on profits is one of the strengths of a Six Sigma approach.

The third fundamental nuance of Six Sigma is the way it is organized. Six Sigma is a bonanza for consultants and providers of training because it is organized around creating champions, black belts, green belts, and in some situations, yellow belts. Later in the chapter we discuss how Six Sigma efforts are normally organized.

Fourth, Six Sigma and lean production have been combined into an approach termed *Lean-Six Sigma.* It is Six Sigma with an increased emphasis on reducing waste.

For this text, we approach Six Sigma from a contingency perspective. This is simply one of the more popular current approaches to quality improvement. If after studying this chapter you feel the Six Sigma approach will be helpful to your company, then you can strongly support implementation.

WHAT IS SIX SIGMA?

The *sigma* in Six Sigma refers to the Greek symbol σ, which designates a standard deviation in statistics. The *six* refers to the number of standard deviations from a specification limit to the mean of a highly capable process.

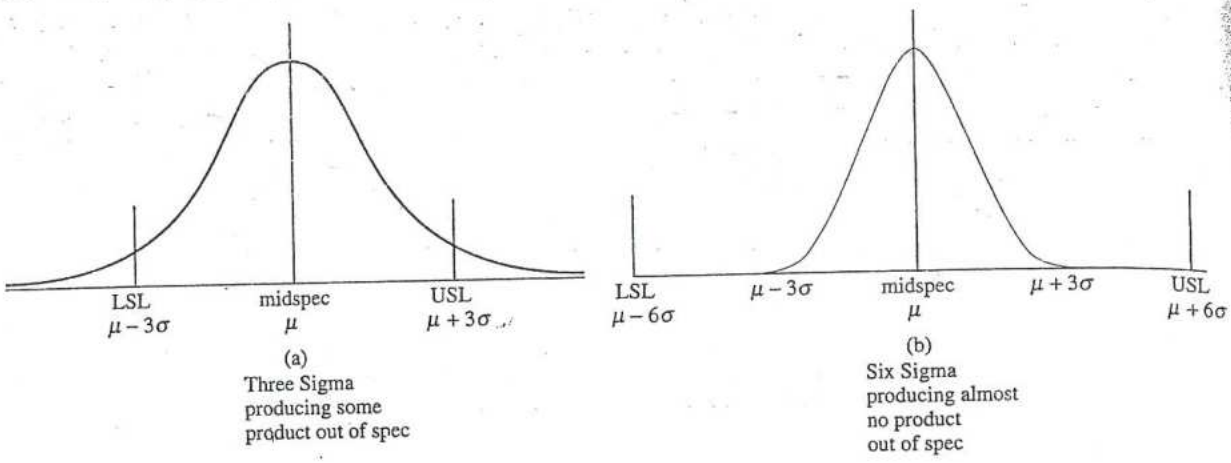


FIGURE 13-1 Six Sigma Variation



Video Clip:
Six Sigma at Kurt Manufacturing

There are two key versions of Six Sigma. From one perspective, Six Sigma is a program begun at Motorola in 1982. That year, Motorola's CEO requested that costs be cut in half. He then repeated the same request the following year. These efforts pointed out that Motorola needed to improve its product designs and analytical techniques to achieve these goals. Motorola emphasized designing products to achieve Six Sigma. Figure 13-1 shows what this means. In the figure, distribution *a* shows a typical product design with 3-standard-deviation specifications (or tolerances). If this is the case, about 0.5% of products will not meet specification. As shown in part *b* of the figure, if the tolerances are 6 standard deviations, the probability of producing a bad part is very low. Notice how in part *b* the mean or dispersion of the process could change significantly, and the product still would meet specs. Table 13-1 shows the number of defective parts per million (ppm) that are produced between one and Six Sigma levels. Using this definition, Six Sigma translates into more robust designs, radically lower defect levels, and lowered costs of poor quality (COPQ).

From the early days of improving the robustness of design at Motorola, Six Sigma has morphed into an organization-wide program for improvement involving hierarchical training, organizational learning, and pay for learning. As you will see in this chapter, none of the analytical tools used in Six Sigma efforts are new. What is new is how they are packaged and deployed within a company.

Some argue that Six Sigma is an advanced quality improvement approach designed to help tackle the most difficult quality problems. As you can see in the pyramid in Figure 13-2, the basic tools of quality can be used to handle 90% of quality problems. Most of the next 10%

TABLE 13-1 Sigma Levels and ppm Defects

Sigma Level	Long-Term ppm* Defects
1	691,462
2	308,538
3	66,807
4	6,210
5	233
6	3.4

*ppm = parts per million.

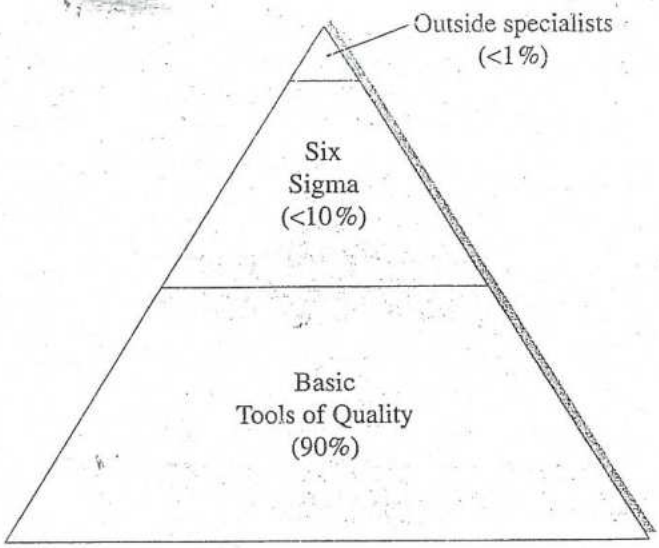


FIGURE 13-2 Six Sigma Effectiveness

requires advanced training and analytical techniques. Beyond that, there are a few problems that require expertise that may not be found within the company. Thus you can see that care should be taken in determining what projects should be undertaken by Six Sigma specialists.

At the core of Six Sigma is the following equation:

$$Y = f(X) \tag{13.1}$$

Strictly speaking, this means that Y (the dependent variable) is a function of X (an independent variable). To Six Sigma practitioners, this means that an output is a function of inputs and processes, where

Y = output (key business objectives and measures)
f = function (interrelationships to be controlled and managed)
X = controllable and noncontrollable variables that affect Y

For example, the profitability of a company (Y) is affected by several variables (Xs), including customer retention, inventory turnovers, rolled throughput yield, production costs, and many others. If our objective is to improve profits, we focus on these variables on a project-by-project basis and improve our performance. In this scenario, the job of management is to identify and prioritize projects to achieve the goal of lowered costs and higher profits. The job of employees is to obtain the training and expertise required to meet these objectives.

As you can see, Six Sigma started as a single firm's approach to reducing costs and improving quality. Currently, it is much more. It involves planning, organization, training, human resources planning, and pay for knowledge. This requires both organizational and individual cooperation to achieve a goal. At GE, management made it clear that participation in Six Sigma was a prerequisite for advancement within the company.

ORGANIZING LEAN-SIX SIGMA

Probably you have heard about lean-Six Sigma black belts. This is the designation for a person who has completed rigorous (and costly) black-belt training and has completed one or more lean-Six Sigma projects (depending on the company providing the training and the certificate) with demonstrated results. The cost of training generally runs between $10,000 and $20,000 for a single black belt. Expected returns from Six Sigma projects can run into the hundreds of

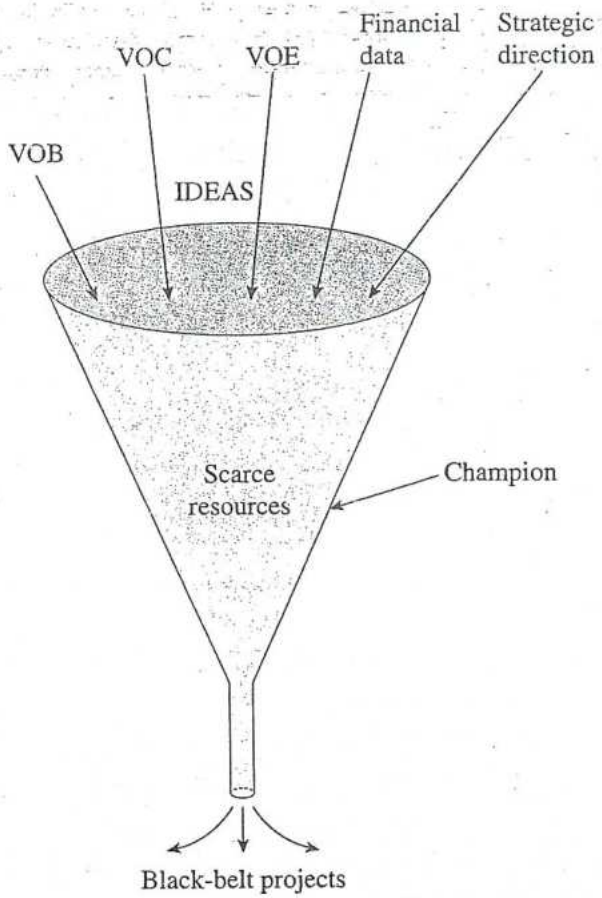


FIGURE 13-3 Champion Decision Making

thousand dollars. Although these payoffs are attractive to management, they do provide quite a bit of pressure for the organization to achieve outstanding results from their Six Sigma efforts.

Below we list some of the key players in Six Sigma efforts:

Champion. The job of the **champion** is to work with black belts and potential black belts to identify possible projects. They get information from a variety of sources such as the *voice of the business* (VOB), the *voice of the customer* (VOC), and the *voice of the employee* (VOE) for potential project ideas. As shown in Figure 13-3, they act as a funnel for project ideas and use Pareto analysis (Chapter 10) to analyze the ideas to determine where the best return on investment lies. This can involve COPQ analysis and regression studies to determine the main causes of quality-related losses. From the champion's perspective, Six Sigma is not so much about tools. It is about managing the process for improvement. The champion provides continuing support for the project and validates the results at the end of the project. In a small company, the champion might be the CEO. In larger companies, they may be senior executives.

Master black belts. In some firms, experienced black belts are designated **master black belts**. In these cases, master black belts serve as mentors and trainers for new black belts. This brings the training in-house and can reduce costs.

Black belt. The **black belt** is the key to lean-Six Sigma. These are specially trained individuals. The training usually lasts about four months. After completing training, these individuals are committed full time to completing cost-reduction projects. At GE, black belts were expected to complete two more projects after their certification. Each project

lasts from two months to a year depending on the project scope. The black belt is a specialist. Within nine months of beginning Six Sigma within its appliance division, GE had advertised, created, and filled 115 black belt positions.[1] It has been suggested that small to midsized companies may only need between one and five black belts at one time. Individuals usually spend about 2 years as a black belt and are then moved into management jobs. The black-belt designation is also very valuable for finding new jobs.

Green belts. **Green belts** are trained in basic quality tools and work in teams to improve quality. Green belts are assigned part time to work on process and design improvement. In some cases, the results of green-belt activities are the same as black belts. In other organizations, green belts are involved in less critical projects. In a small company of 100 employees, there might be 1 black belt and 60 green belts. Some companies also have **yellow belts**, who are employees familiar with improvement processes.

Packaging Lean with Six Sigma

When firms undertook implementing Six Sigma, many saw that it had many things in common with lean manufacturing. Rather than having two competing models for improvement, many have combined Six Sigma with lean. This is often referred to as **lean-Six Sigma**. In this section, we elaborate on the concepts relating to lean production. Companies who implement lean-Six Sigma still generally follow the DMAIC process described in the next section. However, with lean, the focus of Six Sigma becomes more oriented toward reducing wastefulness in organizations. In lean-Six Sigma, the Japanese term **muda** is often used to describe process waste.

Lean focuses on continually pursuing the reduction of waste with an emphasis on just-in-time practices such as **pull production**. This recognizes that all processes are inherently wasteful and include the possibility of improvement. As a starting point, Shingo's seven wastes of overproduction, defects, inventory, motion, overprocessing, conveyance, and waiting are targeted as opportunities for improvement.

Although lean and Six Sigma approaches have been combined, lean especially utilizes value stream and SIPOC diagrams to identify and isolate steps in key processes that do not add value for customers. By isolating and identifying these non-value-added activities, Lean can result in lower costs, lower defects, and improved customer value. Figure 13-4 shows a simplified value-stream map for a typical process. This shows information flows, process steps, and average times relating to different steps in the value stream. Often, value stream maps show cycle times for particular tasks, costs, and work-in-process (WIP) inventory at each stage of the process. This provides a basis for studying the value stream and identifying its costs and inefficiencies.

DMAIC OVERVIEW

Table 13-2 shows the steps in the **DMAIC process**. DMAIC stands for *define, measure, analyze, improve, and control.* This is very similar to the PDCA cycle proposed by Shewhart and Deming. We discuss each of these steps in two parts. Here we define each of the steps. Then we fit quality tools to each of these steps. Figure 13-5 shows an overview of the tools used at each stage of the DMAIC process. We discuss these in much more depth over the next several pages. In some cases, where we have already presented a tool, such as the basic seven (B7) tools, we mention the tool. However, it is up to you to refer to the other chapter where the tool is defined and explained. A Closer Look at Quality 13-1 shows some results of DMAIC processes in different companies.

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[1]Hendricks, C. A., and Kelbaugh, R. L., "Implementing Six Sigma at GE," *Journal for Quality and Participation* 21, 4 (1998): 48–53.

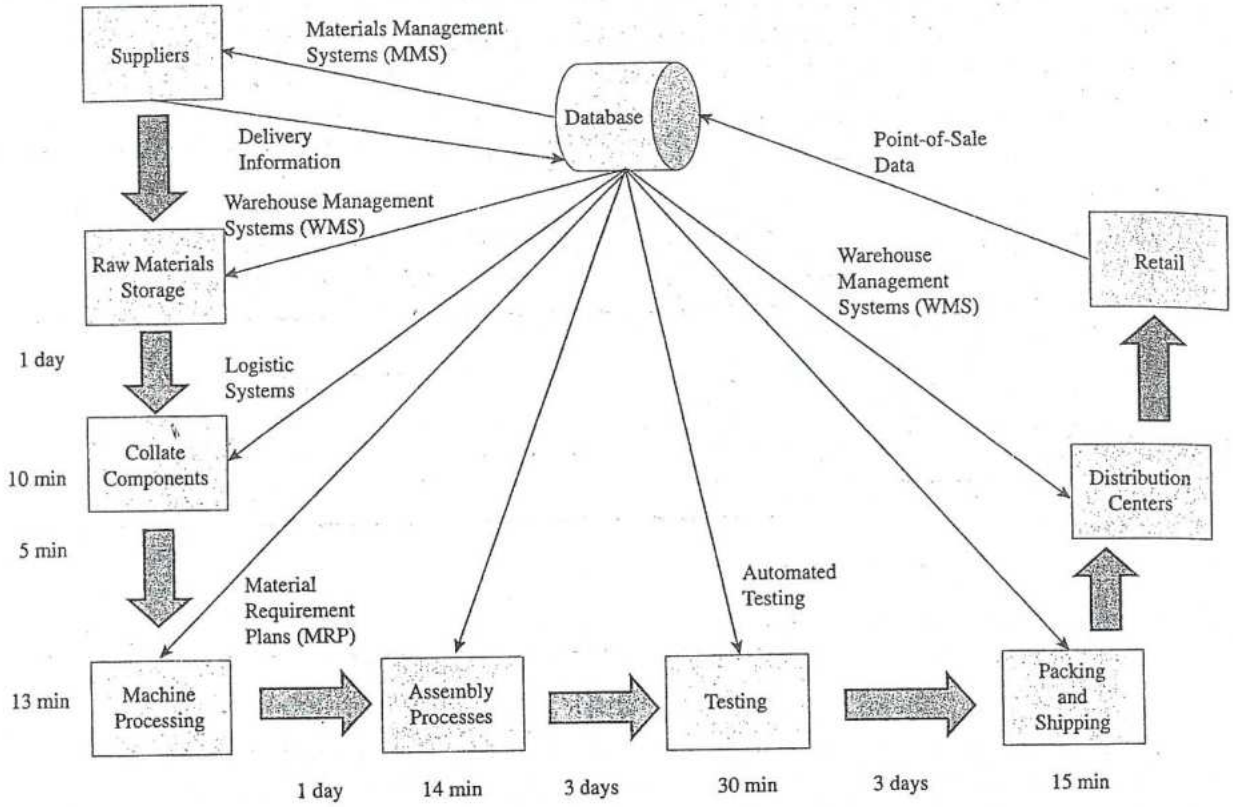


FIGURE 13-4 Simple Value-Stream Map

TABLE 13-2 The Six Sigma Process—DMAIC

DMAIC		
	Define	Define the project goals and customer (internal and external) deliverables
	Measure	Measure the process to determine current performance
	Analyze	Analyze and determine the root cause(s) of the defects
	Improve	Improve the process by eliminating defects
	Control	Control future process performance

Source: www.freequality.org (2009).

A CLOSER LOOK AT QUALITY 13-1 DMAIC In Action

While Kevin Colby was working on a Six Sigma project at the Truck Components Automated Products Division of Eaton Corporation, the company was examining cost savings opportunities. The division produced transmissions that included speed sensors, which measure shaft speeds and work in conjunction with the gears produced by the Cleveland, Ohio-based company. The gears with holes caused signal fluctuations that affected the sensors. Two electronic control units (ECUs) with different circuit speeds were manufactured to allow the sensor to work with both types of gears.

Engineers within the division's design group who were involved with the gear project realized that they could simultaneously have an impact on two divisions. Jerry Ganski, principal engineer who led the effort to eliminate the second ECU, said, "We realized that removal of the holes in the gears would allow the Automated Products Division to eliminate the special ECU we had to manufacture to

deal with the holes. We now use a common ECU for all our platforms and thus save the money it took to build, stock, and handle two ECU styles where the only difference between them was the speed sensor circuit. The savings is estimated at approximately 12 percent." Based on the improvements realized from these three projects, Eaton is investigating other gear-related projects for potential improvement opportunities.

DEFINE PHASE

In the **define phase**, projects are identified and selected. Project selection is performed under the direction and with the participation of the champion. Also involved in selection are master black belts and black or green belts. We discuss this in four phases:

1. Developing the business case
2. Project evaluation
3. Pareto analysis
4. Project definition

Developing the Business Case

Business case development involves

- Identifying a group of possible projects
- Writing the business case
- Stratifying the business case into problem statement and objective statements

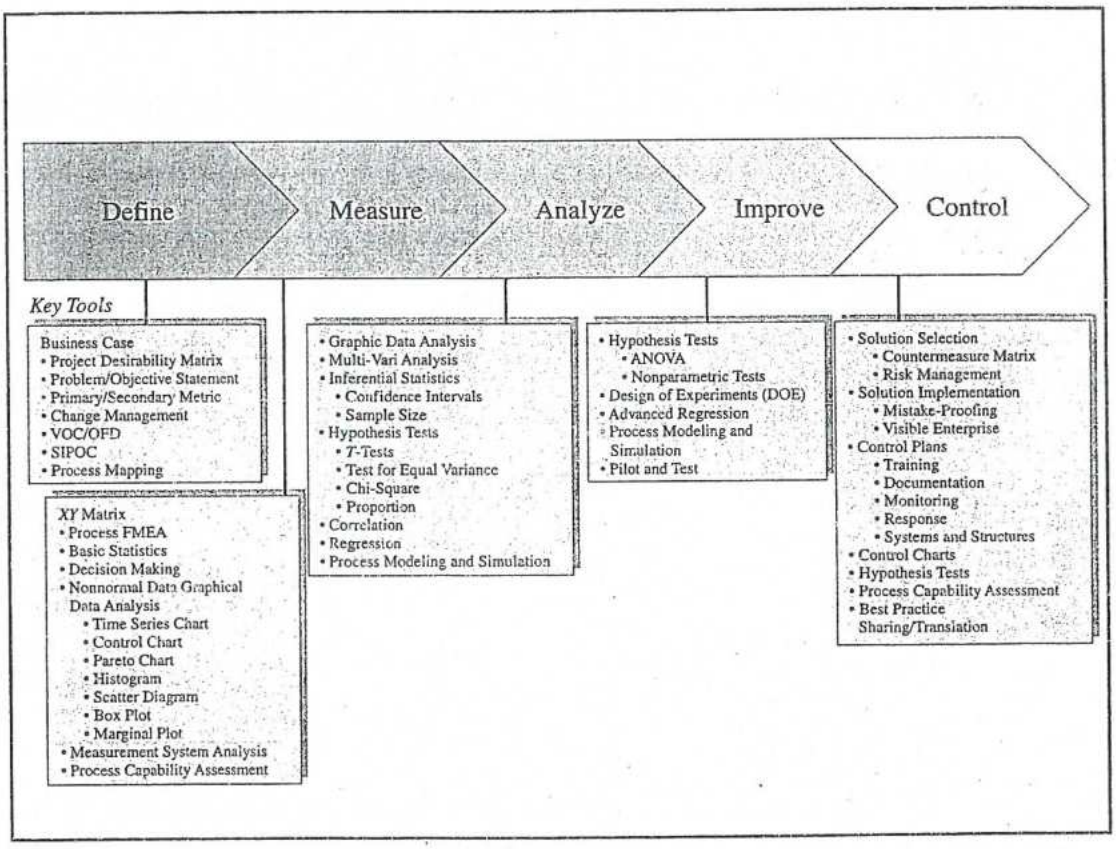


FIGURE 13-5 Overview of the Six Sigma Process

Six Sigma Project Return

Before this worksheet can be completed, the following questions must be answered: *Does the defect / key characteristic for this project relate to one of the company's business drivers, or a reliability or service measure?*

If you answered *Yes*, proceed with the worksheet.
If you answered *No*, see your sponsor or mentor. This project may not provide appropriate returns.

Project:	Plant 3 Throughput	Growth Score:	2/5
Belt:	Foster	Urgency Score:	2/5
Sponsor(s):	Shannon	Impact Score:	2/5
Date:	Sept. 12, 2011	Return Value:	6/15 = 40%

Growth = Competitive Advantage
Choose the single best answer

Return Scale		
0	☐	The project does not result in incremental sales with paying customer(s).
1	☐	The project does not create incremental sales with paying customer(s), but does improve the competitive position of the company by improving operating efficiencies that bear on competitive performance.
2	☑	The project does not create incremental sales with paying customer(s), but does improve the competitive position of the company by improving operating efficiencies in a key strategic area.
3	☐	The project provides some degree of incremental sales with paying customer(s) and moderately improves the competitive position of the company.
4	☐	The project provides a moderate degree of incremental sales with paying customer(s) and substantially improves the competitive position of the company by providing a higher level of service.
5	☐	The project provides a high degree of incremental sales with paying customer(s) and greatly improves the competitive position of the company by providing a level of service unmatched by competitors.

Urgency = Competitive Response
Choose the single best answer

Return Scale		
0	☐	The project can be postponed for at least 12 months without affecting competitive position, or existing processes or procedures can produce substantially the same result and will not affect competitive position.
1	☐	The postponement of the project does not affect competitive position, and minimal incremental operating costs are expected to be incurred to produce substantially the same result.
2	☑	The postponement of the project does not affect competitive position; however, operating costs may escalate to produce substantially the same result.
3	☐	If the project is postponed for now, the company remains capable of responding to the needed change without affecting its competitive position. However, it is expected the company will be substantially hindered in responding rapidly and effectively to future changes in the competitive environment.
4	☐	The postponement of the project may result in further competitive disadvantage to the company, or in a loss of competitive opportunity; or existing successful activities in the company may be curtailed because of the lack of the proposed system.
5	☐	The postponement of the project will result in further competitive disadvantage to the company, or in a loss of competitive opportunity; or existing successful activities in the company must be curtailed because of the lack of having a solution to this problem.

Impact = Annual Expected Financial Savings
Choose the single best answer

Return Scale	
0	☐ Less than $20,000*
1	☐ $20,000-$99,999*
2	☑ $100,000-$200,000
3	☐ $200,001-$300,000
4	☐ $300,001-$400,000
5	☐ Over $400,000

(*Projects are expected to have, on average, an annual expected savings of $100,000 or more. If the project does not meet this criteria, it should have significantly high scores in the Growth and Urgency categories)

FIGURE 13-7 Project Return Analysis

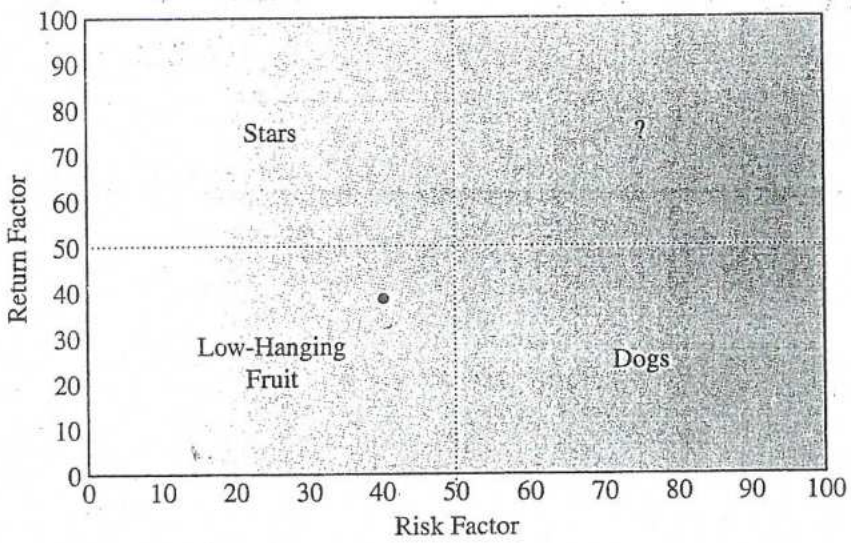


FIGURE 13-8 Project Risk and Return Matrix

Pareto Analysis

Part of the responsibility of the champion is to perform a cost of poor quality (COPQ) analysis. This is based on the PAF categorization of costs (see Chapter 4). Performing a study of internal and external failure costs will help determine where the most benefit can be found. Figure 13-9 shows a two-level Pareto analysis of COPQ. The first-level analysis shows $5.6-million quality costs in plant A. This is the plant with the highest losses. When we study causes of poor quality in plant A, it becomes clear that operation *P* accounts for about 62% of the $5.6 million loss (in the second-level analysis). For this reason, this project holds great promise for breakthrough improvement.

Problem Definition

Once the risk analysis and Pareto analysis have been completed for the project, a project definition consists of a problem statement, project goals/objectives, primary metrics, secondary metrics, and team member identification. Figure 13-10 shows an example of problem definition.

MEASURE PHASE

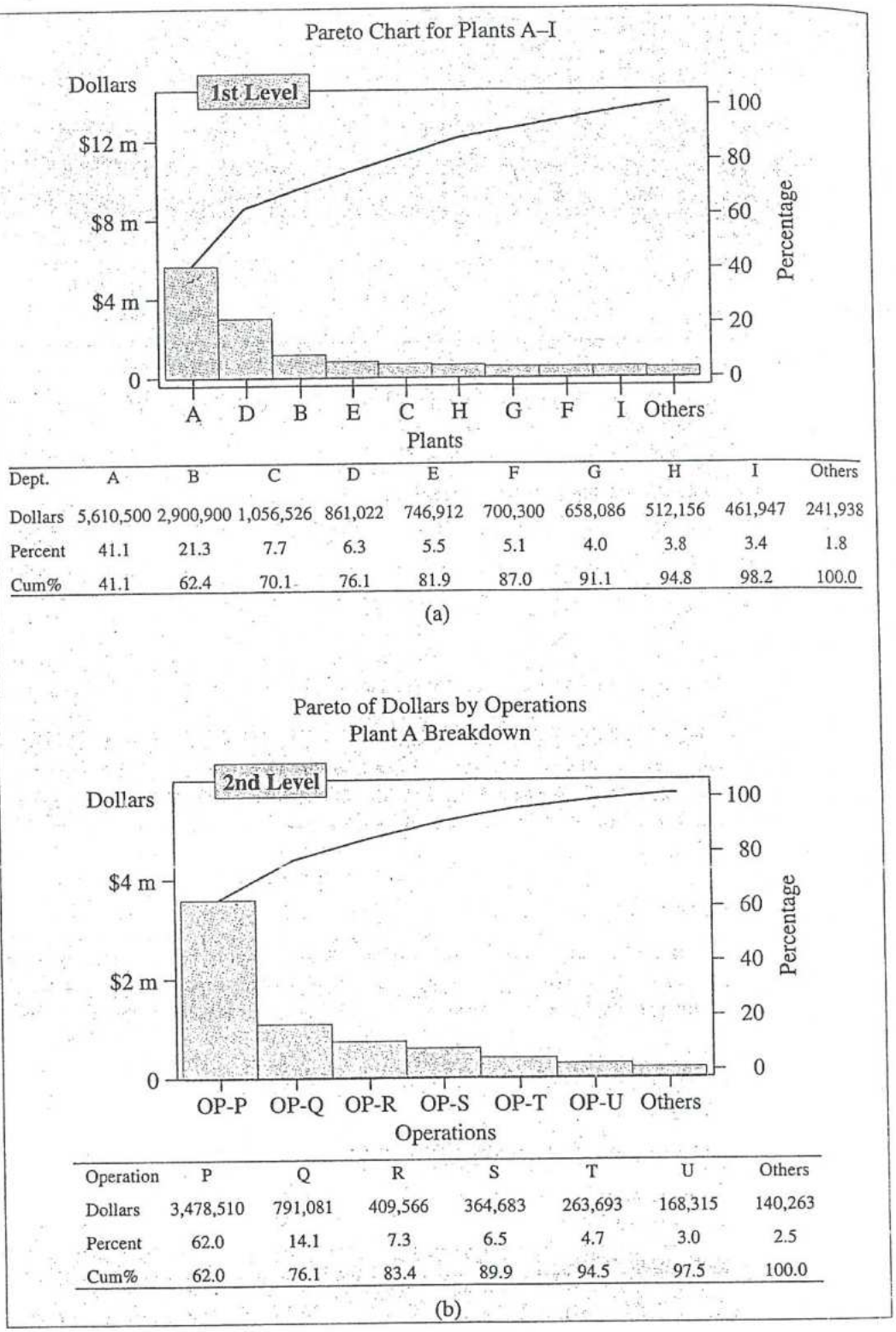
The **measure phase** involves two major steps:

1. Selecting process outcomes
2. Verifying measurements

We discuss these separately.

Selecting Process Outcomes

Table 13-3 shows the tools often used in the measure phase. To define process outcomes, you first need to understand the process. This involves process mapping. The process map uses the same approach defined in Chapter 10. A *process map* is a flowchart with responsibility.



Dept.	A	B	C	D	E	F	G	H	I	Others
Dollars	5,610,500	2,900,900	1,056,526	861,022	746,912	700,300	658,086	512,156	461,947	241,938
Percent	41.1	21.3	7.7	6.3	5.5	5.1	4.0	3.8	3.4	1.8
Cum%	41.1	62.4	70.1	76.1	81.9	87.0	91.1	94.8	98.2	100.0

(a)

Operation	P	Q	R	S	T	U	Others
Dollars	3,478,510	791,081	409,566	364,683	263,693	168,315	140,263
Percent	62.0	14.1	7.3	6.5	4.7	3.0	2.5
Cum%	62.0	76.1	83.4	89.9	94.5	97.5	100.0

(b)

FIGURE 13-9 Pareto Analysis

Problem Statement:	In 2011, plant A lost $5.6 million on COPQ. Of this, almost $3.5 million occurred in operation P (see Figure 13-9). This has resulted in a loss of profitability for the firm.		
Project Goals/Objective:	Reduce COPQ for operation P by 30% by year end.		
Primary Metrics:	COPQ	Secondary Metrics:	Downtime for process
	Rework (% of sales)		Plant sales
	Scrap (% of sales)		Labor productivity
Team Members:	Bill S.		Scott W.
	Cynthia W.	Scott S.	

FIGURE 13-10 Problem Definition

In Figure 13-11 there is a high-level process map showing champion responsibilities in the Six Sigma process. Notice that any of the individual steps could be broken out into lower-level process maps. The goal with a process map is to identify non-value-added activities. Two important measures that are monitored are **defects per unit (DPU)** and **defects per million opportunities (DPMO)**.

The ***XY* matrix** is used to identify inputs (*X*s) and outputs (*Y*s) from a project you have mapped and are desiring to pursue. Figure 13-12 shows an *XY* matrix for a potential project. The inputs include dimensions, standard operating procedures (SOPs), and other inputs along the left-hand column. Output variables include key dimensions, sizes, flashing, and the presence of all needed welds. Each of the outputs is provided an importance weight (1–10). The relationship between each of the *X*s and *Y*s is placed in the matrix (1–10 scale). These are multiplied horizontally, with ranks and scores computed by multiplying each matrix cell by its weight and summing the products horizontally. As you can see, the most important aspects of the process are SOPs, weld schedules, and daily tip dressing.

TABLE 13-3 Measure-Phase Tools

Process map
XY matrix
FMEA
Gauge R&R
Capability assessment

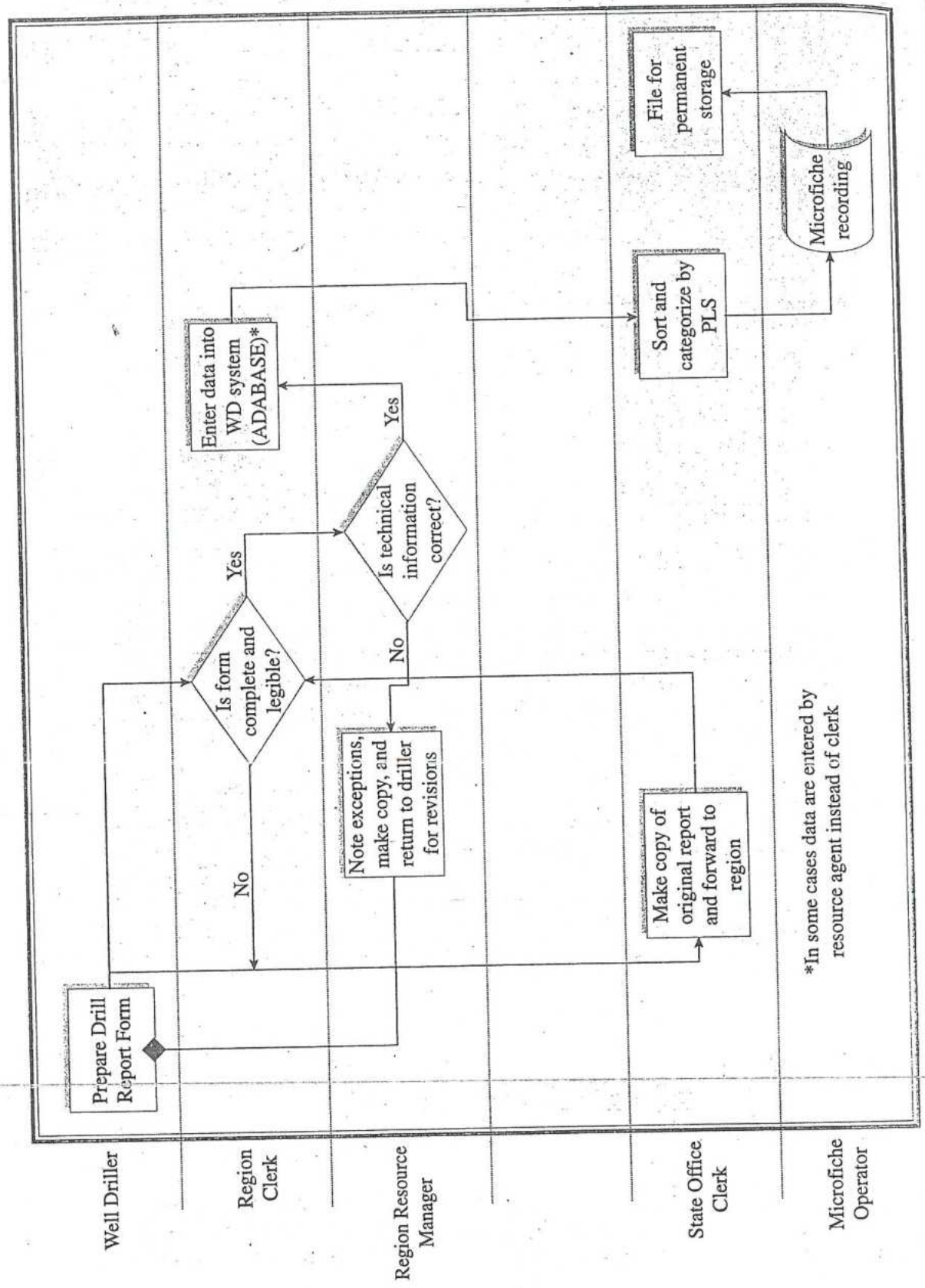


FIGURE 13-11 High-Level Process Map

XY Matrix Project: Welding Operation
Date: Oct. 14, 2011

	Output Variables	Width Dimension	Length Dimension	Assembly Size	Flash Free	All Welds Present	Product	Rank
	Rank	5	7	9	8	10		
	Inputs							
1	Width Grommet 1	10					50	8
2	Length Grommet 1		7				49	10
3	Subassembly Width	7					35	12
4	Subassembly Length		10				70	1
5	All SOPs	9	9		9	6	240	1*
6	Weld Schedule			10		10	190	2*
7	Air Pressure			5	5	5	135	4
8	Line Voltage			5	5	5	135	4
9	H_2O Circulation			5	5	5	135	4
10	Width Bracket 2	10					50	8
11	Length Bracket 2		7				49	10
12	Daily Tip Dressing			10	8		154	3*
13								
14								
15								

← Importance weights

(9×5)+(9×7) +(9×8) +(6×10) = 240

Relationship weights

FIGURE 13-12 *XY* Matrix

EXAMPLE 13-3 XY Matrix in Action

Problem: Figure 13-13 shows a matrix for a services process. On the left, inputs *A* through *G* are listed with their associated correlations with five different outputs.

Solution: Figure 13-14 shows the solution for Example 13-3. As you can see, inputs *F* and *D* should be studied especially closely.

FMEA

FMEA is used to identify ways a process or product can fail to meet critical customer requirements.

Verifying Measurements

When measuring critical characteristics of processes, it is necessary to use gauges, calipers, and other tools. Although these tools are often very accurate, there can be problems with variation in measurements. As a result, **measurement system analysis (MSA)** is used to determine if

Project: Service Process
Date: Oct. 14, 2011

	Inputs	Vendor Selection	Component Selection	Internal Lead Time	Cost	Ship to Location					
	Rank	7	10	8	9	5					
1	*A*		10	4	5						
2	*B*	9		7	2						
3	*C*	8	4		10						
4	*D*	10	9	8							
5	*E*	4		3		10					
6	*F*	4	7	8	5	10					
7	*G*	3	7		10						
8											
9											

FIGURE 13-13 *XY* Matrix for Example 13-3

measurements are consistent. Another approach for verifying measurements is to perform product and process capability analysis.

Gauge R&R

The most commonly used MSA is **gauge repeatability and reproducibility analysis (gauge R&R, sometimes referred to as gage R&R)**. Gauge R&R is used to determine the accuracy

Project: Service Process
Date: Oct. 14, 2011

	Inputs	Vendor Selection	Component Selection	Internal Lead Time	Cost	Shift to Location				Total	Rank	
	Rank	7	10	8	9	5						
1	*A*		10	4	5					177	5	
2	*B*	9		7	2					137	6	
3	*C*	8	4		10					186	3	
4	*D*	10	9	8						224	2	*
5	*E*	4		3		10				102	7	
6	*F*	4	7	8	5	10				257	1	*
7	*G*	3	7		10					181	4	
8												
9												

FIGURE 13-14 Solution to Example 13-3

Solution: Figure 13-15 shows the ANOVA table for these data. From the ANOVA table we can see that parts contribute most of the variation (sample row in the ANOVA table, $p = .000$), operator effect is insignificant (columns row in the ANOVA table, $p = .275$), and part–operator interactions are insignificant ($p = .881$). As a result, we conclude that the gauge measurement is repeatable and reproducible.

Using Excel to Perform Gauge R&R Analysis

The data need to be entered into an Excel spreadsheet exactly as shown in Figure 13-15. The labels for the operators are inserted in row 1. The part numbers are listed only once in column A as shown. And the data are entered as shown. This problem is set up for only two measurements per part. Follow the steps outlined in the figure. *Note*: Use two-factor analysis of variance with replication.

The results for Example 13-4 are shown in Figure 13-15. The *P*-value column in the ANOVA table shows what variables significantly contribute to variation.

ANALYZE PHASE

The **analyze phase** involves gathering and analyzing data relative to a particular black-belt project. Following are the analyze-phase steps:

1. Define your performance objectives.
2. Identify independent variables (*X*s).
3. Analyze sources of variability.

We discuss each of these steps separately. Because the tools used in this analysis were already discussed in Chapters 10, 11, and 12, we only refer to these tools. You may need to refer to the other chapters to refresh your memory about these tools.

Defining Objectives

When defining performance objectives, you are attempting to determine what characteristics of the process need to be changed to achieve improvement. First, capability analysis is reviewed to determine where the processes are incapable. These areas are prioritized in order of importance. As shown in Figure 13-16, capability analysis demonstrates whether certain quantitative parameters or discrete events are meeting specification. It helps to determine whether these parameters or events are centered on the mean and whether or not they meet specification. If they are not centered on the desired mean, the process mean needs to be adjusted. If there is too much variability, then the variability is reduced. We discuss means for reducing variation in the improve phase.

Identifying *X*s

This step involves identifying the independent variables where data will be gathered. These are variables that contribute significantly to process or product variation. Process maps, *XY* matrices, brainstorming, and FMEAs are the primary tools used in identifying *X*s.

Analyzing Sources of Variation

The goal of this step is to use visual and statistical tools to better understand the relationships between dependent and independent variables (*X*s and *Y*s) for use in future experimentation. A number of tools are used in this analysis. They include histograms, box plots, scatter plots, regression analysis, and hypothesis tests.

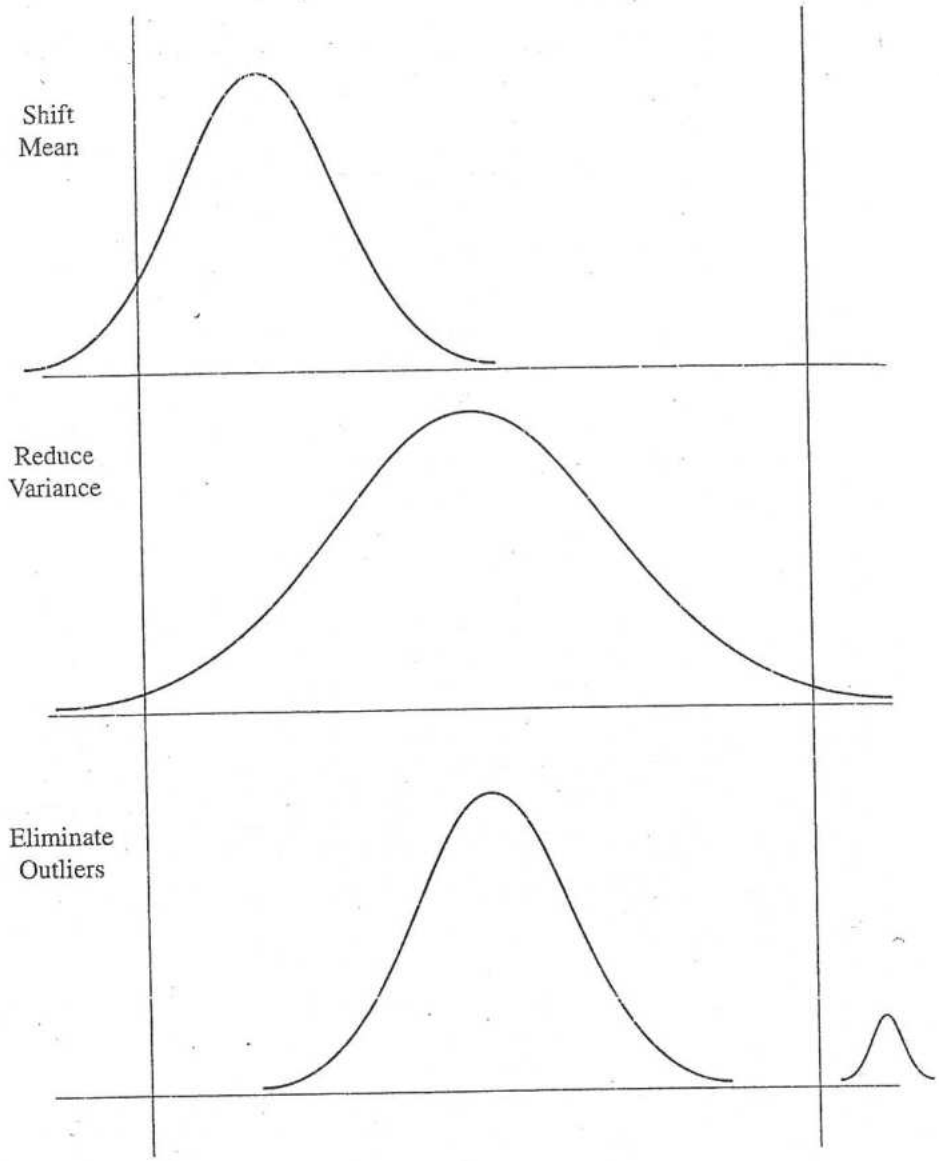


FIGURE 13-16 Capability Results

IMPROVE PHASE

The **improve phase** of the DMAIC process involves offline experimentation. Offline experimentation involves studying the variables we have identified and using ANOVA to determine whether these independent variables significantly affect variation in our dependent variables. We introduce an important method for performing offline experiments, the *Taguchi method.*

CONTROL PHASE

The **control phase** involves managing the improved processes using process charts and implementing control plans. These topics were covered in Chapters 11 and 12.

TAGUCHI DESIGN OF EXPERIMENTS

Many different factors, inputs, or variables need to be considered when making a product. For example, suppose that you wanted to bake a cake. How much flour should you use? How many eggs? How long should it bake? At what temperature should you set the oven? Probably you would find a recipe to follow. What if there were no recipes, and you were the pioneer trying to invent the best combinations of inputs to bake a cake? Likely you would have to resort to trial and error. However, there is a better way to design an experiment to find out the best combination of variables to make your product (cake).

The **Taguchi method** is a standardized approach for determining the best combination of inputs to produce a product or service. This is accomplished through **design of experiments** (DOE) for determining parameters. DOE is an important tool in the arsenal of tools available to the design and process engineer. It provides a method for quantitatively identifying just the right ingredients that go together to make a high-quality product or service. In this section we discuss first the Taguchi definitions, stages, and behavioral issues that form Taguchi's approach to design of experiments. The purpose here is to introduce concepts and processes relating to the Taguchi method from a managerial perspective. The more technical engineering explanation is available in a variety of engineering books. Taguchi approaches design from four perspectives: robust design, concept design, parameter design, and tolerance design. These are defined in the following paragraphs.

Robust Design

The Taguchi concept of **robust design** states that products and services should be designed so that they are inherently defect-free and insensitive to random variation. The concept is not necessarily new. The notion that products and services should be designed to be of high quality or that processes should be defect-free is as old as mass assembly. However, Taguchi has provided new approaches for creating robust designs through a three-step method of concept design, parameter design, and tolerance design.

Concept design is the process of examining competing technologies to produce a product. Concept design includes process technology choices and process design choices. Appropriate choices in these areas can reduce production costs and result in higher-quality products. In a *copying* store, concept design includes layout choices and choices of technology. Each candidate copying machine is tested separately to determine its suitability for the job. In financial services companies, this step likely will involve user groups, MIS staff, and systems analysts in defining processes and choices of equipment and technology.

Parameter design refers to the selection of **control factors** and the determination of **optimal levels** for each of the factors. Control factors are those variables in a process that management can manipulate. For example, the type and amount of training provided to customer service representatives is controlled by management. If it is determined that the amount of training received by customer service representatives determines the quality of service provided the customer, then training is identified as a control factor. Control factors do not affect production costs. Optimal levels are the targets or measurements for performance. For example, a sheet of paper is 8.5 inches wide. This would be the target. The goal is to find the most efficient process and service design. Parameter design involves selecting the best level for performance. For example, in baking cookies, what is the best temperature and time for baking? These parameters can be determined through experimentation.

Tolerance design deals with developing specification limits. Tolerance design occurs after parameter design has been used to reduce variation and the resulting improvement has been insufficient. This often results in an increase in production costs. For example, in tolerance design, engineers selectively tighten specified tolerances and require the use of higher-grade materials in production.

Of these four design considerations, the Taguchi method focuses primarily on parameter design. Getting back to our cake-baking example, using the Taguchi method, we could identify

the best amounts of heat, baking time, flour, eggs, and other ingredients to make the best tasting cake. These ingredients are called *parameters.* Their best amounts are referred to as *levels* or *settings.*

BACKGROUND OF THE TAGUCHI METHOD

The Taguchi method was first introduced by Dr. Genichi Taguchi to AT&T Bell Laboratories in 1980. Thanks to its wide acceptance and utilization, the Taguchi method for improving quality is now commonly viewed as comparable in importance to statistical process control (SPC), the Deming approach, and the Japanese concept of total quality control. From a historical perspective Taguchi's method is a continuation of the work in quality improvement that began with Shewhart's work in statistical quality control (SQC) and Deming's work in improving Japanese quality. The Taguchi method provides

1. A basis for determining the functional relationship between controllable product or service design factors and the outcomes of a process.
2. A method for adjusting the mean of a process by optimizing controllable variables.
3. A procedure for examining the relationship between random noise in the process and product or service variability.

Among the unique aspects of the Taguchi method are the Taguchi definition of quality, the quality loss function (QLF), and the concept of robust design. These are discussed briefly in the following paragraphs.

Taguchi Definition of Quality

The traditional definition of quality was conformance to specification. However, Taguchi diverges from the traditional view of conformance quality. In Taguchi terms, **ideal quality** refers to a reference point or target value for determining the quality level of a product or service. This reference point is expressed as a target value. Ideal quality is delivered if a product or a tangible service performs its intended function throughout its projected life under reasonable operating conditions without harmful side effects. In services, because production and consumption of the service often occur simultaneously, ideal quality is a function of customer perceptions and satisfaction. Taguchi measures service quality in terms of loss to society if the service is not performed as expected.

Quality Loss Function

In Figure 13-17 a measurement is taken of the critical product characteristic. This is shown in the figure as *A*. If *A* is within the specification limits, the traditional conclusion was that it wasn't a problem. However, point *A* is closer to being out of specification than to being at the target measurement. This means that over time it might cause a problem. Taguchi calls this potential for

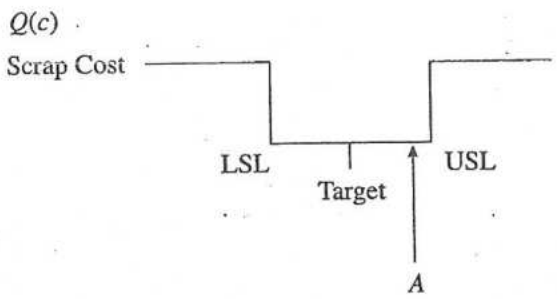


FIGURE 13-17 Classical QC-Step Function

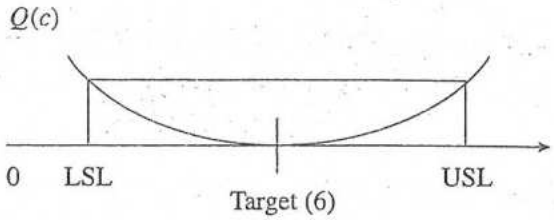


FIGURE 13-18 Taguchi Quadratic Loss Function

problem a potential **loss to society**. In a "hard-core" manufacturing operation, Taguchi identifies these losses to society not only in terms of rejection, scrap, or rework but also in terms of pollution that is added to the environment, products that wear out too quickly, or other negative effects that occur. Loss to society is the cost of a deviation from a target value.

To quantify loss to society, Taguchi used the concept of a *quadratic loss function.* Figure 13-18 shows that any variation from the target of six (where $T = 6$) results in some loss to the company. The **quality loss function (QLF)** focuses on the economic and societal penalties incurred as a result of purchasing a nonconforming product. Losses may include maintenance costs, failure costs, ill effects to the environment such as pollution, or excessive costs of operating the product. The QLF is determined by first computing the constant

$$K = C/T^2 \tag{13.2}$$

where

K = a constant
C = the unit repair cost
T = a tolerance interval (the allowable variation in a parameter)

After computing the constant, next compute

$$L = K * V^2 \text{ (\$/unit)}$$

where

L = the economic penalty incurred by the customer as a result of the product quality deviation
V^2 = the mean squared deviation from the desired target value

The application of this concept is demonstrated in the followed example.

EXAMPLE 13-5 Application of the QLF

Problem: Suppose the cost to repair a radiator on an automobile is \$200. Compute the QLF for losses incurred as a result of a deviation from a target setting where a tolerance of 6 ± 0.5 mm is required and the mean squared deviation from the target is $(1/6)^2$.

Solution:

$$K = 200/.5^2 = 800, \text{ and}$$

$$L = K * V^2 = 800 * (1/6)^2 = \$22.22/\text{unit}$$

Therefore, the loss caused by deviation from the target standard is \$22.22 per unit. When we can compare the costs of other defectives, we can establish priorities for implementing product design improvement.

The QLF deviated from the historical concept of statistical based control charting and the establishment of specification limits in that any deviation from the target or mean specification is expressed in terms of an economic loss to the customer.

THE TAGUCHI PROCESS

An outline is presented here of the steps in the Taguchi process. Although the Taguchi process is viewed as fairly technical and statistical, a major component involves behavioral steps such as teamwork and brainstorming. We now examine the steps in the Taguchi process. As shown in Figure 13-19, a series of six steps is followed in the initial phase of the Taguchi experiment. These steps are described in the following paragraphs.

1. ***Problem identification.*** First, the production problem must be identified. The problem may have to do with the production process or the service itself.

2. ***Brainstorming session.*** Second, a brainstorming session to identify variables that have a critical effect on service or product quality takes place. At a minimum, the brainstorming session is attended by the project facilitator/leader and workers taking part in the process to be changed. Managers attending the brainstorming session should be careful that their attendance does not stifle frank discussion among the session participants. In services and manufacturing environments, managerial practices are often critical variables impeding ideal, quality results. When appropriate, technical staff members such as computer programmers or systems analysts also attend. The role of the facilitator is to initiate the brainstorming session, to maintain a non-judgmental environment conducive to discussion, and to document the discussion for future use.

The critical variables identified in this session are referred to by Taguchi as *factors.* These may be identified as either *control factors* (variables that are under the control of management) or **noise factors** (uncontrollable variation). Examples of control factors within a production process might be procedures, amount of lighting, or ambient temperature setting. Noise-factor examples include uncontrollable variation in temperature, variations in human performance, or environmental variables that cannot be controlled.

Once these factors have been identified, different levels or settings of the control factors are defined. For example, three or four possible levels of ambient temperature settings may be identified for the production of silicon wafers. At least three levels should be used for each factor in order to identify functional forms (such as interactions) of the effects more clearly. Possible

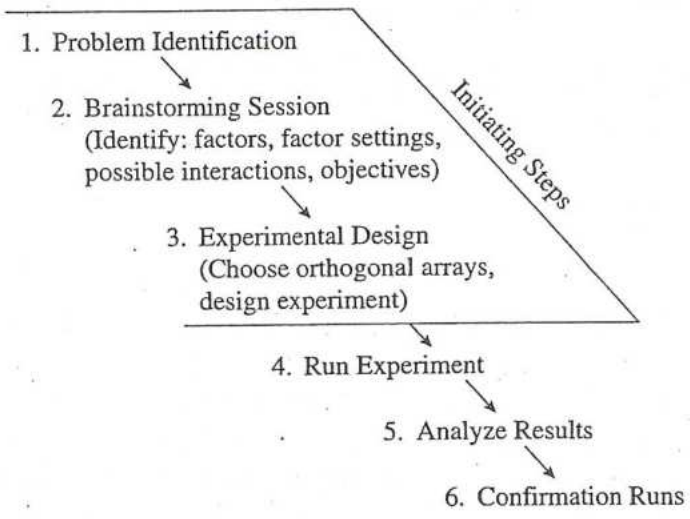


FIGURE 13-19 Taguchi Process

interactions between factors should be identified during the brainstorming session. Noise factors can be measured at the time of the experiment and included in the analysis.

Once the decision variables are established, *objectives of the experiments should be defined.* Examples of objectives are the less the better, nominal is best, or the more the better. These objectives are defined as follows:

- ***The less the better.*** This desired level of defectives or errors is as close to zero as possible. For example, in a cake-baking process, we may want zero "fallen" cakes. In an egg-packaging process, we desire the lowest number possible of broken eggs.
- ***Nominal is best.*** This desired outcome usually relates to a measurement. For example, we may desire to have all boards exactly 0.75 inches thick or all sheets of paper 8.5 inches wide.
- ***The more the better.*** This desired outcome is the opposite of the less the better. We may desire the maximum number of computer chips per lot without defects. We may want maximum weight gain from a nutrient we give to a farm animal.

3. ***Experimental design.*** Using the factors, factor levels, and objectives from the brainstorming session, the experiment is designed. The Taguchi method uses **offline experimentation** as a means of improving quality. This contrasts with traditional online (in-process) quality measurement. For this reason, the experimental design is a key consideration in conducting a Taguchi experiment. As with any experiment, care should be taken in selecting an appropriate number of trials and with the conditions for each trial, such as means of performing measurements, maintaining continuity with objectives, and reducing random noise by providing sufficient controls. The number of **replications** to be used in the experiment should be established beforehand.

4. ***Experimentation.*** Different Taguchi analysis approaches use quantitatively rigorous techniques, such as ANOVA, signal-to-noise (S/N) ratios, and response charts. These approaches, although not always theoretically sound,[3] are useful in engineering related projects involving engineered specifications, torques, and tolerances.

For services, the approach advocated by Ross[4] may be the most useful. This methodology is more intuitively understandable for management and provides essentially the same results as ANOVA and S/N ratios. What is compromised with the Ross methodology is the additional information provided by the more quantitative results of ANOVA and S/N ratios. Here are the experimental steps used in this methodology:

a. Choose the appropriate orthogonal array for the experiment. (**Orthogonal arrays** are tools to maintain independence between the successive trials of a Taguchi experiment.) The appropriate orthogonal array is determined by the number of factors and levels chosen from the brainstorming session. A number of standard orthogonal arrays can be found in the book mentioned in the footnotes.
b. Run the experiment for the appropriate number of replications and record the results.
c. Compute average performance levels for each of the factors and levels.
d. Plot the average responses on a response chart showing the best outcomes in accordance with the objective of the experiment.

5. ***Analysis.*** Experimentation is used to identify the factors that result in closest-to-target performance. In essence, the best levels for all factors are determined. If interactions between factors are evident, two alternatives are possible. Either ignore the interactions (there is inherent risk to this approach) or, provided the cost is not prohibitive, run a full factorial experiment to detect interactions. The full factorial experiment tests all possible interactions among variables.

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[3]Box, G. E. P., and Bisgaard, S., "The Scientific Context of Quality Improvement," *Quality Progress* 20, 6 (June 1987): 54–61.
[4]Ross, P., *Taguchi Techniques for Quality Engineering* (New York: McGraw-Hill, 1988).

6. *Confirming experiment.* Once the optimal levels for each of the factors have been determined, a confirming experiment with factors set at the optimal levels should be conducted to validate the earlier results. If earlier results are not validated, the experiment may have somehow been significantly flawed. If results vary from those expected, interactions also may be present, and the experiment should, therefore, be repeated.

EXAMPLE 13-6 The Taguchi Method in Action

Problem: Here is a standard Taguchi problem. In this experiment it was determined that there were three important factors (*X*s) in producing a wood product. These factors were

- *A*: Pressure applied in treatment
- *B*: Drying temperature
- *C*: Process time

For each of these factors, two levels were established for each setting:

- *A*: 250 psi, 300 psi
- *B*: 150 degrees, 180 degrees
- *C*: 3 hours, 4 hours

We need to determine the best levels for each of the settings. The objective is the more the better.

Solution: When performing a Taguchi experiment, you need to use an orthogonal array. Because we have three levels with two factors, a full-factorial experiment would require $2^3 = 8$ trials. The Taguchi method is much more economical, so the L_4 (2^3) orthogonal array (the right array for the job) is used to perform this experiment. The array looks like this:

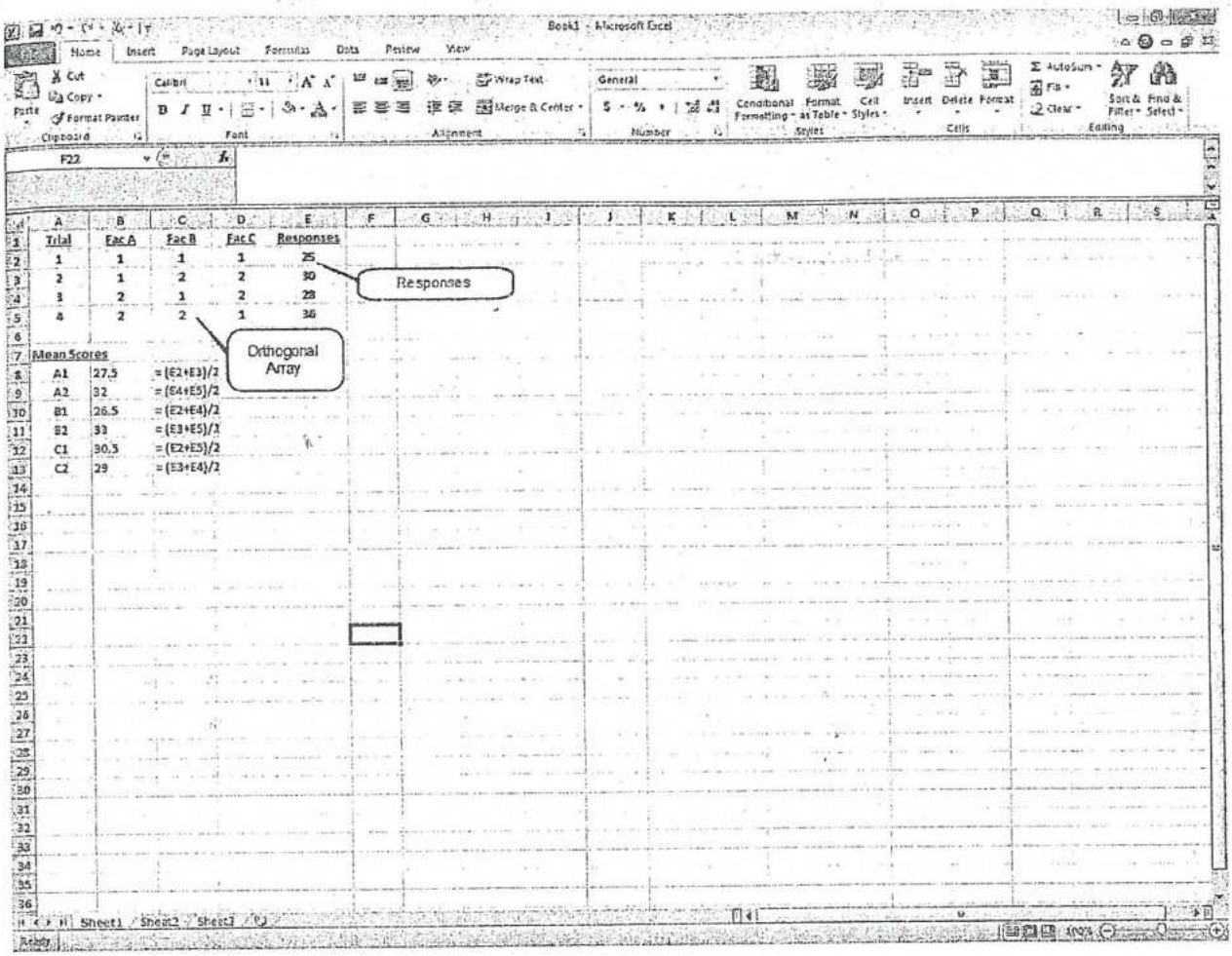
	Factors			
Trials	*A*	*B*	*C*	Responses
1	1	1	1	25
2	1	2	2	30
3	2	1	2	28
4	2	2	1	36

Interpreting the orthogonal array, you see there are three factors and only four trials are needed to run the experiment. Following the first line, this means that for the first trial we use settings A_1, B_1, and C_1. This means we use pressure applied at 250 psi, drying temperature at 150 degrees, and a process time of 3 hours. We then measure the outcome, and the responsiveness of the wood product is rated at 25. Similarly, for trial 2, we set the pressure at 250 psi, the temperature at 180, and the time at 4 hours. As you can now see, the 1s and 2s in the orthogonal array correspond to levels for each of the factors to be used during each trial of the experiment. Remember that a trial is an iteration or "run" of the experiment.

Determining the best levels for each factor requires computing averages and analysis of variance. We demonstrate this in Excel.

Using Excel to Solve Taguchi Experiments

Figure 13-20 shows the results of our Taguchi experiment. To compute our mean scores, we averaged the responses for each factor and level. That is, in trials 1 and 2, factor *A* was set at level 1.



Trial	Fac A	Fac B	Fac C	Responses
1	1	1	1	25
2	1	2	2	30
3	2	1	2	28
4	2	2	1	36

Mean Scores		
A1	27.5	=(E2+E3)/2
A2	32	=(E4+E5)/2
B1	26.5	=(E2+E4)/2
B2	33	=(E3+E5)/2
C1	30.5	=(E2+E5)/2
C2	29	=(E3+E4)/2

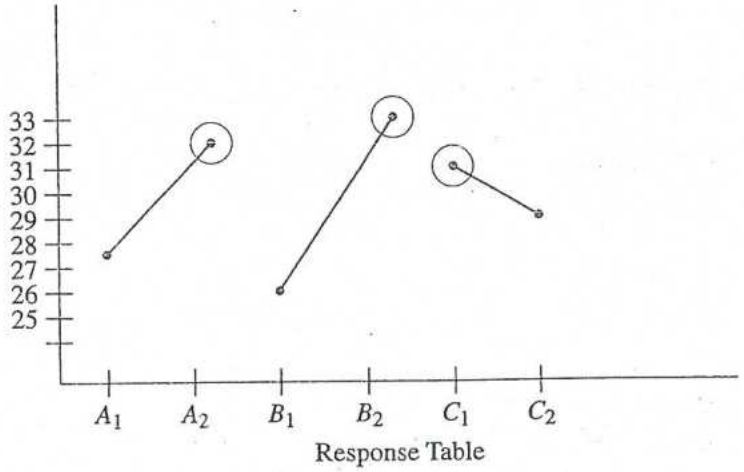


FIGURE 13-20 Example 13-6 Results

Therefore, the average response when factor A was at level 1 was $(25 + 30)/2 = 27.5$. However, when factor A was set at level 2, the mean response was 32. Because our objective is the more the better, the higher response is preferred. Similarly, B_2 and C_1 are preferred settings. This means that the best settings are as follows:

- Pressure applied in treatment = 300 psi
- Drying temperature = 180 degrees
- Process time = 3 hours.

DESIGN FOR SIX SIGMA

Design for Six Sigma (DFSS) is used in designing new products and services with high performance as measured by customer-based critical-to-quality metrics. Instead of the DMAIC methodology, DFSS requires the **DMADV process** (design, measure, analyze, design, verify). Another method for DFSS is **IDOV** (identify, design, optimize, verify). IDOV is focused on final engineering design optimization. These methods are customer-focused, encompassing the entire business-to-market process, and pertain to both services and products. Whereas DMAIC pertains to improving existing processes and products, DMADV pertains to developing new processes and products.

LEAN-SIX SIGMA FROM A CONTINGENCY PERSPECTIVE

As we stated early in the chapter, lean-Six Sigma is a very popular approach for improving the robustness of designs and processes. As you have seen, this approach is very technical and requires special expertise in the form of black-belt specialists. This method can be very useful for companies that need to improve their cost and efficiency through quality efforts.

As with any quality improvement approach, when people implement lean-Six Sigma without thoroughly understanding their processes, sometimes processes fail. Some reasons for lean-Six Sigma failures include

- Lack of leadership by champions
- Misunderstood roles and responsibilities
- Lack of appropriate culture for improvement
- Resistance to change and the Six Sigma structure
- Faulty strategies for deployment
- Lack of data

As with any quality improvement approach, a culture, leadership, and commitment need to be in place to make the effort successful. Also, key to lean-Six Sigma success is the availability of data for projects. Companies where good process data are not available will struggle getting outstanding results from their lean-Six Sigma efforts.

Summary

In this chapter we discussed lean-Six Sigma. We emphasized both managerial and technical requirements for lean-Six Sigma. The process for Lean-Six Sigma is define, measure, analyze, improve, and control.

Many companies have reported outstanding results with lean-Six Sigma. There are also many failures. Keys to lean-Six Sigma success are skilled management, leadership, and long-term commitment.

Key Terms

Analyze phase
Black belt
Business case
Champion
Concept design
Control factors
Control phase
Defects per million opportunities (DPMO)
Defects per unit (DPU)
Define phase
Design for Six Sigma (DFSS)
Design of experiments (DOE)
DMADV (design, measure, analyze, design, verify) process
DMAIC (define, measure, analyze, improve, control) process
Gauge repeatability and reproducibility analysis (gage R&R)
Green belts
Ideal quality
IDOV (identify, design, optimize, verify)
Improve phase
Lean
Lean-Six Sigma
Loss to society
Master black belts
Measure phase
Measurement system analysis (MSA)
Muda
Noise factors
Offline experimentation
Optimal levels
Orthogonal arrays
Parameter design
Project risk assessment
Pull production
Quality loss function (QLF)
Replications
Robust design
RUMBA (realistic, understandable, measurable, believable, actionable)
Six Sigma
Taguchi method
Tolerance design
XY matrix
Yellow belts

Discussion Questions

1. Can you think of an example where the Taguchi quality loss function (QLF) would work in real life? Discuss how it might work.
2. How does the Taguchi concept of ideal quality compare to other definitions of quality discussed in Chapter 1?
3. How could the Taguchi method be used to design a course in quality management? Identify all the variables, measures, and objectives.
4. Why are behavioral processes such as brainstorming important for the Taguchi method?
5. How would you cost-benefit a Taguchi experiment? What might be some of the quantifiable parameters you would use in evaluating the worth of a Taguchi experiment?
6. The chapter cites different services implementations of the Taguchi method. Do you think the Taguchi method is useful for services? Why or why not? Why do you think the technique has not been widely adopted in services?
7. Where do you think that lean-Six Sigma can be used effectively?
8. How will risk assessments vary from industry to industry?
9. How might the principles of Six Sigma be used to improve a quality process in a service industry? What changes might be required to implement a Six Sigma process in the service industries? Are they likely to be easy or difficult?
10. What is different between lean-Six Sigma and traditional quality improvement?

Problems

1. Part of a Six Sigma project is to identify *X*s and *Y*s. What are the *X*s you can identify for student satisfaction with a quality management course? Use the *Y* (dependent variable) of student satisfaction with a quality management class.
2. Part of a Six Sigma project is to identify *X*s and *Y*s. Identify *X*s and *Y*s for an athletic director of a major university (insert the name of your university here) who is interested in increasing attendance at football games.
3. Part of a Six Sigma project is to identify *X*s and *Y*s. Identify these variables for the owner of a copy shop who is interested in reducing mistakes in orders.
4. Develop a problem definition (see Figure 13-10) for the project in Problem 3.

5. Complete the *XY* matrix for the following data:

XY						
Matrix						
	Outputs					
	A	B	C	D	Total	Rank
Ranks:	4	6	5	9		
Inputs						
1	10					
2			5			
3		7				
4				8		
5		3	5			

Which inputs are the most important?

6. Complete the *XY* matrix for the following data:

XY							
Matrix							
	Output						
	A	B	C	D	E	Total	Rank
Ranks:	3	8	9	6	7		
Inputs							
1	4	3	5	1	2		
2	5	3	6		2		
3		7	9		2		
4	3	5	4	8	2		
5	1	3	5	1	2		

Which inputs are the most important?

7. Find the QLF for the following information:
   $C = 300$
   $T = .25$
   $V = 1/3$

8. Compute the QLF for the following information:
   $C = 250$
   $T = .40$
   $V = 1/6$

9. It costs \$50 to repair a component in a VCR. Compute the QLF for losses incurred as a result of a deviation from a target setting with a nominal tolerance of 10 ± 0.25 mm required. The mean squared deviation is $1/2$.

10. It costs \$350 to repair a refrigerator compressor. Compute the QLF for losses incurred as a result of a deviation from a target setting with a nominal tolerance of 60 amps, where a 2-amp variation is acceptable. The mean squared deviation is $1/5$.

11. For a component, the following measurements were taken:

2.04	2.05	2.03	2.04
1.96	1.97	1.95	1.96
2.03	2.04	2.02	2.03
2.02	2.03	2.01	2.02
1.99	2.00	1.98	1.99

If the nominal target value is $2 \pm .05$, compute the QLF for this component where the repair cost is \$200.

12. Here are answers to the worksheets in Figures 13-6 and 13-7. Using these responses, develop a risk assessment for this project. Produce a risk and return matrix to determine if this project is worth pursuing. Use the weights in Figure 13-6.

1. Yes
2. No
3. No
4. Uncertain
5. Yes
6. No
7. No
8. No
9. Uncertain
10. Yes
11. No
12. Uncertain
13. Yes
14. Yes
15. Yes
16. No
17. No
18. No
19. Yes
20. Yes

21–24. All Uncertain

Return scale A: 1 (growth)
Return scale B: 4 (urgency)
Return scale C: 3 (impact)

13. Here are answers to the worksheets in Figures 13-6 and 13-7. Using these responses, develop a risk assessment for this project. Produce a risk and return matrix to determine if this project is worth pursuing. Use the weights in Figure 13-6.

1. No
2. Yes
3. No
4. Yes
5. Uncertain
6. Yes
7. No
8. No
9. Uncertain
10. No
11. Yes
12. Yes
13. Yes
14. Yes
15. Yes
16. Yes
17. Uncertain
18. Yes
19. Yes
20. Yes

21–24. All Uncertain

Return scale A: 3 (growth)
Return scale B: 4 (urgency)
Return scale C: 5 (impact)

14. Using the following data, perform a gauge R&R analysis where there are two replications for each part number.

Part Number	Operator 1	Operator 2	Operator 3
1	28.35	27.20	26.03
	27.00	27.20	28.77
2	32.40	32.64	31.51
	31.05	32.64	32.88
3	27.00	25.84	27.40
	28.35	28.56	30.14
4	36.45	38.08	36.99
	36.45	35.36	38.36
5	25.65	25.84	24.66
	24.30	24.48	28.77
6	31.05	32.64	31.51
	28.35	28.56	30,14
7	29.70	29.92	30.14
	28.35	32.64	27.40
8	25.65	24.48	26.03
	22.95	27.20	24.66
9	32.40	34.00	32.88
	31.05	31.28	32.88
10	33.75	35.36	32.88
	31.05	34.00	34.25
11	28.35	27.20	28.77
	27.00	27.20	27.40
12	24.30	23.12	24.66
	25.65	25.84	26.03
13	31.05	34.00	34.25
	33.75	34.00	34.25
14	32.40	31.28	32.88
	32.40	34.00	34.25
15	39.15	40.80	42.47
	40.50	38.08	41.10
16	35.10	34.00	34.25
	35.10	35.36	36.99
17	27.00	25.84	27.40
	27.00	27.20	27.40
18	25.65	25.84	28.77
	28.35	25.84	31.51
19	33.75	34.00	34.25
	35.10	32.64	34.25
20	25.65	24.48	26.03
	25.65	23.12	23.29

15. Perform a gauge R&R analysis for the following data where there are three replications. What are your findings?

Part Number	Operator 1	Operator 2	Operator 3
1	21	20	19
	20	20	21
	21	20	21
2	24	24	23
	23	24	24
	22	23	24

Part Number	Operator 1	Operator 2	Operator 3
3	20	19	20
	21	21	22
	22	22	22
4	27	28	27
	27	26	28
	26	25	26
5	19	19	18
	18	18	21
	19	18	16
6	23	24	23
	21	21	22
	22	22	21
7	22	22	22
	21	24	20
	24	24	23
8	19	18	19
	17	20	18
	19	18	19
9	24	25	24
	23	23	24
	24	25	24
10	25	26	24
	23	25	25
	25	24	26
11	21	20	21
	20	20	20
	26	26	25
12	18	17	18
	19	19	19
	18	19	20
13	23	25	25
	25	25	25
	24	24	24
14	24	23	24
	24	25	25
	23	23	24
15	29	30	31
	30	28	30
	25	26	31
16	26	25	25
	26	26	27
	26	25	28
17	20	19	20
	20	20	20
	20	20	20
18	19	19	21
	21	19	23
	22	22	22
19	27	26	25
	25	25	25
	26	24	25
20	19	18	19
	19	17	17
	18	19	18

CASE

Case 13-1 The Neiman-Marcus Cookie

One of the fun urban legends to pop up on the Internet has been the Neiman-Marcus Cookie. This work is in the public domain and you might have seen it before. We present the legend here and propose that you develop a Taguchi experiment based on this recipe. It is written in the first person by an anonymous author.

My daughter and I had just finished a salad at Neiman-Marcus in Dallas and decided to have a small dessert. Because our family are such cookie lovers, we decided to try the "Neiman-Marcus Cookie." It was so excellent that I asked if they would give me the recipe, and the server said with a small frown, "I'm afraid not." Well, I said, would you let me buy the recipe? With a cute smile she said, "Yes." I asked how much, and she responded, "Two-fifty." I said with approval, just add it to my tab.

Thirty days later, I received my Visa statement from Neiman-Marcus, and it was $285. I looked again and I remembered I had only spent $9.95 for two salads and about $20 for a scarf. As I glanced at the bottom of the statement, it said, "Cookie Recipe—$250." Boy, was I upset!! I called Neiman's accounting department and told them the waitress said it was "two-fifty," and I did not realize she meant $250 for a cookie recipe.

I asked them to take back the recipe and reduce my bill, and they said they were sorry, but because all the recipes were this expensive so that not just anyone could duplicate any of the bakery recipes, . . . the bill would stand.

I waited, thinking of how I could get even or even try and get any of my money back.

I just said, "Okay, you folks got my $250, and now I'm going to have $250 worth of fun." I told her that I was going to see to it that every cookie lover will have a $250 cookie recipe from Neiman-Marcus for nothing. She replied, "I wish you wouldn't do this." I said, "I'm sorry, but this is the only way I feel I can get even," and I will.

So here it is, and please pass it to someone else or run a few copies . . . . I paid for it; now you can have it for free.

The Neiman-Marcus Cookie (recipe may be halved)

5 cups blended oatmeal
2 cups brown sugar
2 cups sugar
2 cups butter
2 tsp. soda
1 8-oz. Hershey bar, grated
2 tsp. baking powder
2 tsp. vanilla
4 cups flour
24 oz. chocolate chips
1 tsp. salt
4 eggs
3 cups chopped nuts

Measure oatmeal and blend in a blender to a fine powder. In a separate bowl, cream the butter and both sugars. Add eggs and vanilla, mix together with oatmeal, flour, salt, baking powder, and baking soda. Add chocolate chips, Hershey bar, and nuts. Roll into balls and place two inches apart on a cookie sheet. Bake for 10 minutes at 375 degrees. Makes 112 cookies.

Using this recipe and these production procedures, develop a Taguchi experiment to find the optimal process for making chocolate chip cookies. Be careful in identifying control factors, noise factors, objectives, and design the whole experiment.

CHAPTER 7

Quality and Innovation in Product and Process Design

We all prefer copiers whose copies are clear under low power; we all prefer cars designed to steer safely and predictably, even on roads that are wet or bumpy. . . . We say the products are robust. They gain steadfast customer loyalty.

—GENICHI TAGUCHI AND DON CLAUSING[1]

Have you ever needed a copy quickly but the copy machine was jammed? Have you ever worked against an impending deadline only to have a computer or a printer fail? Have you ever gotten into your car on a cold day to find it would not start? These annoyances are relatively minor. However, other examples of product failures can be catastrophic. If a lumberjack uses a defective chainsaw, he or she might lose an arm. If a heart monitor malfunctions, the results might be fatal to a patient. A race car driver's tires blow at 210 miles per hour, and a spinout results. A faulty fire alarm fails to alert the home's occupants until it is too late. These are major product failures that can result in severe injury or death.

In this chapter we focus on quality assurance. We have already learned that we cannot ensure quality at the final stages of inspection. After all, assurance is best achieved at the design stage.

DESIGNING PRODUCTS FOR QUALITY

In designing products, we must first answer many questions. For example, what are the functions the customer wants? What are the capabilities of current products? What are the limitations of the materials we have selected for the product? Are there better materials available? How much will the product cost to make? How much must the product cost to make it successful in the marketplace?

What does it mean to design products for quality? As we have already said, quality has many different dimensions. David Garvin's dimensions of quality from Chapter 1 make it clear that each dimension poses different design problems. Take the first dimension of performance.

[1]Taguchi, G., and Clausing, D., "Robust Quality," *Harvard Business Review* 68 (1990): 65–75.

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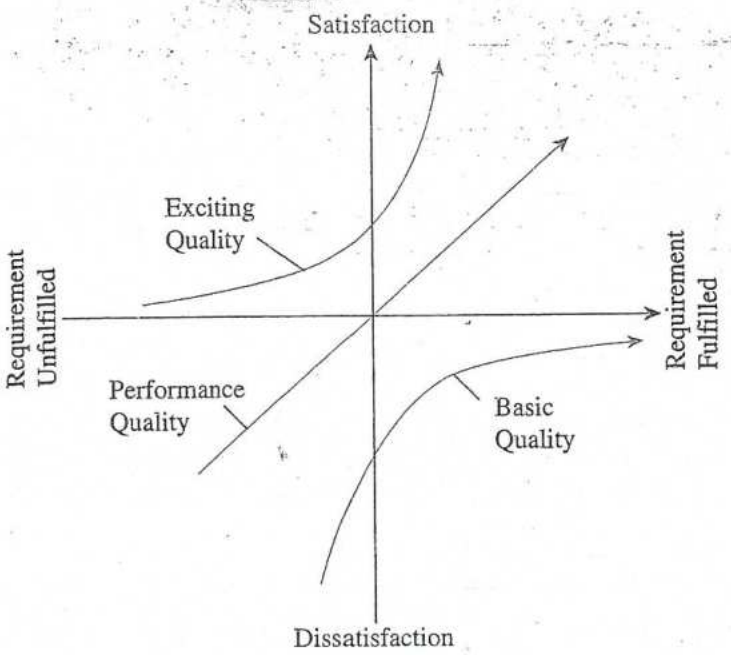


FIGURE 7-1 The Kano Model

What are the critical measurements of performance? How much performance does the customer want? How much performance is overkill? How do we balance competing dimensions of performance (e.g., audio output versus distortion)? Similar questions could be constructed concerning any of Garvin's product quality dimensions. All these questions must be answered early in the design process. For example, if durability is an important quality dimension for the producer of an electronic calculator, then the design team might actively investigate new polymers to find a durable housing for the internal electronics.

It might seem that materials choices are technical and should be made by engineers. However, engineers need input from marketing and operations to understand customer needs, marketing requirements, and the realities of production. Supply chain functions provide inputs on needs such as sourcing, logistics, and collaborations. Given free rein, engineers would design many products to the *n*th degree. If you don't believe this, look at a remote control for a DVD player or a television set. You will never use many of the buttons on the remote. A study was performed by Sony Corporation to determine which buttons were actually used by the customer. Based on the results of the study, the remotes for Sony televisions were simplified.

Professor Noriaki Kano of the Science University of Tokyo illuminates the relationship between quality and design with the **Kano Quality/Design Model** in Figure 7-1. The Kano model shows that quality is a function of fulfilling customer requirements and achieving high levels of satisfaction. He then distinguishes between basic quality, performance quality, and exciting quality. The goal should be exciting quality. As you contemplate the Kano model, you should realize that as time passes, customer demands will increase and what was once exciting will become a basic expectation.

THE DESIGN PROCESS

There are many different approaches to designing products. Even within the same industries, the approaches vary in some important ways. Yet there are some similarities across the board. For example, design projects often involve a project team rather than a single designer working independently. Preferably, these teams will work closely with customers to ensure that customer needs are met.

FIGURE 7-2 Product Development Process

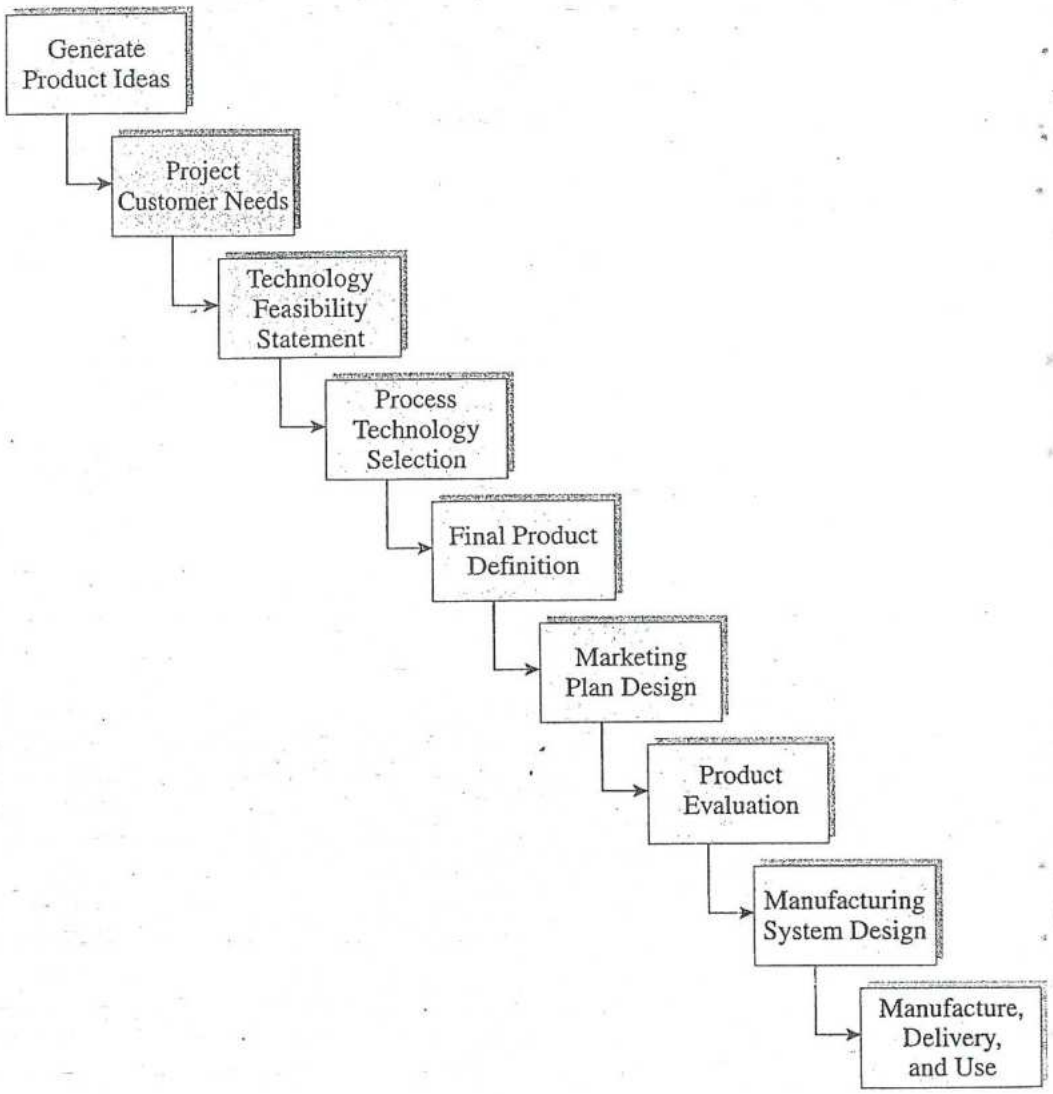
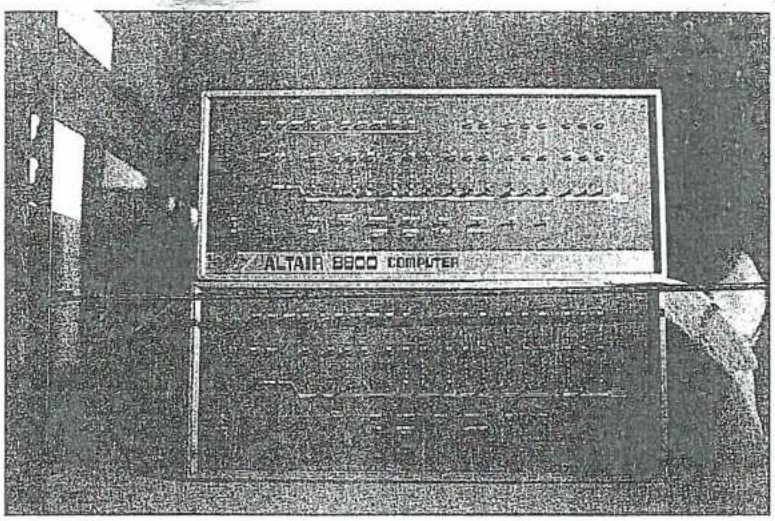


Figure 7-2 shows a generic approach to designing products. The design process includes nine phases that are interrelated. These stages begin with product idea generation and end with manufacture, delivery, and use. Project managers monitor design projects at each stage for cost and adherence to schedules.

Product idea generation is the first step. During this stage, external and internal sources brainstorm new concepts. Internal sources include marketing, management, research and development (R&D), and employee suggestions. The primary source for external product ideas is the customer. Original equipment manufacturers (OEMs) and contract manufacturers work closely with customers to develop new products. In other circumstances, customer needs are identified to generate product ideas. Other external sources for product ideas can be market-related sources such as industry experts, consultants, competitors, suppliers, and inventors. There are fundamental differences between R&D-generated ideas (known as *R&D push*) and marketing-generated ideas (known as *marketing pull*). R&D-generated ideas tend to be groundbreaking, risky, and technologically innovative. An example of R&D-based development was the Altair microcomputer. In the mid-1970s, the MITS (Micro Instrumentation and Telemetry Systems) Altair 8800 appeared on the cover of *Popular Electronics*. At the time, there was a very small market for this



Source: LiPo Ching/MCT/Newscom.

product. However, the article inspired two computer whizzes named Paul Allen and Bill Gates to develop a BASIC Interpreter for the Altair. The rest is history. Although there was not a large established market for personal computers, they have radically affected business and home life since their introduction.

Marketing-generated ideas tend to be more incremental—that is, they build on existing designs—and are better aligned with customer needs. For example, at the product idea-generation stage, a gap in the market or a customer need should be identified. Preliminary assessment of the marketability of the product is performed and funding provided for beginning development of a prototype of the product. Recent developments in computers have included technological developments such as improved multimedia capabilities and faster speeds as well as cosmetic changes in casings such as tablet designs and the use of clear plastics. These are marketing-oriented changes. As shown in Quality Highlight 7-1, new product ideas have enhanced the bottom line.

QUALITY HIGHLIGHT 7-1 A Turnaround at Kellogg's Cereals: Driven by Design[2]

www.kelloggcompany.com

Due to the leadership of Carlos Gutierrez, former CEO, Kellogg has regained the top spot in sales in the highly competitive cereal industry. Driving the turnaround is research and development (R&D). In the 1990s, the company only introduced two new products: Nutri-Grain Bars and Raisin Bran Crunch. Since 2000, over 100 food scientists have been busily working at the new R&D center in Battle Creek, Michigan. The results are evident—Kellogg generates over 100 new products per year! In addition, over 20% of Kellogg's sales are from new products—up from less than 5% in prior years.

Here is one example of a new product: Special K with Red Berries. When Kellogg marketers in France decided to jazz up Special K by adding freeze-dried berries, headquarters took notice. Cereal makers had tried using freeze drying in the 1970s, but freeze drying was more primitive back then and wreaked havoc with moisture levels in the cereal boxes, turning flakes into mush. Now, food scientists at Kellogg have perfected the technology, and the R&D folks in Battle Creek and Europe tinkered with a mix of tart raspberries and sweet cherries until they had the right blend. The cereal now generates over $100 million in sales according to figures that exclude Walmart sales.

[2]Adapted from "The Man Who Fixed Kellogg," *Fortune*, 6 September, 2004: 218–226.

Stage 2 is **customer future needs projection.** This uses data to predict future customer needs. Designers for Intel, the maker of the microprocessors for personal computers, have been masters at this. They have been able to project and introduce new products that are well timed to fit with changes in the technology requiring them. With the explosion of graphics in programs and on the Internet, Intel developed new chips to fit these needs. The company also has introduced these microprocessors at a rate that has not outstripped the ability of the market to absorb the new technology. At the same time, the company has been able to outpace competing microprocessor developers by staying slightly ahead of the technological curve.

The task of the product designer is to offer products with value that exceed customer needs at any point in time by careful planning and thought as to what future customer needs will be. There is no single approach to gathering information about future customer needs. Surveys might give insights, but they are usually insufficient to uncover emerging customer needs.

During **technology selection for product development**, designers choose the materials and technologies that will provide the best performance for the customer at an acceptable cost. A **technology feasibility statement** is used in the design process to assess a variety of issues such as necessary parameters for performance, manufacturing imperatives, limitations in the physics of materials, special considerations, changes in manufacturing technologies, and conditions for quality-testing the product. At this stage, preliminary work can be performed to identify key quality characteristics and potential for variability with each of the different materials.

Technology development for process selection means choosing those processes used to transform the materials picked in the prior step into final products. Careful technology selection of both automated and manual processes is key from a quality perspective because machinery, processes, and flows need to be developed that will result in a process insensitive to variations in ambient and material-related conditions.

Final product definition results in final drawings and specifications for the product with product families by identifying base product and derivative products.

Product marketing and supply chain preparation are marketing-related activities such as developing a marketing plan. The marketing plan should define customers and distribution streams. The production-related activities are identifying supply chain activities and defining distribution networks. Nowadays, this step often requires the design of after-sales processes such as maintenance, warranties, and repair processes that occur after the customer owns the product.

Product design and evaluation requires definition of the product architecture, the design, production, testing of subassemblies, and testing of the system for production. A product design specification (PDS) demonstrates the design to be implemented with its major features, uses, and conditions for use of the product. The PDS contains product characteristics, the expected life of the product, intended customer use, product development special needs, production infrastructure, packaging, and marketing plans.

Manufacturing system design is the selection of the process technologies that will result in a low-cost, high-quality product. The selection of process technology is a result of projected demand and the finances of the firm. Processes must be stable and capable of producing products that meet specification. One of the major developments in this area is that firms now desire the ability to change over to new products with a minimum of cost associated with defects. In the past, it was considered standard operating procedure to produce a certain amount of bad product to prove that the system works. For example, a producer of stove pipe would process a small batch of pipe, inspect the pipe and then adjust the line, produce another small batch and reinspect, and so forth until they *proved* the process. This is no longer considered a cost-effective means of introducing new products.

Finally, **product manufacture, delivery, and use** finish this process. The consumer then enjoys the result of the design process.

QUALITY FUNCTION DEPLOYMENT (QFD)

When you have determined customer needs, those needs must be translated into functional product design. **Quality function deployment (QFD)** describes a method for translating customer requirements into functional design. Sometimes this process of translation is referred to as the *voice of the customer*. The quality function deployment approach was developed by Dr. S. Mizuno,[3] a former professor of the Tokyo Institute of Technology. Since then, this approach has been used extensively throughout the world. In the United States, Hauser and Clausing,[4] two MIT professors, were central in researching and publishing articles describing this approach.[5]

Designers need a means for implementing customer requirements into designs. The house of quality illustrated in Figure 7-3 shows how QFD is used to accomplish this. The left wall on the **house of quality** contains a listing of customer requirements. The roof on the house of quality

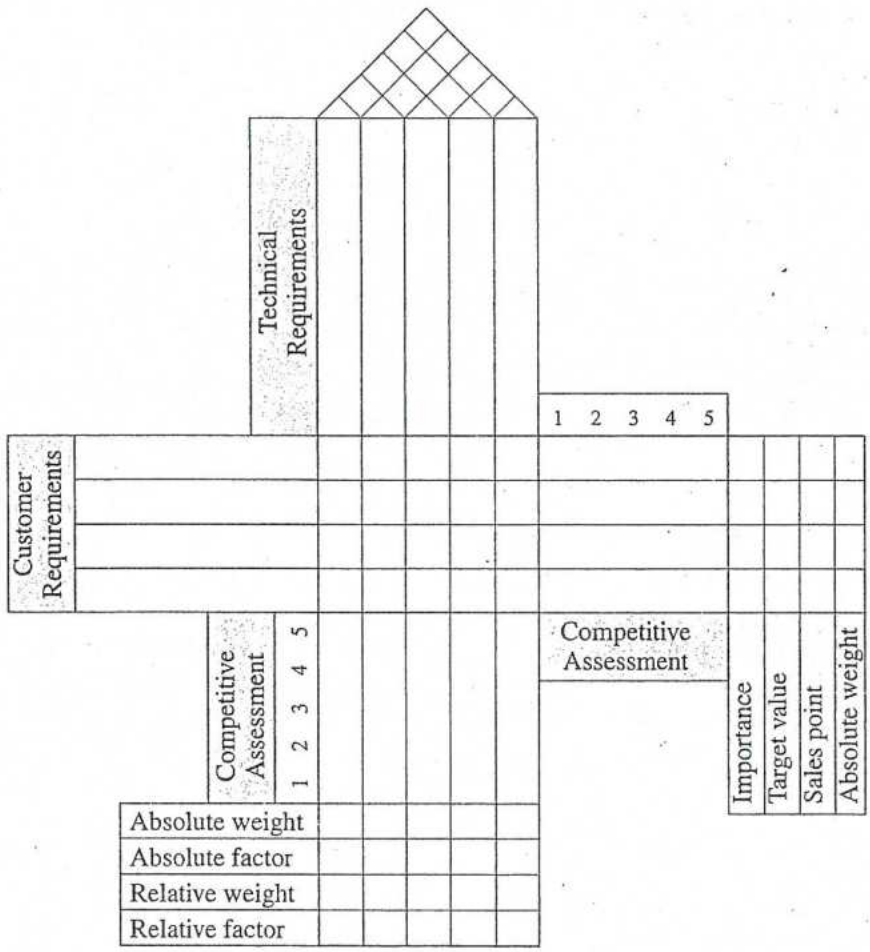


FIGURE 7-3 QFD Layout: The House of Quality

[3]Mizuno, S., and Akao, Y., "QFD: The Customer-Driven Approach to Quality Planning and Development," Asian Productivity Organization, Tokyo, Japan, 1994.
[4]Hauser, J., and Clausing, D., "The House of Quality," *Harvard Business Review* (May–June 1988): 63–73.
[5]Ibid.

Customer Requirements
Clean facilities
Comfortable seating
Delicious food
Responsive servers

FIGURE 7-4 QFD Customer Requirements

Customer Requirements	Technical Requirements: Type of tile	Dirt resistance of floor tiles	Seat material	Server training	Menu standardization
Clean facilities					
Comfortable seating					
Delicious food					
Responsive servers					

FIGURE 7-5 QFD Technical Requirements

lists technical requirements. We introduce QFD step by step so that you can see how a house of quality is developed and analyzed. Following are steps in performing a QFD:

1. ***Develop a list of customer requirements.*** The list of customer requirements includes the major customer needs as they relate to a particular aspect of a process. In Figure 7-4, a part of a QFD house of quality is shown with customer requirements for a restaurant. Customers want to have a clean restaurant, a comfortable seating arrangement, delicious food, and responsive servers.
2. ***Develop a listing of technical design elements along the roof of the house.*** These are the design elements that relate to customer needs. Figure 7-5 shows the design elements for the restaurant that may affect the customers' requirements. These design elements are building materials such as type of tile, dirt resistance of floor tiles, material used in making seats, training for servers, and standardization of menu.
3. ***Demonstrate the relationships between the customer requirements and technical design elements.*** A diagram can be used to demonstrate these relationships. The symbols shown in Figure 7-6 are used, and scores are assigned relating to these symbols (i.e., 1, 3, and 9).

FIGURE 7-6 QFD Technical Requirements and Customer Requirements Relationships

Customer Requirements	Technical Requirements: Type of tile	Dirt resistance of floor tiles	Seat material	Server training	Menu standardization
Clean facilities	●	●	○	△	
Comfortable seating			●		
Delicious food				△	●
Responsive servers				●	○

Symbols:
● = 9 (Strong association)
○ = 3 (Somewhat associated)
△ = 1 (Weak association)

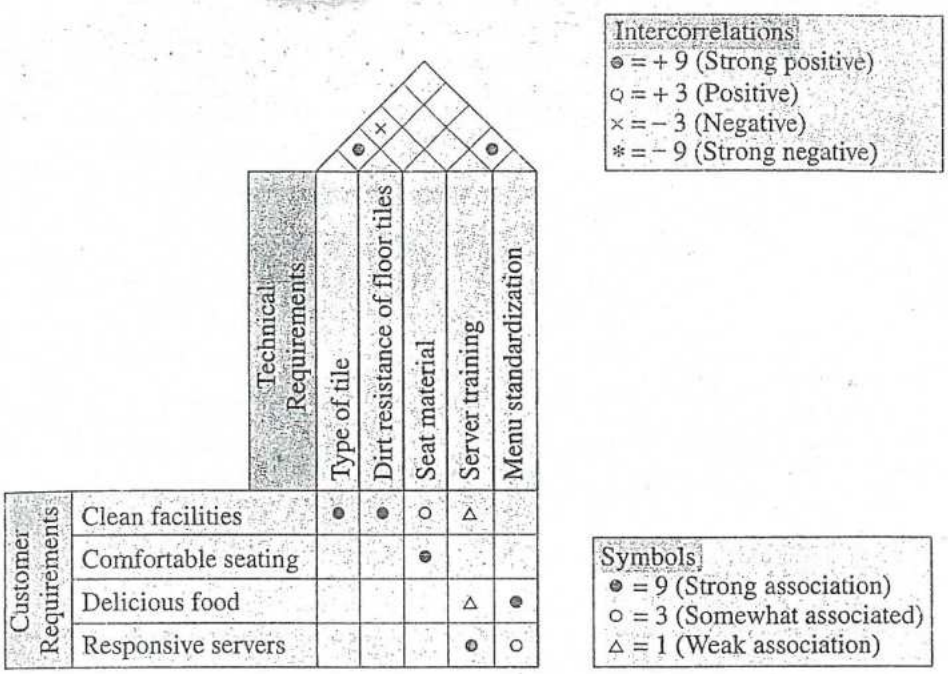


FIGURE 7-7 QFD Technical Requirements Interrelationships

Where 9 means strongly associated, 3 is somewhat associated, and 1 is weakly associated. Notice that tile and dirt resistance are strongly associated to clean facilities.

4. ***Identify the correlations between design elements in the roof of the house.*** Using the symbols identified in Figure 7-6, show whether different design elements are positively or negatively correlated. As shown in Figure 7-7, positive and negative scores are assigned to each symbol as shown. Notice that seat material and type of tile are negatively related, whereas type of tile is strongly positively related to dirt resistance. Server training and menu standardization are also strongly positively related.
5. ***Perform a competitive assessment of the customer requirements.*** On both the right side and in the lower middle portion of Figure 7-8, there is an assessment of how your product compares with those of your key competitors. These comparisons are on a 5-point scale with 5 being high. A stands for competitor A, B means competitor B, and Us stands for the company in question. Note that there are two assessments, one for customer requirements and another for technical requirements.
6. ***Prioritize customer requirements.*** On the far right side of Figure 7-9 are customer requirements priorities. These priorities include importance to customer, target value, sales point, and absolute weight. A focus group of customers assigns ratings for importance. This is a subjective assessment of how critical a particular customer requirement is on a 10-point scale, with 10 being most important. Customer requirements with low competitive assessments and high importance are candidates for improvement. Target values are set on a 5-point scale (where 1 is no change, 3 is improve the product, and 5 is make the product better than the competition). With the target value, the design team decides whether to change the product.

   The sales point is established by the QFD team members on a scale of 1 or 2, with 2 meaning high sales effect and 1 being low effect on sales. The absolute weight is then found by multiplying the customer importance, target factor, and sales point. This is expressed in the following equation:

$$\text{Absolute weight} = \text{customer importance} \times \text{target value} \times \text{sales point} \qquad (7.1)$$

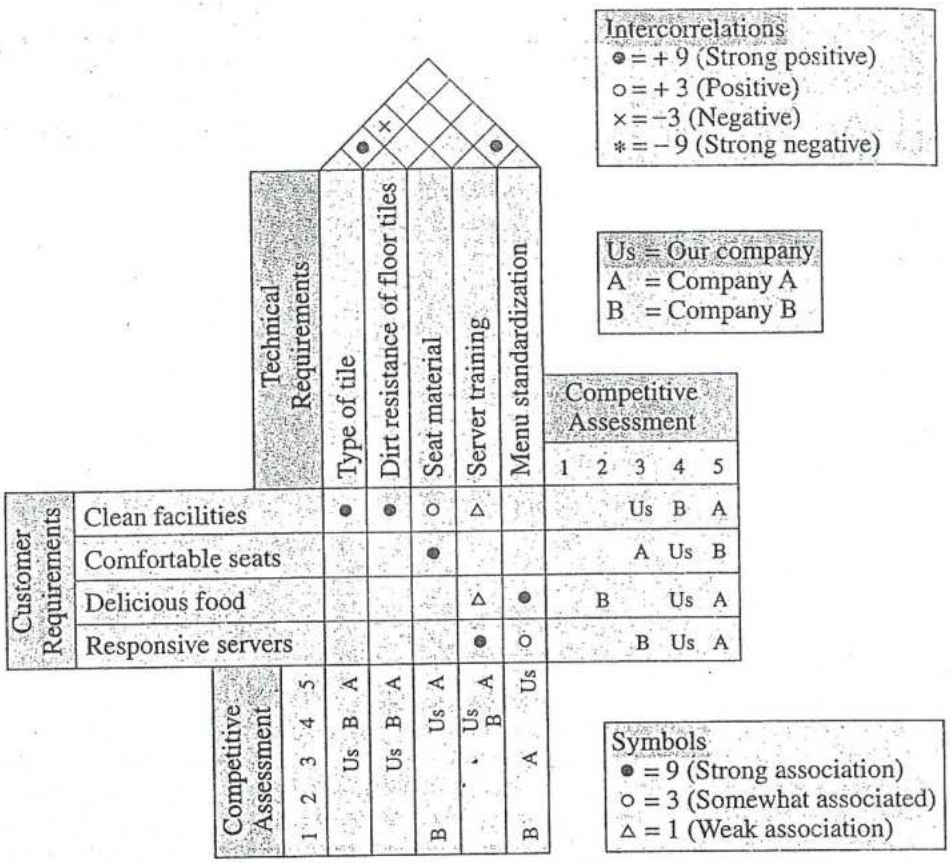


FIGURE 7-8 Competitive Assessment

7. ***Prioritize technical requirements.*** As shown in Figure 7-10, technical requirements are prioritized by determining degree of difficulty, target value, absolute weight, and relative weight. The degree of difficulty is assigned by design engineers on a scale of 1 to 10, with 1 being least difficult and 10 being most difficult. The target value for the technical requirements is defined the same way the target values for the customer requirements were assigned.

   The values for absolute and relative weights are now established. The value for the absolute weight is the sum of the products of the relationship between customer and technical requirements and the importance to the customer columns (fourth column from the right). The value for relative weight is the sum of the products of the relationship between customer requirements and technical requirements and the customer requirements absolute weights (the farthest right column).
8. ***Final evaluation.*** The relative and absolute weights for technical requirements are evaluated to determine what engineering decisions need to be made to improve the design based on customer input. This evaluation is performed by computing a percentage weight factor for each of the absolute weight and relative weight numbers (see Figure 7-11).

As you can see in this example, the standardized menu has a very high relative importance. This gives the restaurant a focus for the coming period.

Finally, the house of quality we have shown is only the first level. As shown in Figure 7-12, a similar process is followed in rolling out a new design. The first stage we have discussed is the *technical requirement stage.* During the second stage, a house of quality is completed for

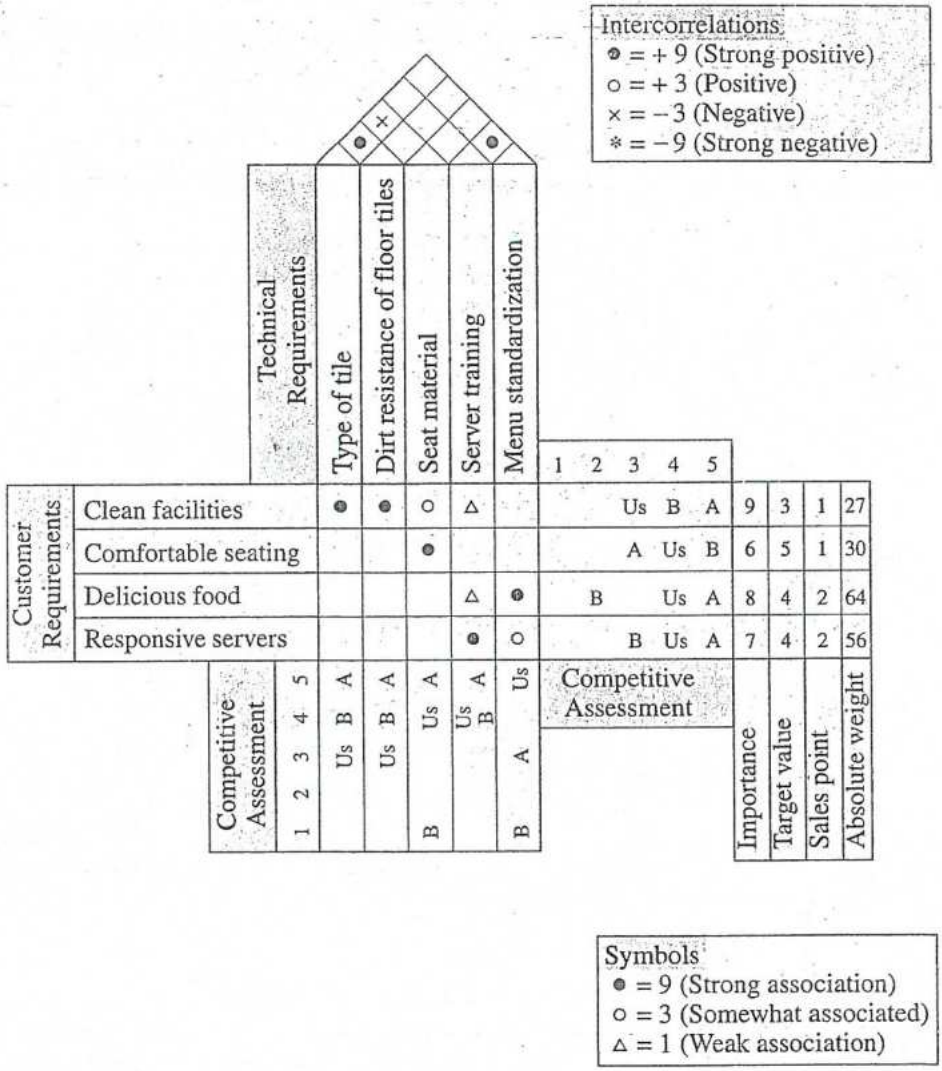


FIGURE 7-9 Competitive Assessment Requirement Priorities

component attributes to prioritize components and subsystems. At the third level, *process operations,* process engineers use QFD to prioritize process points that can lead to better customer satisfaction. At the fourth stage, the *quality control plan* is put in place to ensure that customer needs are given proper priority.

TECHNOLOGY IN DESIGN

No longer are the tools of the designer a square, a pencil, and a drafting table. Today, a designer is much more likely to use a **computer-aided design (CAD) system**. These systems are used in designing anything from an ultralight airplane, to a hamburger, to a home, or to a new intersection that can handle higher volumes of traffic. Computer-aided tools greatly improve the ability of designers to generate new and varied designs. In addition, they simplify the design process. For example, auto designers once had to place mock-ups of automobiles into wind tunnels to test the aerodynamics of a design. However, now the wind resistance coefficients for automobiles can be simulated on computers, cutting costs and design times and allowing for quick adjustments to the design. CAD systems help to develop more reliable and robust designs.

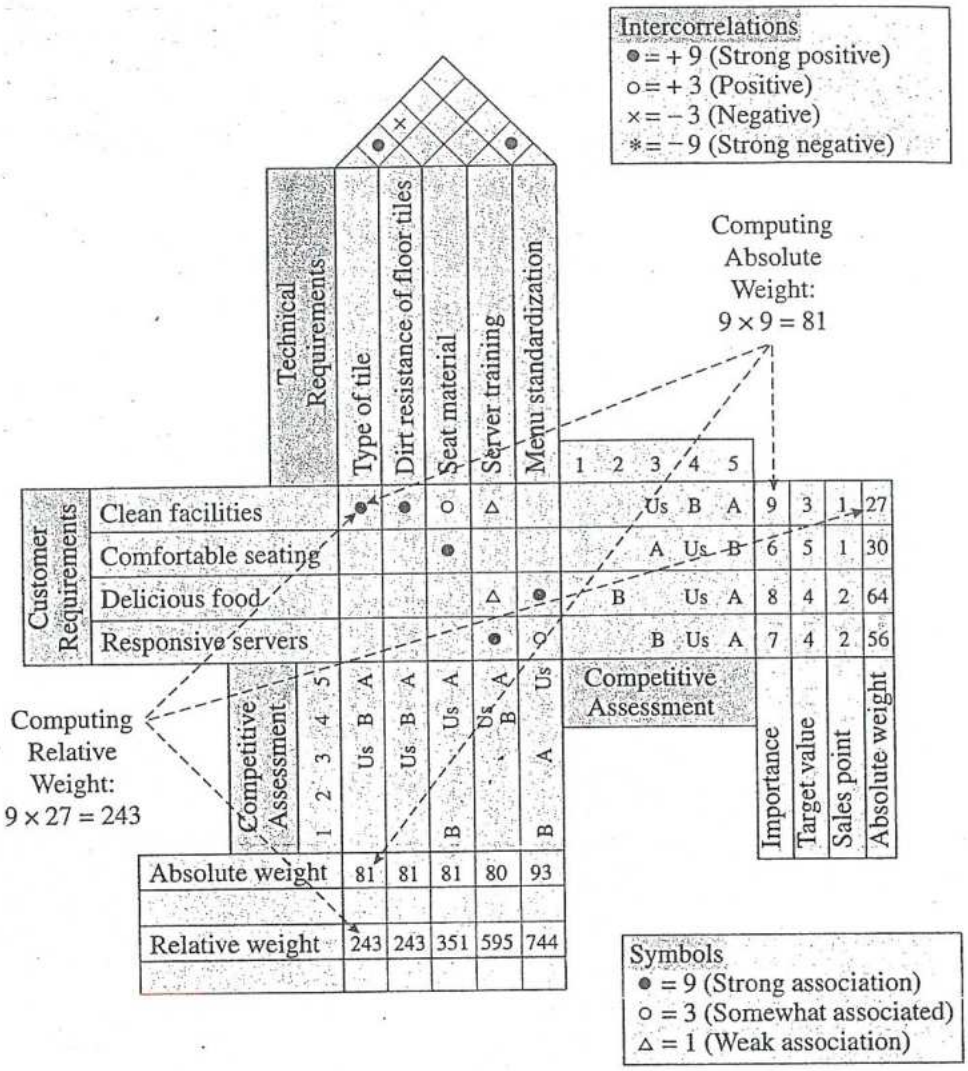


FIGURE 7-10 QFD Example

An important advance in CAD systems has been the advent of **multi-user CAD systems.** Using a common database in a network, multiple designers in locations worldwide can work on a design simultaneously around the clock. Consider a multinational corporation developing a new product. When the U.S. designers sleep, Asian and European designers work. When the U.S. designers return to work, they can see the progress that has been made overnight. For example, when developing a new airplane, Boeing used hundreds of designers on the project simultaneously. These designers used their CAD systems to ensure there were no inconsistencies in design that would render the airplane unusable.

CAD systems are used in geometric design, engineering analysis, design review and automation, and automated drafting. **Geometric modeling** is used to develop a computer-compatible mathematical description of a part.[6] The image developed is typically a wire-frame drawing of a component. This part may appear in two dimensions, as a two-dimensional drawing of a three-dimensional object, or in full three-dimensional view with complex geometry.

[6]Stroud, I., and Nagy, H., *Solid Modelling and CAD Systems* (New York: Springer, 2011).

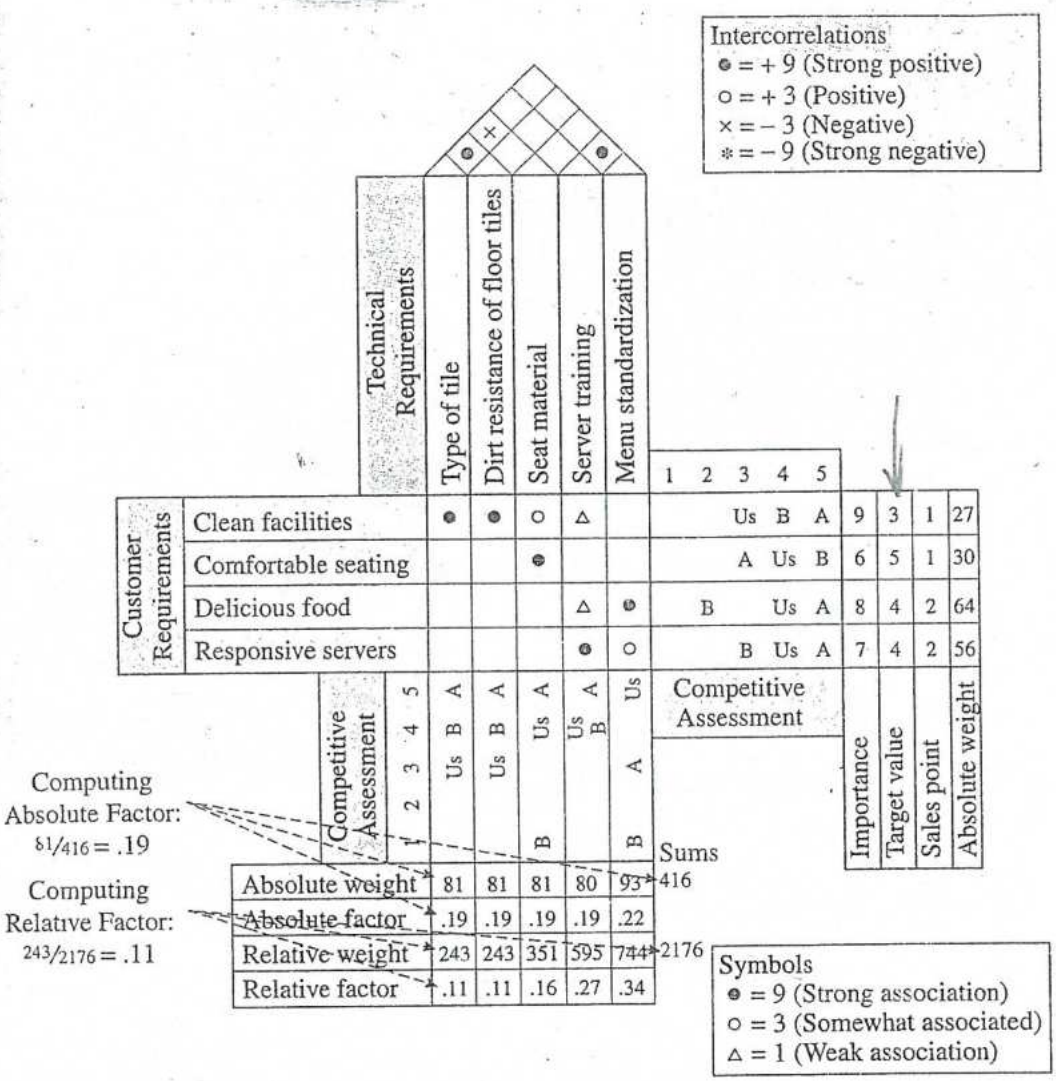


FIGURE 7-11 QFD Example

Engineering analysis may involve many different engineering tests such as heat-transfer calculations, stress calculations, or differential equations to determine the dynamic behavior of the system being designed. Analysis-of-mass-properties features in CAD systems automatically identify properties of a designed object such as weight, area, volume, center of gravity, and moment of inertia. CAD systems allow for the automatic calculation of these properties.

Designs are checked for accuracy during **design review**. Using CAD, the designer can zoom in on any part of design detail for close inspection of a part. Layering also is performed during design review by overlaying the geometric images of the final shape of a part over an image of a rough casting. This layering validates the design by ensuring that enough material is available on the casting to accomplish the final machined dimensions of the part.

Examining a design to see if different components in a product occupy the same space is called **interference checking**. Interference checking is of major importance in an design of airplanes. Hundreds of pipes and thousands of wires occupy the walls of the aircraft. Interference checking in design review ensures that designs are feasible. This is especially important for airplane makers because so many engineers are participating in the design. Automated drafting results in the creation of a final drawing of the designed product and its components. Some of the features of an engineered drawing include automated dimensioning, generation of cross-hatched

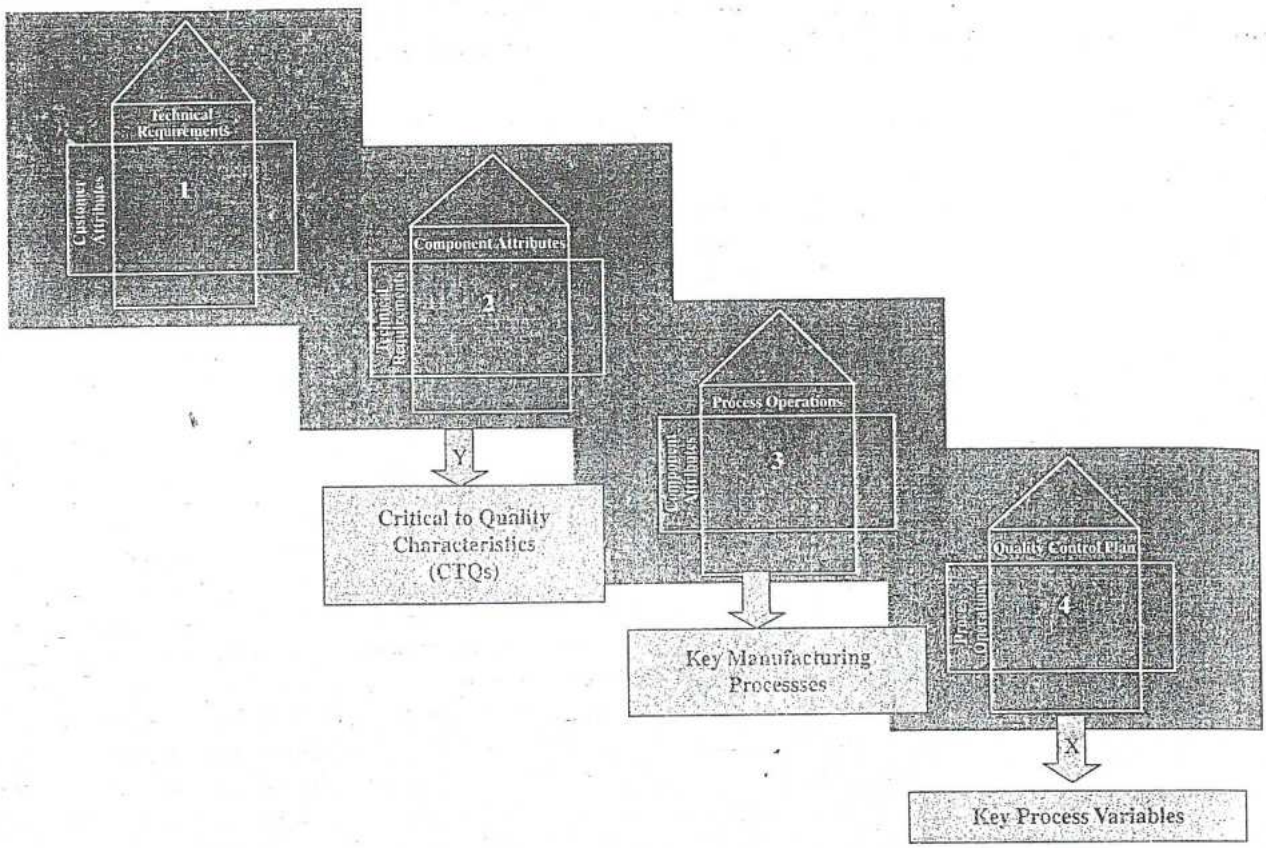


FIGURE 7-12 The Houses of Quality

areas, scaling of the drawing, development of sectional views, and enlarged views of particular part areas.

CAD systems can be stand-alone or tied into computer-assisted manufacturing (CAM) systems that are used in automated production systems. Another important component of a CAD system is the **group technology** component that allows for the cataloging and standardization of parts and components for complex products. Standard parts can result in fewer suppliers, simpler inventory, and less variability in processes.

CAD/CAM systems are often tied together in a closed-loop system with **computer-aided inspection (CAI)** and **computer-aided testing (CAT)** quality control systems. CAI and CAT allow for 100% inspection of products at a relatively low cost. Inspection is performed by infrared and noncontact sensors that allow for parts to be inspected without handling, thereby reducing the chance of damage to products.

OTHER DESIGN METHODOLOGIES

Organizing the Design Team

If the design process steps discussed previously are performed sequentially, the design process will be very time-consuming. Therefore, the steps are performed simultaneously as often as possible. This approach is called **concurrent engineering** and has been very helpful in speeding up the design life cycle. Products such as John Deere tractors and all-new automobiles have been designed using this strategy. Teams are a primary component of concurrent engineering and include program management teams, technical teams, and design-build teams.

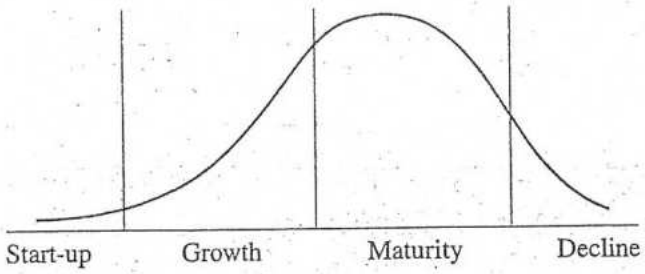


FIGURE 7-13 Phases of the Product Life Cycle

The benefits of concurrent engineering primarily include communication among group members and speed. By working on products and processes simultaneously, the group makes fewer mistakes, and the time to get the concept to market is reduced drastically. The team concept joins people from various disciplines, which enhances communication and the cross-fertilization of ideas.

Another benefit of concurrent engineering is increased interaction with the customer. Often customers are included in concurrent engineering teams to give immediate feedback on product designs. This requires contractual agreements between suppliers and customers because the customer representatives may work for the design team on a contract basis. However, the immediate feedback is very helpful.

The Product Life Cycle

As is shown by the ski industry (see A Closer Look at Quality 7-1), product development is not a static process. Once new products are developed, work may already be under way to introduce the next generation of products. The product life-cycle concept demonstrates the need for developing new products by showing product design, redesign, and complementary product development on a continuum. Figure 7-13 shows a product life cycle for a typical product. As soon as a product is developed, it is on its way to decline.



Video Clip: Product Life Cycles at Regal Marine

A CLOSER LOOK AT QUALITY 7-1 Ski Design

www.rossignol.com

During the 1930s and 1940s, skiing in the United States was a sport for the very wealthy, who could afford to take a train to Sun Valley, Idaho, or a resort in Colorado. By the 1950s and 1960s, middle-class people had taken up skiing. By the 1970s, skiing was at the peak of its popularity. People in the 1960s and 1970s began spending more time outside and were living a less sedentary lifestyle. However, by the 1980s, skiing had begun to decline. Other winter sports were becoming popular. The baby boomers were aging, and many downhill skiers were turning to cross-country skiing. This resulted in a decline of sales for ski makers such as K2 and Rossignol. These companies responded by pouring more money into research and development. One development was the introduction of snowboards. Snowboards appealed to skate boarders and young people. This market grew steadily, and now almost all ski areas in the United States have snowboard parks with half-pipes (a snowboarding area) and other amenities for snowboarders. In the early 1990s, ski sales were still flat, and "capped" skis were introduced. The theory behind capping of skis was that shock was more evenly dispersed throughout the skis. However, it was suspected that the real appeal of the capped ski was that it could hold 30% more graphics than the traditional models. In the mid-1990s, "fat boy" skis were introduced. These were skis that were much shorter and wider than traditional skis, and they made it much easier to ski in deep-powder snow and frozen, chunky, icy snow.

(continued)

Later, the industry introduced a radical change in ski design known as *parabolic,* or shaped, skis. The shaped skis have wider tips and tails that provide ease in turning and greater stability in the snow. "Rocker" design makes it easier to ski in deep snow. One interesting variation of this growth in ski designs is the "parabolic fat boy" manufactured by Rossignol and others. The parabolic skis have adapted snowboard technology into skis and make skiing much easier. Although this ski is recommended for expert skiers, it is great for intermediate skiers who want to improve. This is a pleasure to aging baby boomers, whose legs enjoy the relief provided by these technological design changes. These design changes have reinvigorated the ski industry.



Source: Rossignol S3 Freeride Ski.

Product Families and the Product Life Cycle

Two imperatives have come to the forefront in the study of product life cycles. The first is that product life cycles are becoming shorter. This means that obsolescence is a greater problem for designers and that the speed at which new product concepts are delivered to market is becoming much more important for companies around the world. The second imperative is that as product life cycles shorten, product variety and change become much more important to the successful competitor because complementary products are needed to consume productive capacity. Complementary products are needed for two reasons. First, as discussed, product obsolescence requires that products be updated. Second, some products have seasonal demand necessitating counterseasonal products. **Variety** refers to the differences in products that are produced and marketed by a single firm at any given time. **Change** is the magnitude of the differences in a product when measured at two different times.[7] Using the framework for variety and change developed by Sanderson and Uzumeri,[8] variety is the range of different items produced by a firm. Variety is related to a specific family of products. Change can occur as a result of evolutionary small changes to a product or drastic big changes to a product.

Complementary Products

What do we mean by managing product life cycles? Don't they just occur naturally? Well, yes, they do occur naturally. There probably isn't a lot you can do to control the rate at which the life cycle occurs. However, we can plan to introduce new and **complementary products**, which are new products using similar technologies that can coexist in a family of products. These products extend the life of the product line by offering new features or improvements to prior versions of the product. At times, these improvements are cosmetic, and at times, they are substantive. One example of a complementary product is a product that has a counterseasonal demand when compared with a base product such as motorcycles and snowmobiles. Arctic Cat produces ATVs for summer use and snowmobiles for winter use. This allows for level production rates throughout the year.

When we study issues such as variety and change, it becomes clear that at a strategic level, the problem of the product life cycle is not that a single product is becoming obsolete. Rather, if a variety of products are produced by a given company, management must be aware that several product life cycles must be managed simultaneously.

Designing Products That Work

As A Closer Look at Quality 7-2 shows, there are many things to consider when designing products. One of the biggest considerations is **design for manufacture (DFM)**—"Now that we have

[7] Ashby, W. R., *An Introduction to Cybernetics* (New York: Methuen, 1956).
[8] Sanderson, S. W., and Uzumeri, M., *Managing Product Families* (Chicago: Irwin, 1997).

designed it, can we make it?" Loosely speaking, design for manufacture means to design products so that they are cost-effective and simple to build. However, there are many other considerations in a design. One consideration is how we design the product so it is easy to maintain. After all, maintenance, if required, can be very expensive. Another aspect is designing for reliability. It makes little sense to design a product that is capable and stable but not reliable. Another issue relating to design is *speed,* the time it takes for a concept to reach the market. If it takes a long time for products to reach the market, competitiveness may be hampered. Product designs must be simple. Designing for simplicity means standardizing parts, modularizing, and using as few parts as possible in a design. Environmental issues also have become key considerations for companies designing products. With changes in regulations around the world, products must be designed for reuse, disassembly, and remanufacture.

Design engineers, operations managers, supply chain managers, and others involved in the design process must consider each of these topics simultaneously. Although this may seem complicated, in fact, design's cycle times have improved for many companies.

A CLOSER LOOK AT QUALITY 7-2 It Takes a Scientist to Design a Winter Coat[9]

If you think that it is easy to design products such as clothing, it's not just about style and fit. There is a lot of technology that goes into keeping skiers warm. First, there is a need. For example, Vermont's Jay Peak is known as one of the coldest ski areas in the United States. Where else can you find a lift nicknamed "The Freezer"? Temperatures can hit minus 30 with 50-mph winds. Last winter a group of frigid skiers had to be rescued by ski patrol. "They were so cold," says patrol director Peg Doheny, "that their brains were freezing up."

Cold and skiing go together like noses and sniffles. Now, thanks to advances in the science and technology of skiwear, modern skiers can stay warmer longer. "If your clothing performs at a higher level, you can accomplish more and enjoy skiing more," says Tom Duguid, brand-marketing director for Arc'teryx. Battling the cold is big business. Consumers spent more than $1.1 billion on cold-weather apparel last winter. "We want to keep people warm, dry and protected," says Woody Blackford, vice president of innovation at Columbia Sportswear.

Modern ski clothing is an amalgam of synthetics, insulations, and chemical treatments that make the best down jackets of only a few years ago seem like wool knickers. Take Patagonia's Nano Storm jacket. It has a breathable waterproof H2No barrier bonded to a 2.6-ounce, 50-denier nylon shell. Beneath is a layer of 60-gram PrimaLoft One polyester insulation. To shed moisture, the shell and 22-denier polyester lining are treated with Deluge DWR water-repellent finish. You almost need a PhD to buy cold-weather apparel these days.

Not surprisingly, textile companies, such as GoreTex, have chemists devising new fabrics, insulations, membranes, and coatings. Polartec works with military researchers. PrimaLoft uses technology from the aerospace industry. Others turn to physiologists to understand how the body reacts to temperature changes. Columbia Sportswear has hired electrical engineers to develop heated garments. On the materials front, the company's Omni Heat jackets and gloves have metallic-dot linings to reflect and preserve warmth.

Sewing machines? Ha. Manufacturing modern ski garments requires machines that spray, heat, inflate, and laminate the layers together. Columbia Sportswear uses high-pressure compressors to adhere the interior membrances and baniers of its gloves to the outer fabric layers. The gloves are then baked to activate adhesives.

"Body mapping"—structuring a garment to provide heat retention in some zones, breathability in others—is a recent development. Body-mapped jackets often have waterproof fabric on the shoulders

(continued)

[9]Based on Tolme, P., "The Cold War," *Ski* (January 2011): 24–26.

and breathable fabric on the core and sides, mimicking the body's own natural heat-retention systems. Wet skin loses heat 30 times faster than dry skin. "Staying dry is paramount to staying warm," says Dr. Gregory Haggquist, founder and chief scientist of Cocona, a fabric technology company.

Insulation is where the big advances are taking place. Powderhorn weaves ceramic yarn into its goose down to better disperse heat. To mimic down, synthetic insulation makers combine a variety of fiber and filament sizes. Electronic apparel is the new frontier. Until now, electrically heated apparel has suffered from short battery life and electronics that were too bulky, not durable, or had burn risks. But modern materials are making heated garments, or "wearable technology," more viable.

Columbia Sportswear's Circuit Breaker Softshell uses lithium polymer batteries and carbon fiber instead of metal wire to conduct heat. Carbon fiber is stronger, lighter and corrosion resistant. "In 10 years, heated products will be commonplace," Columbia Sportswear's Blackford predicts.

"Today's ski apparel is light-years better," says John Seifert, an associate professor at Montana State University, who has done research for The North Face in the school's Subzero Lab, a 2,700-square-foot meat locker. The facility has cold rooms, environmental chambers, CT scanners, a treadmill, and medical devices to measure cold's impact on performance.

While modern lab research is vital, nothing can replace fieldwork. That's why garment makers have teams of product testers. Columbia has 300 worldwide. Greg Hill is Arc'teryx's star tester. He's attempting to skin 2 million vertical feet in one winter, providing product feedback and marketing buzz.

Companies use a range of tests to quantify a garment's performance. The hydrostatic resistance test, for instance, measures how hard it is to force water through fabric at high pressure. Other tests include the dynamic moisture permeation cell, which changes humidity and air pressure levels to mimic weather conditions. The moisture-vapor transmission-rate test involves heating water beneath a piece of fabric and measuring how much vapor moves through the material in 24 hours.

But are the marketing hype and performance pledges just hot air? Sometimes. Many companies, for instance, cite their garments' wicking abilities. "A paper towel wicks," says Polartec's Simmons, "but you're not going to wear paper-towel underwear." What matters most is a garment's ability to transport moisture away from the body after it's been wicked.

There isn't government oversight of marketing claims for ski apparel. "This is where consumers get left out in the cold," Cocona's Haggquist says. Testing standards organizations, such as ASTM, ensure that everyone uses the same protocols.

But not everyone agrees on the best tests. Sometimes tests developed for other industries are used by apparel makers. One example is the ASTM E96 test, which was developed to measure vapor transmission in building materials. With a combination of proper design and testing, we will see better options for winter wear in the future.

Design for Manufacture Method

The overriding concept to consider when discussing DFM is to *make it easy to build.* This may seem intuitive; however, it is sometimes difficult to be intuitive when you are too close to a process (like people who design products). The reason for this may be more behavioral or organizational rather than technical. In the old world of designing products, there existed a hierarchy of engineers. At the top of this hierarchy was the product design engineer. Lower down the hierarchy were the process design engineers. Often these different engineers worked in totally different departments. The fact that they were in different departments often impeded communication.

This organizational problem has been referred to as the **over-the-wall syndrome.** The over-the-wall syndrome is demonstrated by looking at the design process sequentially. First, the product design engineers developed a design. This product design would then be approved by the manager or the vice president of product design. The design would then go to the manager or vice president of process design. Process design engineers would then develop the processes to make the product. If at any point a problem with the product design was found by the process engineers, a request for redesign would be sent to the manager of product design. Product design engineers would solve the problem and send the new product design back to the process designers. The process designers would then continue their work of developing the process. When

other problems occurred, they would have to be referred back to the product design engineers. Many times it took years to develop a new product, and the result was processes that built poorly functioning products. DFM methods are designed to eliminate the over-the-wall syndrome and radically reduce design cycle times.

Many firms use **enterprise resource planning (ERP) systems** to integrate financial, planning, and control systems into a single architecture. As a result, there is an effort in the business world to include computerized design systems in these ERP systems. An important component of such design software is the **product data management (PDM)** tool. PDM is a general extension of techniques commonly known as *engineering data management, document management,* and other similar names. PDM helps manage both product data and the product development process by tracking the masses of data needed to design, manufacture, support, and maintain products. It does this in part using a bill of materials that is later transferred to manufacturing, planning, and control systems after the design phase of the product life cycle.[10]

Design for Maintainability

One of the major concerns with new products is ease of maintainability. It often seems cheaper to replace a product than to repair it. This certainly is true for inexpensive products such as electric can openers, transistor radios, and other small appliances. However, the cost of repairing relatively expensive products such as personal computers, automobiles, and large appliances is also becoming prohibitive. Consider a broken video camcorder. A new, relatively inexpensive camcorder may cost $250. If the camcorder breaks, a repair may cost half to two-thirds that. The decision to repair is essentially an economic decision involving costs, benefits, and trade-offs. This decision becomes particularly difficult when the product life cycle is short. Suppose you owned a personal computer for the past few years. You purchased the computer for $1,000, and it satisfied your needs at the time. Now you realize that you need more memory, your sound card is inadequate, and you need a larger hard drive. If you go to a discount store, you can purchase the upgrades you need for about $500. At the same time, for a little more money you can purchase a new computer that has all the desired features as well as many others. For example, the new computer will be faster than your old computer. Should you spend $1,000 on a new computer or $500 to upgrade your old computer? One solution to this problem is design for maintainability. Design for maintainability concepts include

Components that are easily replaced

Components that are easily removed with standard tools

Adequate space to perform the maintenance function

Nondestructive disassembly

Safe maintenance

Available adequate owners' manuals and documentation (e.g., wiring diagrams, help facilities, or videos showing how to perform minor repairs)

Many personal computer manufacturers include how-to videos in their memory that demonstrate maintenance functions such as adding memory, connecting interfaces, and other simple maintenance functions. Craftsman tractors sold by Sears include videos that demonstrate how to change oil, how to operate the tractor, and how to perform other service functions. The bottom line is that customers should be provided with the necessary information and ease of access to the product that allow for simple or preventive maintenance.

An important issue is ease of delivery of more serious maintenance. Many repairs can be performed only by trained professionals. Many personal computer companies offer at-home

[10] Bourke, R. "PDM and ERP Continuing to Converge," *APICS: The Performance Advantage* (August 1997): 66–67.

maintenance for their personal computers. It is common for auto repair facilities to offer rides and loaner cars for customer use. Car rental companies typically offer on-the-road repair and towing service when their cars break down. It is important to recognize that service is also a design issue. At the design phase, after-sale processes must be designed such that maintenance is received simply, rapidly, and cost effectively. Experience has shown that consumers are willing to pay more for products that are supported by outstanding service.

A recent trend in service is remote monitoring of products that diagnoses problems and dispatches repair people before breakdowns occur. BMW has experimented with this approach. One of the leaders in this area is Otis Elevator, with its Remote Elevator Montoring System (REM). REM tracks system function on elevators. The system diagnoses an emerging problem in an elevator and automatically makes a service call to a repair person. Often problems are fixed before elevator owners know that a problem has occurred.

DESIGNING FOR RELIABILITY

Reliable products are always available when you need them, and you can depend on them to work properly. Reliability, as it relates to products, results from the interaction of multiple components in a system. Quality Highlight 7-2 shows how a luxury product is designed to be reliable at Vuitton. Reliability has two dimensions, *failure rate* and *time,* both of which can be applied to components and to systems. **Component reliability** is defined as the propensity for a part to fail over a given time. **System reliability** refers to the probability that a system of components will perform the intended function over a specified product life. It is important to recognize the difference between component reliability and system reliability. The levels of measurement are different for system and component reliability. When we talk of component reliability, we refer to a finite aspect of the overall product. System reliability is computed from the aggregation of multiple components. Reliability models are discussed in Chapter 13.

QUALITY HIGHLIGHT 7-2 Designing Reliable Luxury at Vuitton[11]

www.louisvuitton.com

Behind a locked door in the basement of Louis Vuitton's elegant Paris headquarters, a mechanical arm hoists a brown and tan handbag a half meter off the floor and drops it. The bag, loaded with an eight-pound weight, will be lifted and dropped, over and over again, for four days. This is a type of rapid-life-testing usually reserved for designing reliability into machinery and vehicles. Here it is being used on elegant handbags.

Vuitton has designed a high-tech torture chamber for testing its products. A piece of lab equipment bombards handbags with ultraviolet rays to test resistance to fading. Still another machine tests zippers by tugging them open and shutting them 5,000 times. There's even a mechanized mannequin hand, with a Vuitton charm bracelet on its wrist, being shaken vigorously to make sure none of the charms falls off.

If you think about Louis Vuitton, you likely don't think about robots beating up on bags. Likely, you think of waiflike supermodels or lithe Hollywood celebs toting Vuitton luggage to Palm Springs. However, to understand what makes Vuitton tick, you have to look behind the glittery façade and look closely at the world's most profitable luxury moniker.

Vuitton focuses relentlessly on quality in design and performance. Remember that the robot makes sure that Vuitton rarely has to make good on its lifetime repair guarantee. The supply chain

[11] Adapted from Matlack, C., "The Vuitton Machine," *BusinessWeek,* (22 March, 2004): 98–102. Used with permission.

is rigorously controlled and no bag is ever discounted. Above all, there's the efficiency of a finely tuned machine, fueled by ever-increasing productivity in design and manufacturing—and, as Vuitton grows bigger, the ability to step up advertising and global expansion without denting the bottom line.

Following are some examples of how attention to design detail sets the Vuitton bag apart:

- Zipper: Laboratory equipment randomly tests zippers by opening and closing them 5,000 times.
- Production: Manufacturing methods adopted from automakers and other industries are boosting productivity by 5% per year.
- Handle Metal Ring: To cut costs, Vuitton pressured supplier of metal rings to improve production efficiency.
- Leather Trim: Vuitton uses hides from northern European cattle, which have fewer blemishes from insect bites.
- Price Tag: Forget bargains: Vuitton never holds sales and price increases are common.

Reliability Analysis Tools

There are many ways to make designs more reliable. These methodologies include failure modes and effects analysis; fault-tree analysis; and failure modes, effects, and criticality analysis.

Failure Modes and Effects Analysis

Failure modes and effects analysis (FMEA) systematically considers each component of a system, identifying, analyzing, and documenting the possible failure modes within a system and the effects of each failure on the system. It is a bottom-up analysis beginning at the lowest level of detail to which the system is designed and works upward. The FMEA process results in a detailed description of how failures influence system performance and personnel safety. FMEA answers the question, "How do the systems or components fail?"

Failure modes and effects analysis was created by the aerospace industry in the 1960s and is used extensively in Six Sigma (see Chapter 14). An early application of FMEA occurred when Ford Motor Co. used it to analyze engineering design. Ever since, Ford has tried to refine FMEA through continued use in its operations, as many software applications have evolved recently that aid in the use of FMEA. Some benefits that can be derived through the use of FMEA include

1. Improvement of the safety, quality, and the reliability of products
2. Improvement of a company's image and its competitiveness
3. Increased satisfaction from a user standpoint
4. Reduction in product development cost
5. Record of actions taken to reduce a product risk

There are five basic areas where FMEA can be applied: concept, process, design, service, and equipment.

Concept. FMEA is used to analyze a system or its subsystems in the conception of the design.

Process. FMEA is applied to analyze the assembly and manufacturing processes.

Design. FMEA is used for analysis of products before mass production of the product starts.

Service. With respect to services, FMEA is used to test industry processes for failure prior to their release to customers.

Equipment. A company also can use FMEA to analyze equipment before the final purchase.

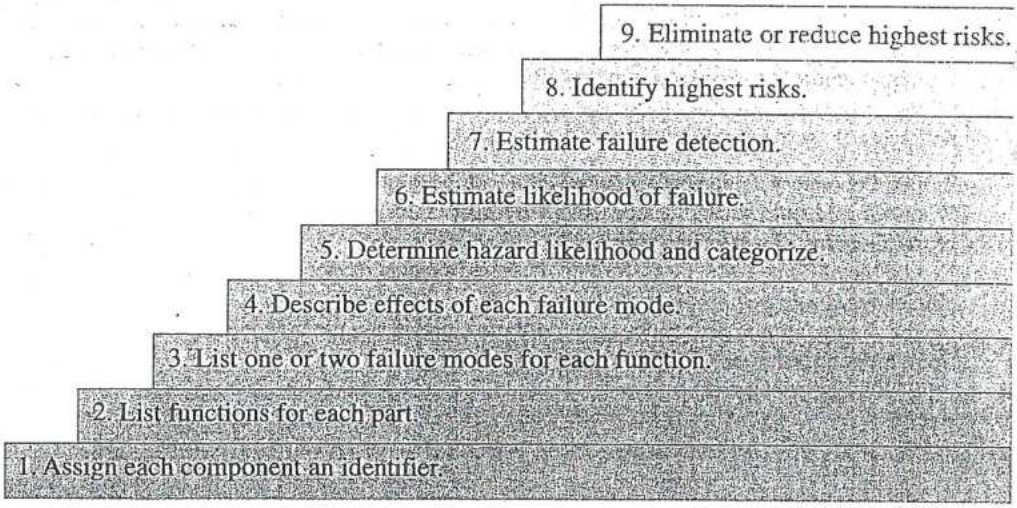


FIGURE 7-14 FMEA Steps

How FMEA Works

As is shown in Figure 7-14, failure modes and effects analysis uses a nine-step process:

1. The first FMEA step is to give each component in the system a unique identifier; this is so that none of the parts will be overlooked in the analysis.
2. In the second step, list all the functions each part of the system performs. This step requires you to develop a block diagram for the description of your design.
3. List the one or two failure modes for each function from the second step. The best description of a failure mode is a short statement of how a function may fail to be performed. What a product does or does not do when it fails describes the failure mode.
4. The fourth step describes what effects each failure mode of the component will have, especially the effects perceived by the user or operator. Analysis of the effects should follow a hierarchical order because any effect should be fairly detailed so that the severity of each effect can be judged. Some of these effects measure the consequence of failures on a component or part of a device, the whole system, the user, and/or the public.
5. Determine whether the failure will result in a potential hazard to personnel or the system. Then categorize how severe each hazard will be. There are four basic categories that hazards fall into: catastrophic, critical, marginal, and negligible.
6. Estimate the relative likelihood of occurrence for each failure. The likelihood of occurrences is estimated using a 10-point scale and described in steps 4 and 5, ranging from highly unlikely (1) to very likely (10).
7. Estimate the ease with which the failure may be detected. If the failure takes so long to be detected that it becomes too late to replace or repair, the magnitude of the problem is likely to be much greater than if the failure can be easily detected.
8. Use the estimates from steps 5, 6, and 7 to identify the highest risks related to the system.
9. Decide what action will be taken to eliminate or reduce the highest risks in the system. The most common decision made is to alter the design to reduce the likelihood of occurrence and failure severity or simply to bring about easy failure detection. Figure 7-15 shows an example of an FMEA form.

Fault-Tree Analysis

Fault-tree analysis (FTA) is an analytical tool that graphically renders the combinations of faults that lead to failure of a system. This technique is useful for describing and assessing the

Potential
Failure Modes and Effects Analysis
(Concept FMEA)

_X_System
__Subsystem
__Component:000000/COMPLETE VEHICLE SYSTEM.
Model Year/Vehicle(s): / (3)
Core Team: (0)

Design Responsibility: (3)
Key Date: (6)

FMEA Number: (1)
Page 1 of 1
Prepared by: (4)
FMEA Date (Orig.): 94.06.06 (Rev.): 94.06.06

Item / Function	*Potential Failure Mode*	*Potential Effect(s) of Failure*	*Sev*	*Class*	*Potential Cause(s)/ Mechanism(s) Failure*	*Occur*	*Current Design Controls*	*Detec*	*R.P.N.*	*Recommended Action(s)*	*Responsibility & Target Completion Date*	*Action Results*				
												Actions Taken	*Sev*	*Occ*	*Det*	*R.P.N.*
(9) Enter a system function. Use the verb-noun format. If known, enter the Engineering require-ments and constraints associated with each function.	(10) Enter the potential failure mode(s) for the system function. Describe the failure mode in terms of "loss of function," or as the negative of the function.	(11) For each failure mode, list its consequences on: —Other Systems —The Vehicle —The Customer —Government Regulations Severity (12) —> For each failure mode, rate the most serious effect. Enter rating in column 12. Use Severity Rating Table for System FMEA.			(14) From the block diagram, determine if/how each element can cause the System failure mode. (The cause will be a failure mode of the element.) Typical causes (element failure modes) will be: —fails to operate —operates prematurely —operates intermittently —fails to stop operating —loss of signal to next element Occurrence (15) —> Estimate the rate at which a cause is expected to occur over the design life of the element. Use Occurrence Rating Table for System FMEA. If no information is available to estimate the Occurrence rating, enter a rating of 10. <—(13) Reserved for future use.		(16) Enter the analytical method, test, or technique used to detect the cause of the System failure mode. If no detection methods are known, enter "None identified at this time" Detection (17) —> Estimate the likeli-hood the Detection method(s) will detect the cause of the System failure mode. If several methods are listed, enter the lowest (best) rating. Use the Detection Rating Table for System FMEA. If no methods can be listed, enter a rating of 10	0 0	0	(19) Enter the recommended design actions intended to reduce one or more of the Severity, Occurrence, and/or Detection ratings. If no actions can be listed, enter "None at this time." <—(10) RPN Risk Priority Number	(20) Enter —System design Dept —System design Eng —Target Completion date	(21) Enter a brief description of the action taken and its completion date. Revised (22) —> RPN After actions have been taken, reestimate the ratings for Severity, Occurrence, and Detection. Enter the revised ratings in the columns to the right. If no actions are listed, leave these columns blank.				

FIGURE 7-15 FMEA Form *Source:* FMEA Handbook, "Environmental and Safety Engineering" (Dearborn, MI: Ford Automotive Operations, 1995). Reprinted from *Potential Failure Mode and Effects Analysis*, 4th ed., 2008 Manual, with permission of DaimlerChrysler, Ford, and GM Supplier Quality Requirements Task Force.

events within a system. Such events can be either normal or abnormal, but it is their sequence and combination that are important. FTA shows the probabilities of systems failure caused by any event and is widely used in the aerospace, electronics, and nuclear industries. A fault tree is a qualitative model that also can be evaluated quantitatively. FTA is used for reliability, maintainability, and safety analysis and was used originally in 1961 at Bell labs to evaluate Minuteman Launch Control Systems to avoid inadvertent missile launches.

Failure Modes, Effects, and Criticality Analysis

Failure modes, effects, and criticality analysis (FMECA) is an extensive but simple method for identifying ways in which an engineered system could fail. As in FMEA, failures, effects, and causes are identified. FMECA rates failure modes by ranking each possible mode according to both the probabilities of its occurrence and the severity of its effects. The primary goal of FMECA is to develop priorities for corrective action based on estimated risk. FMECA is used to analyze a probable cause of a product failure, to determine how the problem affects a customer, to identify the probable manufacturing or assembly processes responsible, to identify which process control variable to focus on for prevention detection, and to quantify the effects on the customer.

Criticality in FMECA is important because it prioritizes how the design team should be spending its resources. In general, criticality refers to how often a failure will occur, how easy it is to diagnose, and whether it can be fixed. Criticality assessment is somewhat subjective because it depends on the viewpoint of a service or field engineer. This view is markedly different from the designer or marketing manager. All members of an interdisciplinary team should participate in ranking criticality so that their concerns are factored into rankings. As a design team considers the various failure modes in the ramifications, one or more of the team members fills out a structured FMECA form that summarizes all that is involved in what can go wrong. In general, a design FMECA includes

1. A description of the product's function
2. Listings of the potential failure modes
3. Potential effects each failure mode could have on the end user
4. Potential causes of each failure mode with the likelihood ranking for each
5. Preventive measures in place for firmly scheduling by the time production starts
6. Ranking of the effectiveness of each preventive measure
7. A ranking of the difficulty of detection
8. An estimate of the probability that the cause of a potential failure will be detected and corrected before the product reaches the end user

Product Traceability and Recall Procedures

Although FMEA and FTA help predict where defects will occur and what their effects will be, from time to time unforeseen defects occur that can result in dangerous and costly results that can subject the firm to liability.

For example, one cool summer morning a young pilot was asked to fly some hunters over some extremely remote wilderness territory. The pilot was rather inexperienced at flying in these types of conditions; after all, backcountry flying is dangerous, and experience is hard to obtain. However, the temperature and weather conditions were perfect. The adventure proceeded without incident until the final leg of the trip over some of the most extreme country. The wind began to pick up and gusted to more than 100 miles per hour. The light aircraft had never experienced these types of winds before. The young pilot pulled out of the mountainous canyon to get well above the mountaintops. This caused the aircraft to pitch and roll, and the wind shear coming over the mountaintops stressed the plane. The plane's vertical stabilizer was rendered useless by the powerful winds, but the team was able to return to the airport safely.

Subsequent investigation showed that an alloy structural support had been stressed to the breaking point in the plane's vertical stabilizer. The plane's manufacturer issued a recall of 1,200 planes fitted with the same special alloy in the vertical stabilizer. The problem occurred in one piece used in the manufacturing process. This piece had been produced by another vendor. An identification number allowed the plane manufacturer to track the purchase of this part back to its supplier. All aircraft built with the weak structural piece were recalled to replace the defective vertical stabilizer. Without proper identification techniques and sufficient tracking systems, potentially hazardous products could remain in use without any way of recalling or repairing them.

This characteristic is called **product traceability**. Product traceability and **recall procedures** are important aspects of product design. Because companies are liable for the products they create, it is important to be able to identify the origins of defective products or components through product traceability procedures.

In 1972, Congress created the **Consumer Product Safety Commission (CPSC)** to protect citizens from unreasonable risks of injury and death. To avoid being listed on the CPSC list of hazardous products, a company must have a system in place for tracing components. When a recall is demanded by the CPSC, a company needs to narrow its recall to a particular identification (ID) number or product line. Therefore, a good ID system can help isolate where the breakdown in the product occurred.

A major goal of product traceability and recall procedures is to be able to trace products with a minimum of cost. Product traceability also helps limit product liability relating to safety hazards.

ENVIRONMENTAL CONSIDERATIONS IN DESIGN

Currently, society demands much more from product designers than just high-quality products. Many manufacturers have turned to a more environmental form of manufacturing that offers positive returns on investment. Many companies, such as Siemens, Caterpillar, Xerox, Eastman Kodak, Hewlett Packard, and others, are using environmentally friendly forms of manufacturing.

The move to **green manufacturing** began in Germany with requirements for importers to remove packaging materials. Using a life-cycle approach to product design causes designers to focus not only on incoming materials, manufacturing processes, and customer use but also on the eventual disposal of the product. This life-cycle approach has led to practices known as **design for reuse**, **design for disassembly**, and **design for remanufacture**.

Design for reuse refers to designing products so they can be used in later generations of products. One example is the Kodak FunSaver camera.[12] Initially, the camera was made so it could be disposed of after use. Although Kodak had experimented with recycling the cameras, the cameras really ended up in landfills. Kodak received a wake-up call when it received the dreaded "wastemaker of the year" award for the disposable cameras, and it responded by converting the design from disposable cameras to recyclable cameras. Initially, the camera had been ultrasonically welded. Through design-for-disassembly processes, the camera case is now made so it snaps apart easily. There is great potential for reuse of products. Consider that currently two computers are discarded for every three computers purchased. The method for designing for reuse involves analyzing existing products for materials, identifying other uses for these materials, and developing a disassembly process to sort out these materials. This is good business for the producers of personal computers because if chemicals used in making PCs were to find their way into groundwater, the manufacturers could be held liable. The resulting costs could be in the billions of dollars.

The principles for design for disassembly include using fewer parts and fewer materials, using snap-fits instead of screws, making assembly efficient and improving disposal, using design for disassembly experts in concurrent design teams, and eliminating waste through better design.

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[12] Office of Technology Assessment, Green Products by Design (Washington, DC.: Congress of the United States, 2005).

Summary

As life cycles for products become shorter, a focus on quality in the product design process is necessary to remain competitive. Many of the dimensions of quality we discussed in Chapters 1 and 2 are addressed in the design phase of the product life. By focusing on issues such as maintainability, assembly, reliability, and product traceability, we are able to continually improve our ability to make things.

We have said that you should design products so they are easy to build. By simplifying design processes (through concurrent design teams, by standardizing, and through the use of modular designs), we make products that are more reliable.

Companies have implemented these processes with great results. These results have facilitated huge increases in production capacity, coupled with a reduction in cost. These cost savings do not always result in higher profits. As we have seen, the costs of computer chips dropped consistently. However, a company that does not become better at design will simply not be competitive in the future.

Key Terms

Change
Complementary products
Component reliability
Computer-aided design (CAD) system
Computer-aided inspection (CAI)
Computer-aided testing (CAT)
Concurrent engineering
Consumer Product Safety Commission (CPSC)
Criticality
Customer future needs projection
Design for disassembly
Design for manufacture (DFM)
Design for remanufacture
Design for reuse
Design review
Engineering analysis
Enterprise resource planning (ERP) systems
Failure modes and effects analysis (FMEA)
Failure modes, effects, and criticality analysis (FMECA)
Fault-tree analysis (FTA)
Final product definition
Geometric modeling
Green manufacturing
Group technology
House of quality
Interference checking
Kano Quality/Design Model
Manufacturing system design
Multiuser CAD systems
Over-the-wall syndrome
Product data management (PDM)
Product design and evaluation
Product idea generation
Product manufacture, delivery, and use
Product marketing and supply chain preparation
Product traceability
Quality function deployment (QFD)
Recall procedures
System reliability
Technology development for process selection
Technology feasibility statement
Technology selection for product development
Variety

Discussion Questions

1. Product idea generation initiates the process of designing a product by generating ideas from external and internal sources. What are some examples of external and internal sources that are used in this process?
2. Discuss the concept of consumer future needs projection. Does a firm that excels in this area have a competitive advantage? Explain your answer.
3. What is a technology feasibility statement? Why is it important?
4. Briefly describe the role of computer-aided design (CAD) in the product design process. How has CAD changed the way that product designers go about their jobs?
5. What are some of the competitive advantages of concurrent engineering?
6. The product life cycle for many products is getting shorter. In what ways does this trend complicate the product design process? Can you think of any advantages to shorter product life cycles for firms that have exemplary product design processes?
7. What is the role of complementary products in managing the product life cycle?
8. What is meant by design for manufacture?

9. The design for maintainability concept states that a product should be designed in a way that makes it easy for a consumer to maintain it. What product attributes make it easy for a product to be serviced or maintained?
10. What is the over-the-wall syndrome? How can the over-the-wall syndrome be avoided?
11. Define component reliability and system reliability. What is the major difference between these two concepts?
12. Perform a failure modes and effects analysis (FMEA) individually or in a team for a process you are familiar with. Start the process by identifying a common failure and what you can put in place to avoid the problem next time you do the job.
13. What is the primary purpose of conducting a fault-tree analysis?
14. Describe a method for identifying ways in which an engineered system could fail. What is the primary goal of this method of analysis?
15. Discuss the importance of product traceability and recall procedures. Why is product traceability considered an important consumer safety issue?
16. What environmental considerations are important for product designers? Do you believe that environmental considerations will become more important or less important in the future? Explain your answer.
17. Compare the job of a product designer 20 years ago to the job of a product designer today. In your opinion, what has been the single most significant technological advancement that has changed the job of a product designer?

Problems

1. Flowchart the design and production processes for writing a book such as *Managing Quality: Integrating the Supply Chain.* Use the standard process for designing products in the chapter.
2. Define key customer requirements for a pen. Next, define key technical requirements for the pen. Create a matrix showing the relationships between technical and customer requirements using the QFD format.
3. Define key customer requirements for an automobile windshield. Next, define key technical requirements. Create a matrix showing the relationships between technical and customer requirements using the QFD format.
4. For the QFD Problem 4 Matrix, compute the
   a. Customer requirements absolute weight.
   b. Technical requirements absolute weight and factor.
   c. Technical requirements relative weight and factor.
   d. Which design and technical factors should be emphasized? Why?

		Technical Requirements									
		1	2	3	4	5	1 2 3 4 5				
Customer Requirements	A	○		●				3	5	2	
	B				○			4	4	2	
	C		△					7	3	2	
	D			△		△		2	2	1	
	E				○	●		1	1	1	
Difficulty							Competitive Assessment	Importance	Target	Sales point	Absolute weight
Target											
Absolute weight											
Absolute factor											
Relative weight											
Relative factor											

Problem 4 Matrix

5. For the QFD Problem 5 Matrix, compute the
   a. Customer requirements absolute weight.
   b. Technical requirements absolute weight and factor.
   c. Technical requirements relative weight and factor.
   d. Which design and technical factors should be emphasized? Why?

		Technical Requirements									
		1	2	3	4	5	1 2 3 4 5				
Customer Requirements	A	△	●	△		●		2	1	2	
	B	△	○		○			8	1	1	
	C	●	△	●		●		5	5	2	
	D			●	○	△		3	4	2	
	E	○	△		△	△		2	3	1	
Difficulty							Competitive Assessment	Importance	Target	Sales point	Absolute weight
Target											
Absolute weight											
Absolute factor											
Relative weight											
Relative factor											

Problem 5 Matrix

6. For the QFD Problem 6 Matrix, compute the
   a. Customer requirements absolute weight.
   b. Technical requirements absolute weight and factor.
   c. Technical requirements relative weight and factor.
   d. Which design and technical factors should be emphasized? Why?

		Technical Requirements									
		1	2	3	4	5	1 2 3 4 5				
Customer Requirements	A	●	△	●		△		6	4	1	
	B		○	●	○			9	5	2	
	C	△	●		○	●		9	3	2	
	D	○	△	△	○			4	4	1	
	E	●				●		2	2	2	
Difficulty							Competitive Assessment	Importance	Target	Sales point	Absolute weight
Target											
Absolute weight											
Absolute factor											
Relative weight											
Relative factor											

Problem 6 Matrix

7. What are important design elements for a pair of pants?
   a. Define the customer requirements.
   b. Define technical requirements.
   c. Using the QFD format, show the relationships (with strengths, i.e., 1, 3, or 9) between a and b above.
8. Using the format in Figure 7-15, develop an FMEA for a pair of women's panty hose.

CASES

Case 7-1 Keeping Apple's iPhone Competitive[13]

www.apple.com

The past several years have seen an increase in smartphone ownership by cellphone users. In its infancy, few companies produced the smartphone, such as RIM's Blackberry and Motorola. However, the market is getting crowded. Still, Apple's introduction of the iPhone changed the industry. The purpose of a smartphone has shifted from e-mail and business to apps and functionality.

The cellphone industry must be in tune with the customer. Apple attempts to incorporate popular features in its designs. The iPhone includes Apple staples of app capability and interfacing with other Apple products. The iPhone is operated using a touchscreen and plays music and video. Like other smartphones, the iPhone can manage e-mail accounts.

With a new generation introduction, customers expect improvements to the features. Recent improvements include front and back cameras for video conferences. Including dual cameras in the design required Apple to create new software for the video conferencing. This feature is only available between iPhones, but Apple hopes to expand to other cellphone users. Camera quality in phones is improving as people rely on them more than handhelds. Knowing this is important to some customers, a reviewer of the iPhone commented, "It isn't the best cellphone camera I've tested, but it is a big improvement." This is an example of the trade-offs that may occur in product design. With so many features to incorporate, it may not be possible for a company to have the best for each. A company must decide which areas to focus on in the design.

The iPhone has addressed other areas of cellphone design. Apple claims that the iPhone is the world's thinnest smartphone and sports the world's highest-resolution smartphone screen. The high-resolution screen helps compensate for its smallish screen. Talk-time battery life has been increased. New multitasking software manages apps to reduce battery drain. Battery life is a concern for all cellphone designs.

The iPhone incorporates some features over which Apple has limited control. Facebook, Twitter, and Pandora are popular apps among customers. Incorporating these features requires limiting battery consumption, but allowing for frequent updates. Some users want to be constantly connected to their social networks. Apple's multitasking feature addresses some of these issues but may still disappoint some users.

With all of the care and attention a new product receives, it still isn't perfect. The iPhone had a famous "reception bar" bug that showed the wrong level of signal reception. For Apple, there is still a need to improve iPhone design. Even with its limitations, Apple's iPhone continues to push the limits of smartphone design.

Discussion Questions

1. The case discusses the issues of trade-offs in design. What are some smartphone trade-offs? Why are these important to consider in design.
2. Choose another product besides a smartphone. What are some important trade-offs for that product design?
3. How should Apple evaluate the "quality" of its iPhone?
4. How could Apple improve its design processes for the iPhone?

[13] Mossber, W., "Thinner, Faster, Smarter iPhone Raises the Stakes" *Wall Street Journal*, 20 June 2010.

Case 7-2 Nucor Corporation: Producing Quality Steel by Stressing Sound Management Practices

Nucor Corporation: www.nucor.com

Nucor Corporation, headquartered in Charlotte, North Carolina, is the largest manufacturer of steel and steel products in the United States. The company received a great deal of attention because of its impressive performance in an industry plagued by a multitude of problems, especially in recent years. Since the 1970s, Nucor pioneered the minimill concept, which is a method of making steel by melting scrap metal in electric arc furnaces at a fraction of the cost of conventional steelmaking. Nucor is admired for its quality products, its state-of-the-art manufacturing processes, and its industry-leading productivity ratios.

It is difficult to find a single reason that explains Nucor's success. Although the company has recently made key acquisitions and has modern facilities and equipment, competitors that have the same level of technology do not fare as well. What Nucor does have that is unique is a set of sound management principles and a somewhat novel approach to employee relations. Although Nucor is a $4.8-billion-per-year company, there are only four management layers between the CEO and frontline employees, and the general managers on the plant floor make the day-to-day decisions. Rank-and-file employees are involved in devising methods to improve operations. The company has a very egalitarian culture. There are no company cars, company planes, assigned parking spaces, hunting lodges, or other indications of status. All the employees wear the same color hard hat (with the exception of maintenance workers and visitors, who must be easily recognizable in case of an emergency), have the same group insurance program, have the same holidays, and have the same vacation plan.

There are other areas in which Nucor is distinct. The company has a well-developed employee incentive plan that aligns the interests of the employees with the interests of the firm. The typical millworker at Nucor receives a base pay that is slightly below the industry standard, but the firm's bonus plan is very generous when the company is doing well. Two distinctive features of Nucor's bonus system are that it is all written down and is totally objective, based on firm performance criteria. There is no subjectivity involved. If the firm reaches certain performance levels, a bonus will be paid, period. With bonuses figured in, Nucor employees typically lead the steel industry in terms of average pay. Yet the company's total cost per ton of steel produced is lower than that of other integrated producers.

In return for the generous compensation package, Nucor holds its employees to a high standard. Decision making is pushed down to the factory floor in many instances, requiring mental toughness and continuous education on the part of the company's employees. The company also asks its employees to be prompt and fully engaged in their jobs. For example, if an employee is late to work, he or she loses his or her bonus for the day. If the employee is more than 30 minutes late, the bonus is lost for a week. In return for this level of employee commitment, Nucor has not laid off a single employee for lack of work in 20 years. A very unusual indication of what Nucor thinks of its employees is evidenced in the company's Annual Report for 2006[14] (and in many previous years). The name of each of the company's 10,600 employees is written on the front and back cover of the Annual Report. Nucor produces high-quality products by stressing sound management techniques. Commenting on this issue in a book about Nucor, Jeffery L. Roengen wrote, "The amazing thing about Nucor's success is that it is so simple: Give employees a stake in the company's growth; focus on the business at hand; keep red tape and bureaucracy to a minimum." Apparently, this formula has continued to work for Nucor.

Discussion Questions

1. This chapter has emphasized process design. At Nucor, do human resources processes affect product quality?
2. How do Nucor's management practices affect its ability to produce high-quality products? Make your answer as substantive as possible.
3. Would you enjoy working at Nucor? Why or why not?

[14] Nucor Annual Report, 2006.

CHAPTER 8

Designing Quality Services

Encouraging employees to solve customer problems and eliminate the source of complaints allows them to be "nice," and customers treat them better in return. Not just customers but also employees want to continue their relationship with the business.

—FREDERICK REICHHELD AND W. EARL SASSER[1]

High-quality service is essential for competitiveness and can even improve employee satisfaction. However, service, like quality, is a multidimensional term. To provide high-quality service, we need a profound understanding of the needs, wants, and desires customer and an understanding of who the customer is.

Quality service is not only an imperative for competitiveness but also a sign of quality y. As we have discussed previously, even manufacturing firms—after reliability, confor- sign, and other requirements have been met—eventually focus on service throughout ly chain. In today's economy, service still is a major differentiator that allows firms to petitors in the marketplace.[2]

ure 8-1 shows the power of satisfied customers. If customers are satisfied, they will be venue streams will increase—as will profits. If a credit card customer leaves after one redit card firm will lose money. For example, for every dollar lost in year one of card hip, 60 cents is made in year two and the profits grow as time passes. Profit per cus- the laundry industry increases steadily year after year as well. This principle is the other service industries.

ur chapter we discuss services in general first and then services from a quality perspec- such as the SERVQUAL, gap analysis, and services blueprinting will be developed. theme of this chapter is to understand customers' needs and to use that understanding rvices that will satisfy customers.

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d Sasser, E., "Zero Defections: Quality Comes to Services," *Harvard Business Review* (September–
05–113.

l., "Putting the Service-Profit Chain to Work," *Harvard Business Review* (March–April 1989):

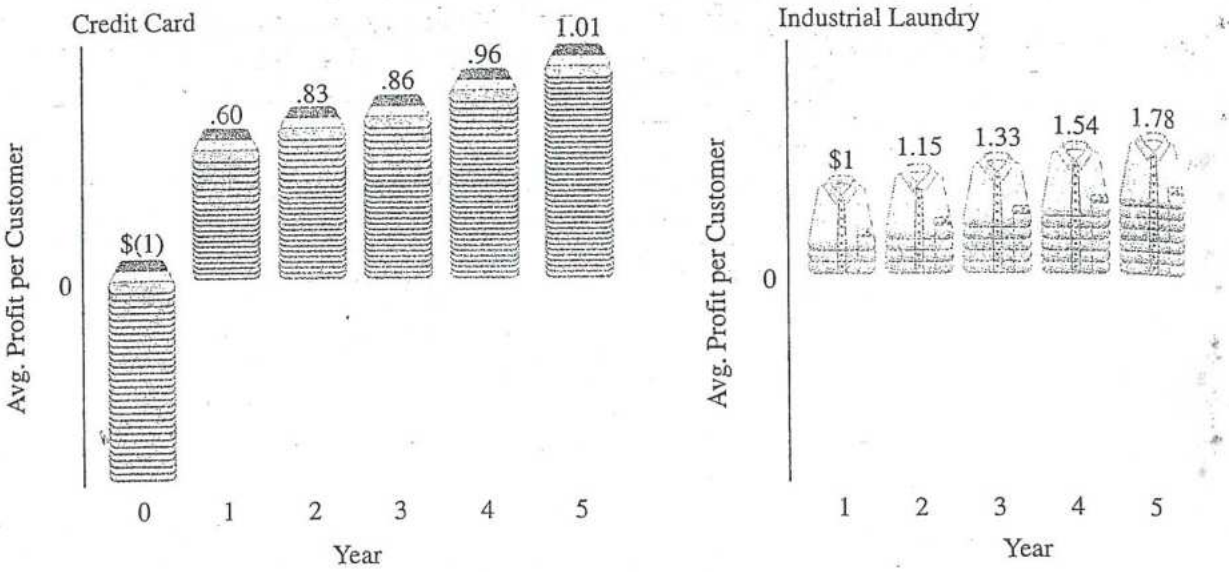


FIGURE 8-1 Profit Growth over Time Based on F. Reichheld and E. Sasser, "Zero Defections: Quality Comes to Services," *Harvard Business Review* (September–October 1990): 106. Copyright 1990 by the Harvard Business School Publishing Corporation. All rights reserved.

DIFFERENCES BETWEEN SERVICES AND MANUFACTURING

In Chapter 1 we talked about the multidimensional nature of quality. If quality is multidimensional for manufactured products, it will be more so for services. Understanding some of the differences between manufacturing and services helps to design useful approaches to quality improvement in services. Using a contingency perspective, we understand that the nature of services causes us to approach service quality improvement from a different direction from manufacturing.

Services are distinguished from manufacturing on several dimensions. First, many service attributes are **intangible**. This means that they cannot be inventoried or carried in stock over long periods of time. However, all services have some tangible aspects as well. The outputs of services are also **heterogeneous**. This means that for many companies, no two services are exactly the same. Consider, for instance, an advertising firm. No two advertising campaigns are alike. Customer requirements are different, and different campaigns are launched for different customers according to their needs. A third factor is that production and consumption of services often *occur simultaneously*. If you hire someone to mow your grass, you'll receive the service exactly at the same time it is produced.

The term *service* is very broad and covers many diverse industries, such as hotels, hospitals, financial services, and even prisons. Are financial services distinctly different from transportation, health care, or law firms? Certainly, there are similarities among the problems faced by these different categories of firms. However, there are also many dissimilarities.

One useful distinction between services and manufacturing centers on the aspect of **customer contact**. Customers tend to be more involved in the production of services than they are in production of goods. For instance, you probably have never seen anything you own during its manufacturing stage. In fact, many of the products you own were manufactured overseas. However, you probably are actively involved in the production of services you receive. If you work for a firm that hires a consultant, you will work closely with the consultant as he or she provides the services you purchased. When you receive a haircut, you are actively involved in the service by providing information and sitting still. In many restaurants it is not uncommon for the customers to fill their own drinks. This is called **customer coproduction**.

Because customers are actively involved in producing the services they consume, they create problems for service providers. For example, the time required to serve different customers can vary widely, making it difficult to plan capacity. The varying demands of customers also contribute to process variability that makes quality production of services difficult. Therefore, even though customers are the reason for the existence of services firms, they also make providing good service difficult.

The good news for customers is that by being actively involved in the production of the service, they can exert control over the service provider and achieve customization. This control can be manifested in a variety of different ways. For instance, if you have never visited the producer of a food product you purchase, you may not be aware of many issues concerning the products, such as sanitation or environmental pollution. However, you are not likely to remain a customer of a restaurant that is unclean or creating environmental problems. As a result of this greater customer control, service facilities, processes, and interactions must be designed in a way that promotes a positive encounter with the customer.

Internal versus External Services

An aspect of services that affects the definition of quality is whether a service is internal or external. **External services** are those whose customers pay the bills. **Internal services** are in-house services such as data processing, printing, and mail. Typically, these services are separate from the external customer. However, customer service to internal customers is very important to internal service because their services often can be outsourced. There is a trend in companies to outsource internal services. In a sense, this presents a competitive pressure on internal services. Although internal and external services may be very different, they do have many similarities. In both cases, competitive pressures can result in the possible loss of customers.

Voluntary versus Involuntary Services

Another way services differ is by being voluntary or involuntary. **Voluntary services** are services that we actively seek out and employ of our own accord. Generally, we research a voluntary service, such as a gas station, a restaurant, or a hotel, and have certain expectations when we engage its services. Even doctors often provide many voluntary services because patients can choose among different doctors to some extent.

The quintessential example of an **involuntary service** is a prison. Other involuntary services include hospitals, the IRS, the police department, the fire department, and other services that you do not choose. If you have the chance to engage this type of service at some point, you likely will have vague expectations about the experience. It is generally more difficult to achieve high levels of customer satisfaction in involuntary services. For example, does anyone really enjoy visiting a hospital or a dental clinic? A customer service survey would be laughable for a county jail. Yet employees of these organizations often desire to provide better service to the patrons. For example, many IRS agents are involved in quality improvement activities. Certainly, our perceptions and expectations of service quality can be affected by whether the service is voluntary or involuntary.

How Are Service Quality Issues Different from Those of Manufacturing?

We've identified three major realities in services that affect the approaches to quality adopted by service providers; these are intangibility, simultaneous production and consumption, and customer contact. Not surprisingly, they lead us to the major differences between services and manufacturing when it comes to quality.

Because services' attributes can be intangible, it is sometimes difficult to obtain hard data relating to services. In manufacturing, dimensions such as height, weight, and width are available for measurement. Conformance to these measurements implies a certain dimension of

quality. However, in services, such measurable dimensions are often unavailable. For this reason, many services organizations that use quality control charts encounter difficulty in using them, or they use them incorrectly. This is not to say that control charts cannot be used in services. However, compared with manufacturing, their use in services is quite low. Generally speaking, time (such as cycle time or response time) is a primary measurement available in service environments.

Simultaneous production and consumption of services means that you have to do it right the first time. You can't easily inspect and rework defects in a hair salon the way you can in manufacturing.

Customer contact leads to an increase in variability in the process. This leads to a high degree of customization in services as well as great variability in the time required to perform services. In manufacturing, repetitive tasks are easily measured, and cycle times are generally consistent. When customers are intimately involved in processes, there is much more customization and much more variability than in manufacturing.

Services design, as is discussed in this chapter, is also very different from design in manufacturing. Because services involve intangibles, warranty or repair processes are not as important as recovery or reimbursement processes (see A Closer Look at Quality 8-1). Also, the design of the services must take into account such variables as customer moods and feelings because these affect customer perceptions of service quality.

Product liability issues in services are very different from manufacturing. Whereas in manufacturing liability issues center around safety concerns, in services liability issues often relate to **malpractice**, which refers to the professionalism of the service provider and whether reasonable measures were taken to ensure the customer's well-being. However, services also may have liability issues. In the Rocky Mountains, ski areas are sued regularly by customers

A CLOSER LOOK AT QUALITY 8-1 Service Warranties: Profitable or a Rip-off—You Decide[3]

Here's a secret one of the nation's largest consumer electronics retailers doesn't want you to know: Many times, they make more money off service contracts than they do selling products. Best Buy Co. isn't banking on sales of TVs, computers, and DVD players to make profits. They are counting on the service contracts to make them profitable.

Just look at the numbers. At Best Buy, service contracts are 4% of sales but provide 45% of profits. Before bankruptcy at Circuit City, the numbers were 3.3% and 100%! The profit margins on these contracts are between 50% and 60%. If you spend $400 on a service contract, Best Buy keeps $240 itself and gives $160 to the insurer. As profitable as these are, it is interesting that Walmart has been slow to jump aboard. However, unlike Best Buy, they don't have as many salespeople to pitch these contracts.

As service contracts have become more profitable, Best Buy has cut back on disclosure. The company no longer reports its warranty profits separately. Best Buy's spokesperson says the products and contracts should be seen as inseparable.

So, as a consumer, when do service contracts make sense? Most often, the correct answer is "Never!" Typically, only 20% goes to repair or replacement of products. That's why consumer organizations generally counsel against service contracts. According to one consumer advocate, "The worst rip-off is on appliances because they have gotten so reliable."

Consumer Reports cites four products for which contracts *might* make sense—these are treadmills, elliptical trainers, plasma TVs, and laptop computers. Remember, most products come with manufacturer warranties. Many times, extended warranties can be purchased more cheaply directly from the manufactuer.

[3]Adapted from Symonds, W. "The Warranty Windfall," *BusinessWeek* (20 December, 2004): 84–89.

who are injured. In many states, laws protect ski areas from such lawsuits by limiting liability for injuries.

Services do not have as long a history of quality practice as does manufacturing. Although many quality techniques such as control charts have been adopted by services companies, this trend is still new. Certainly, as time passes, more quality techniques are being developed specifically for services. For example, a new tool is emerging for service supply chains known as process chain network (PCNP diagrams).

How Are Service Quality Issues Similar to Manufacturing?

For both manufacturing and service firms, the customer is the core of the business, and customer needs provide *the* major input to design. By focusing on the customer, many manufacturers and services firms have come to view themselves as service providers. Companies from Harley-Davidson to Hewlett Packard have spent extraordinary amounts of time designing services for their customers.

WHAT DO SERVICES CUSTOMERS WANT?

In Chapter 1 we considered the different quality dimensions relating to services. These were

Tangibles
Reliability
Responsiveness
Assurance
Empathy

Parasuraman, Zeithamel, and Berry[4] provided this list of dimensions of service quality after extensive research in a number of services sectors, and they have become widely accepted. However, this does not mean that your particular services industry does not include other dimensions. Therefore, the adoption of these dimensions in your service should include a careful consideration of the applicability of these and other dimensions.

As in any industry, the concept of leadership is one that Parasuraman, Zeithamel, and Berry believe is the key to success. However, they define this leadership role in a way that is quite interesting. The key aspects of a leader in services are given in Table 8-1.

First, a leader has a *service vision*. Such leaders really view service quality as the force underlying profitability and business success. When selecting strategies for improvement, leaders see quality as the winning strategy. Such a vision can be translated into action and excitement for others in the company. To win in services, a firm must develop a passion for service quality within the entire workforce. When there is intense interaction between customers and service providers, the attitude of employees is the key element in achieving service success. Active and involved leadership is very important to attaining this important organizational attribute.

Services leaders have *high standards*. In services, you will notice that some firms are better equipped and maintained than others. Sometimes this is evident in the small details. Some doctors' offices have a better selection of magazines than others; some restaurants are more comfortable

TABLE 8-1 Attributes of Services Leaders

Service vision
High standards
In-the-field leadership style

[4]Zeithamel, V., Parasuraman, A., and Berry, L., *Delivering Quality Service* (New York: Free Press, 1990).

than competitors; some grocers have a better selection of products; the list goes on and on. Those things don't happen by magic. They are the result of a leader with high standards and a focus on details. Have you noticed that some professors come to class impeccably prepared and others appear somewhat disorganized? This is so because the student/customer-oriented professor has higher standards for preparation and presentation than other professors. Think about yourself in a work situation. Do you provide a high level of service that reflects a high standard?

Outstanding services leaders have an *in-the-field style of leadership*. Because there is so much contact with the customer in a service system, the field is where the action is. Sam Skaggs, the founder of American Stores Corporation in Salt Lake City, Utah, was famous for stopping by his stores to make sure that things were in order. He viewed this as an important way of keeping the management on its toes. If Skaggs showed up at a single store in Kansas City, Missouri, for example, the manager immediately contacted all the other managers in town to give them a "heads up" that Skaggs was in town. Too often owners can become isolated from their businesses. By being in the field, they gain a better understanding of the business and how to serve the customer. Quality Highlight 8-1 shows how Ritz-Carlton uses a gold standard to keep its managers in touch with its customers.

QUALITY HIGHLIGHT 8-1 Ritz-Carlton Hotels[5]

www.ritzcarlton.com

The Ritz-Carlton hotel company is a success in one of the economy's most logistically complex service businesses. Targeting primarily industry executives, meeting and corporate travel planners, and affluent business travelers, the Atlanta-based company manages more than 60 luxurious hotels that pursue the goal of being the very best in each market. Ritz-Carlton does so on the strength of a comprehensive service quality program that is integrated into marketing and business objectives.

Hallmarks of the program include participatory executive leadership, thorough information gathering, coordinated planning execution, and a trained workforce that is empowered to satisfy customers. Quality planning begins with the president, the CEO, and the 13 senior executives who make up the corporate steering committee. This group, which doubles as the senior quality management team, meets weekly to review the quality of products and services, satisfaction, market growth and development, organizational indicators, profits, and competitive status. Each year executives devote about one-quarter of their time to quality-related matters.

The company's business plan demonstrates the value placed on goals for quality products and services. Quality goals draw heavily on consumer requirements derived from extensive research by the travel industry and the company's customer reaction data, focus groups, and surveys. The plan relies on a management system designed to avoid the variability of service delivery traditionally associated with hotels. Processes are well defined and documented at all levels of the company.

Key products and service requirements of the travel consumer have been translated into Ritz-Carlton *gold standards,* which include a credo, three steps of service, and 20 "Ritz-Carlton basics." Each employee is expected to understand and adhere to the standards with defined processes for solving guests' problems as well as detailed grooming, housekeeping, safety, and efficiency standards. Company studies prove that this emphasis is on the mark, paying dividends to customers and, ultimately, to Ritz-Carlton.

The corporate motto is "ladies and gentlemen serving ladies and gentlemen." To provide superior service, Ritz-Carlton trains employees with a thorough orientation, followed by on-the-job training, and then job certification. Ritz-Carlton values are reinforced continuously by daily "line-ups," frequent recognition for extraordinary achievement, and a performance appraisal based on expectations explained during the orientation, training, and certification processes.

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[5]NIST, Profiles of Baldrige Winners, 2011.

To ensure that problems are resolved quickly, workers are required to act at first notice regardless of the type of problem or customer complaint. All employees are empowered to do whatever it takes to provide "instant pacification." No matter what their normal duties are, other employees must assist if aid is requested by a co-worker who is responding to a guest's complaint or wish.

Much of the responsibility for ensuring high-quality guest services and accommodations rests with the employees. Surveyed annually to ascertain their levels of satisfaction and understanding of quality standards, workers are keenly aware that excellence in guest services is a top hotel and personal priority. At each level in the company—from corporate leaders to managers and employees in individual work areas—teams are charged with setting objectives and devising action plans, which are reviewed by the corporate steering committee. In addition, each hotel has a "quality leader" who serves as a resource and advocate as teams and workers develop and implement their quality plans.

Teams and other mechanisms cultivate employee commitment. For example, each work area is covered by three teams responsible for setting quality-certification standards for each position, solving problems, and planning strategy.

SERVQUAL

An important tool developed by Parasuraman, Zeithamel, and Berry for assessing services quality is **SERVQUAL**. The SERVQUAL survey has been used by many firms and is an off-the-shelf approach that can be used in many services situations. The SERVQUAL instrument, a survey, has many advantages. Among these are the following:

- It is accepted as a *standard* for assessing different dimensions of services quality.
- It has been shown to be *valid* for a number of service situations.
- It has been demonstrated to be *reliable*, meaning that different readers interpret the questions similarly.
- Each instrument is *parsimonious* in that they have only 22 items. This means that it can be filled out quickly by customers and employees.
- Finally, it has a standardized analysis procedure to aid both interpretation and results.

One of the benefits of statistical quality control (SQC) is that it is an accepted procedure for assessing process variability. One of the comforts of implementing SQC is knowing that many other firms have used this approach and benefited from it. Although the SERVQUAL survey is not as widely used as SQC, it is a standardized approach to gathering information about customer perceptions of service quality. As such, it provides a base, or a means, to get started in assessing customer perceptions of quality.

Expectations

The SERVQUAL survey has two parts: **customer expectations** and **customer perceptions**. Before discussing SERVQUAL expectations, we should first discuss the reasons for assessing both expectations and perceptions.

Let's say that you desire to improve service quality along some dimension—either tangibles or reliability. The natural question is "Which will create the *greater* improvement to the system for service?" If we understand both customer expectations and perceptions, we can assess the **gap** in these areas. For example, if customers have higher expectations for tangibles than for reliability, and customers perceive tangibles as poor, then a large gap or disconnect exists between the expected and delivered performance on tangibility. Given that this gap is larger, the greater potential for increasing customer satisfaction lies in addressing tangibles first. This type of analysis provides a good way to understand how best to improve customer satisfaction. Figure 8-2 shows the 22 survey items for expectations. The wording of the statements in the expectations survey relates to a generic firm in an industry that interests you. For example, if you were assessing customer service for a given grocery store, you might first administer the expectations survey

	Strongly Disagree						Strongly Agree
1. Excellent _____ companies will have modern-looking equipment.	1	2	3	4	5	6	7
2. The physical facilities at excellent _____ companies will be visually appealing.	1	2	3	4	5	6	7
3. Employees at excellent _____ companies will be neat-appearing.	1	2	3	4	5	6	7
4. Materials associated with the service (such as pamphlets or statements) will be visually appealing in an excellent _____ company.	1	2	3	4	5	6	7
5. When excellent _____ companies promise to do something by a certain time, they will do so.	1	2	3	4	5	6	7
6. When a customer has a problem, excellent _____ companies will show a sincere interest in solving it.	1	2	3	4	5	6	7
7. Excellent _____ companies will perform the service right the first time.	1	2	3	4	5	6	7
8. Excellent _____ companies will provide their services at the time they promise to do so.	1	2	3	4	5	6	7
9. Excellent _____ companies will insist on error-free records.	1	2	3	4	5	6	7
10. Employees in excellent _____ companies will tell customers exactly when services will be performed.	1	2	3	4	5	6	7
11. Employees in excellent _____ companies will give prompt service to customers.	1	2	3	4	5	6	7
12. Employees in excellent _____ companies will always be willing to help customers.	1	2	3	4	5	6	7
13. Employees in excellent _____ companies will never be too busy to respond to customers' requests.	1	2	3	4	5	6	7
14. The behavior of employees in excellent _____ companies will instill confidence in customers.	1	2	3	4	5	6	7
15. Customers of excellent _____ companies will feel safe in their transactions.	1	2	3	4	5	6	7
16. Employees in excellent _____ companies will be consistently courteous with customers.	1	2	3	4	5	6	7
17. Employees in excellent _____ companies will have the knowledge to answer customers' questions.	1	2	3	4	5	6	7
18. Excellent _____ companies will give customers individual attention.	1	2	3	4	5	6	7
19. Excellent _____ companies will have operating hours convenient to all their customers.	1	2	3	4	5	6	7
20. Excellent _____ companies will have employees who give customers personal attention.	1	2	3	4	5	6	7
21. Excellent _____ companies will have the customer's best interests at heart.	1	2	3	4	5	6	7
22. The employees of excellent _____ companies will understand the specific needs of their customers.	1	2	3	4	5	6	7

FIGURE 8-2 SERVQUAL Expectations Survey *Source:* Based on V. Zeithamel, A. Parasuraman, and L. Berry, "SERVQUAL: A Multiple-Item Scale for Measuring Customer Perceptions of Service Quality," *Journal of Retailing* (Spring 1988): 12–40. Copyright Elsevier.

TABLE 8-2 SERVQUAL Items and Dimensions

Dimension	Items
Tangibles	1–4
Reliability	5–9
Responsiveness	10–13
Assurance	14–17
Empathy	18–22

to customers concerning a grocery store in general. Later, the perceptions survey might be administered to the customers of the particular grocery store. Table 8-2 shows the items that address specific service quality dimensions. The averaged scores for these dimensions provide SERVQUAL difference scores (demonstrated later).

Perceptions

The SERVQUAL perceptions survey shown in Figure 8-3 is administered to customers in the same way that the expectations survey was administered. Notice that the perceptions survey also

	Strongly Disagree						Strongly Agree
1. XYZ Co. has modern-looking equipment.	1	2	3	4	5	6	7
2. XYZ Co.'s physical facilities are visually appealing.	1	2	3	4	5	6	7
3. XYZ Co.'s employees are neat-appearing.	1	2	3	4	5	6	7
4. Materials associated with the service (such as pamphlets or statements) are visually appealing at XYZ Co.	1	2	3	4	5	6	7
5. When XYZ Co. promises to do something by a certain time, it does so.	1	2	3	4	5	6	7
6. When you have a problem, XYZ Co. shows a sincere interest in solving it.	1	2	3	4	5	6	7
7. XYZ Co. performs the service right the first time.	1	2	3	4	5	6	7
8. XYZ Co. provides its services at the time it promises to do so.	1	2	3	4	5	6	7
9. XYZ Co. insists on error-free records.	1	2	3	4	5	6	7
10. Employees in XYZ Co. tell you exactly when services will be performed.	1	2	3	4	5	6	7
11. Employees in XYZ Co. give you prompt service.	1	2	3	4	5	6	7
12. Employees in XYZ Co. are always willing to help you.	1	2	3	4	5	6	7
13. Employees in XYZ Co. are never too busy to respond to your requests.	1	2	3	4	5	6	7
14. The behavior of employees in XYZ Co. instills confidence in you.	1	2	3	4	5	6	7
15. You feel safe in your transactions with XYZ Co.	1	2	3	4	5	6	7
16. Employees in XYZ Co. are consistently courteous with you.	1	2	3	4	5	6	7
17. Employees in XYZ Co. have the knowledge to answer your questions.	1	2	3	4	5	6	
18. XYZ Co. gives you individual attention.	1	2	3	4	5	6	7
19. XYZ Co. has operating hours convenient to all its customers.	1	2	3	4	5	6	7
20. XYZ Co. has employees who give you personal attention.	1	2	3	4	5	6	7
21. XYZ Co. has your best interests at heart.	1	2	3	4	5	6	7
22. Employees of XYZ Co. understand your specific needs.	1	2	3	4	5	6	7

FIGURE 8-3 SERVQUAL Perceptions Survey *Source:* Based on V. Zeithamel, A. Parasuraman, and L. Berry, "SERVQUAL: A Multiple-Item Scale for Measuring Customer Perceptions of Service Quality," *Journal of Retailing* (Spring 1988): 12–40. Copyright Elsevier.

contains 22 items that are matched with the same five service quality dimensions as the expectations survey (the dimensions are listed in Table 8-2).

Gap Analysis

The SERVQUAL instrument is useful for performing what is called **gap analysis**. Because services are often intangible, gaps in communication and understanding between employees and customers have a serious negative effect on the perceptions of services quality. The model in Figure 8-4 shows the gaps that commonly occur and can affect the perceptions of services quality.

Each of the gaps in the model demonstrates differences in perceptions that can have a detrimental effect on quality perceptions in services. The SERVQUAL survey instrument can be administered in a variety of ways that examine each of these gaps. For example, SERVQUAL can be used to explore differences in perceptions between customers, between managers, between managers and customers, and between employees. We briefly examine each of the different gaps in the next paragraphs.

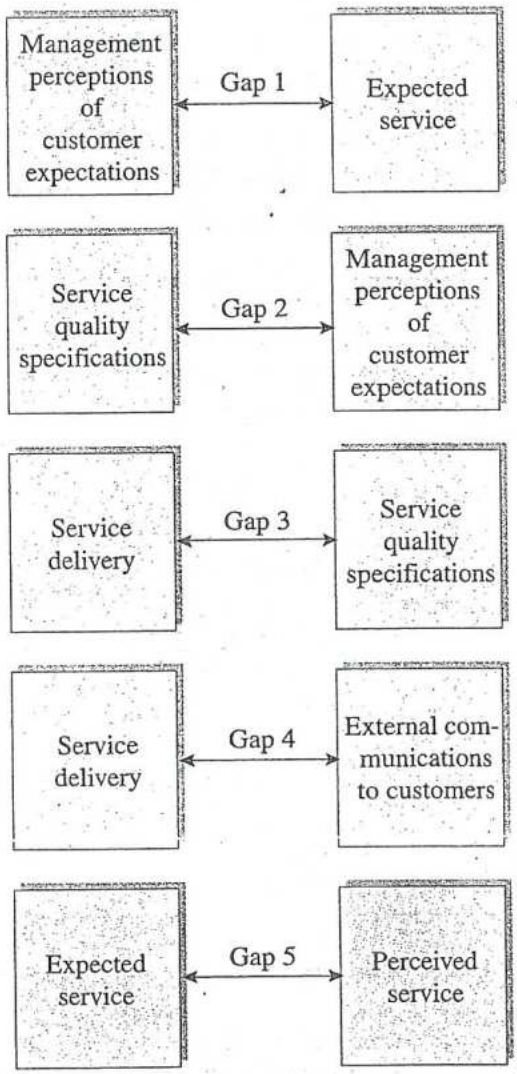


FIGURE 8-4 Gaps 1–5

Gap 1 shows that there can be a difference between *actual* customer expectations and *management's idea* or perception of customer expectations. As a customer, have you ever wanted to tell a service provider, "I don't want you to do that; I want you to do something else!" It is very difficult for managers or employees to break out of the internal, process-oriented view of the business. Many times, improving processes does not equal improving customer service. To truly improve customer service, we must understand what the customer wants. The SERVQUAL instrument can be used to help in this understanding (see Figure 8-4).

Managers' expectations of service quality may not match service quality specifications. This mismatch is demonstrated in *gap 2*. Once managers truly understand what the customer wants, then a system can be developed to help provide exactly what the customer wants. Often, because firms do not specify customer requirements according to a well-defined process, there is no way to know whether customer specifications and management expectations are aligned.

Once services specifications have been established, the delivery of perfect services quality is still not guaranteed. Inadequate training, communication, and preparation of employees who interact with the customer, referred to as **contact personnel**, can lower the quality of service delivered. This mismatch is *gap 3*.

Gap 4 shows the differences between services delivery and external communications with the customer. Companies influence customer expectations of services through word of mouth and through other media such as advertising. As a result, there could be a difference between what customers hear you say you are going to deliver as a service provider and what you actually deliver. Have you ever heard someone say, "They promised me one thing and gave me another." This gap can lead to seriously negative customer perceptions of service quality.

Gap 5 is the difference between perceived and expected services, which we considered briefly when we introduced the SERVQUAL instrument. Think of the first time you dealt with your university admissions office or financial aid office. In many universities and colleges, these offices are well run and provide great service. However, in other colleges, their service is not so good. The difference between your expectations and your perceptions is directly related to your perception of service quality.

The key to closing gap 5 is to first close gaps 1 through 4 through thoughtful systems design, careful communication with the customer, and a workforce trained to provide consistently outstanding customer service. As long as these gaps exist, there will be lowered perceptions of customer service.

Assessing Differences in Expectations and Perceptions by Using the Differencing Technique

Let's suppose that you have administered both the expectations and the perceptions SERVQUAL instruments to your customers. Typically, you need a sample size of between 50 and 100 for each of the surveys (i.e., $50 < n < 100$, where n is the sample size). The difference score for SERVQUAL is computed by the following steps. Separate the SERVQUAL dimensions as follows:

Dimension	Items
Tangibles	1–4
Reliability	5–9
Responsiveness	10–13
Assurance	14–17
Empathy	18–22

For each respondent, sum your SERVQUAL scores for each set of items relating to a given dimension. Sum across the n respondents and divide the total by n.

EXAMPLE 8-1 SERVQUAL Differencing

Recently, a hospital administered the SERVQUAL survey to its customers as a way to determine where it should focus the training of its employees to best improve customer service. Fifty surveys were administered to customers before and after they were treated. In cases where the patients were in too much pain to fill out the perceptions survey after a procedure, they were asked to fill out the survey at the follow-up visit. On the basis of the 50 responses, the following averages were computed for each item:

Item Number	Average Perception	Average Expectation
1	6.5	6.3
2	6.4	6.4
3	6.9	6.2
4	6.8	6.8
5	3.2	5.2
6	3.4	6.1
7	3.3	6.3
8	3.5	5.9
9	3.6	6.6
10	5.2	2.4
11	5.5	2.2
12	5.6	2.4
13	5.8	2.6
14	4.1	3.2
15	5.5	3.3
16	4.3	3.4
17	4.1	3.2
18	4.2	3.5
19	2.6	6.5
20	2.8	6.6
21	2.5	6.4
22	2.4	6.3

On the basis of these means, the following overall averages were computed for the different dimensions:

Perception Averages		Average Perception	Average Expectation	Expectation Averages	
Tangibles:	6.650	6.5	6.3	Tangibles:	6.425
(Avg. items 1–4)		6.4	6.4	(Avg. items 1–4)	
		6.9	6.2		
		6.8	6.8		
Reliability:	3.400	3.2	5.2	Reliability:	6.020
(Avg. items 5–9)		3.4	6.1	(Avg. items 5–9)	
		3.3	6.3		
		3.5	5.9		
		3.6	6.6		

(continued)

Perception Averages		Average Perception	Average Expectation	Expectation Averages	
Responsiveness:	5.525	5.2	2.4	Responsiveness:	2.400
(Avg. items 10–13)		5.5	2.2	(Avg. items 10–13)	
		5.6	2.4		
		5.8	2.6		
Assurance:	4.500	4.1	3.2	Assurance:	3.275
(Avg. items 14–17)		5.5	3.3	(Avg. items 14–17)	
		4.3	3.4		
		4.1	3.2		
Empathy:	2.900	4.2	3.5	Empathy:	5.860
(Avg. items 18–22)		2.6	6.5	(Avg. items 18–22)	
		2.8	6.6		
		2.5	6.4		
		2.4	6.3		

The averages for each of the dimensions of service quality were computed by averaging the items pertaining to each dimension. Finally, differences for the dimensions were computed as follows:

	Perception		Expected		
Tangible difference =	6.65	less	6.425	equals	0.225
Reliability difference =	3.4	less	6.02	equals	−2.62
Responsiveness difference =	5.525	less	2.4	equals	3.125
Assurance difference =	4.5	less	3.275	equals	1.225
Empathy difference =	2.9	less	5.86	equals	−2.96

The differences show that the greatest negative mismatch exists in the dimension of empathy, with reliability as a close second. Therefore, the training program should focus on teaching employees to be empathetic. Also, the process improvement efforts should focus on improving reliability. These changes will lead to the greatest improvements in customer service.

EXAMPLE 8-2 SERVQUAL Two-Dimensional Differencing

If there is enough variation in the responses given to different dimensions, the two-dimensional differencing technique is very useful for evaluating SERVQUAL responses. Note that this technique is also used for specific questionnaires relating to specific services offered by companies. For example, St. John's Hospital administers surveys to patients asking about several specific services such as food, laundry, nursing, and many other services. The two-dimensional differencing technique allows the hospital to determine which services it should emphasize to improve customer perceptions and those that make little difference.

Using the information from Example 8.1, it is fairly simple to develop a two-dimensional services plane. The vertical axis reflects the expectations score and the horizontal axis relates to the perceptions score (Figure 8-5) using 4 (the neutral response) as the origin. The hospital analyst learns that emphasis is needed in the areas of reliability and empathy as these are areas where expectations are high and perceptions are relatively low.

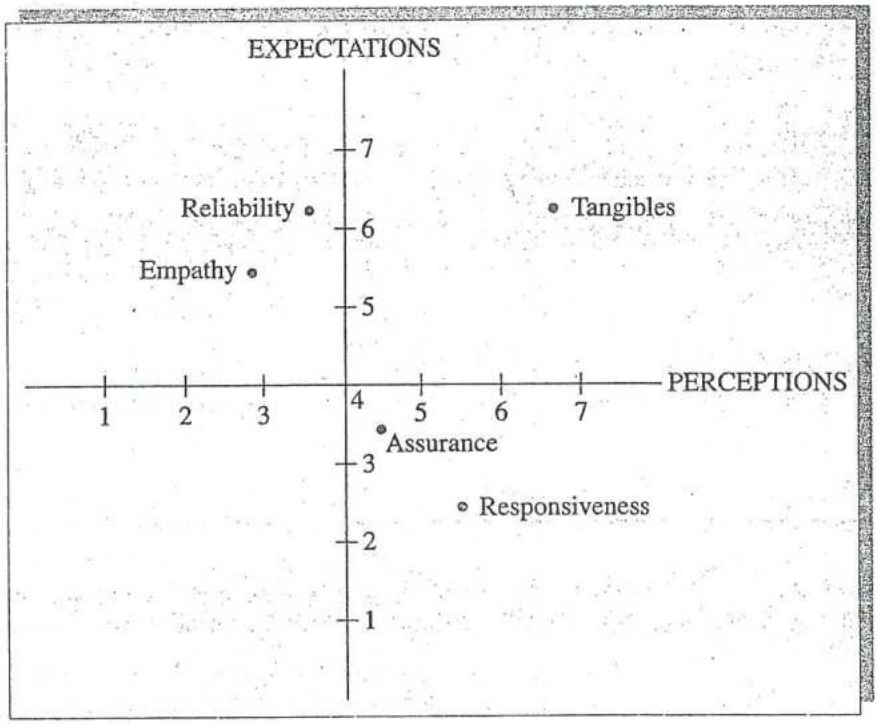


FIGURE 8-5 Two-Dimensional Differencing Plane

DESIGNING AND IMPROVING THE SERVICES TRANSACTION

So far in this chapter we have discussed customer perceptions of quality. One of the ways to improve customers' perceptions of quality is to improve the process of delivery of the service. Just as teams can succeed in manufacturing, teams in services can develop ways to improve processes and customer satisfaction.

Other concepts and tools include services blueprinting, moments-of-truth concept, and the Japanese method known as poka-yoke. Each of these is discussed in the following paragraphs.

Services Blueprinting

Lynn Shostack, CEO of Joyce International, Inc., is known for the statement, "The process is the service." Shostack also developed the process known as **services blueprinting**.[6] A services blueprint is a flowchart that isolates potential fail points in a process. She recommends that blueprints be kept on every process in a service and that a "keeper of the blueprint" make the blueprints available for others in the firm. If possible, the blueprint also should be available on a computer network for all to view. There are four steps to developing a services blueprint:

1. ***Identify processes.*** In this step, processes are flowcharted so that the bounds of the process are identified. Figure 8-6 shows a simple process used by Shostack to demonstrate services blueprinting, in this case for a hair salon's processes.
2. ***Isolate fail points.*** Notice in Figure 8-6 that the hair coloring stage is a possible fail point. What can happen here? The wrong color could be applied, and the hair style will be ruined. This would be a very expensive mistake.

[6]Shostack, G. L., "Designing Services That Deliver," *Harvard Business Review* 62, 1 (1984): 135.

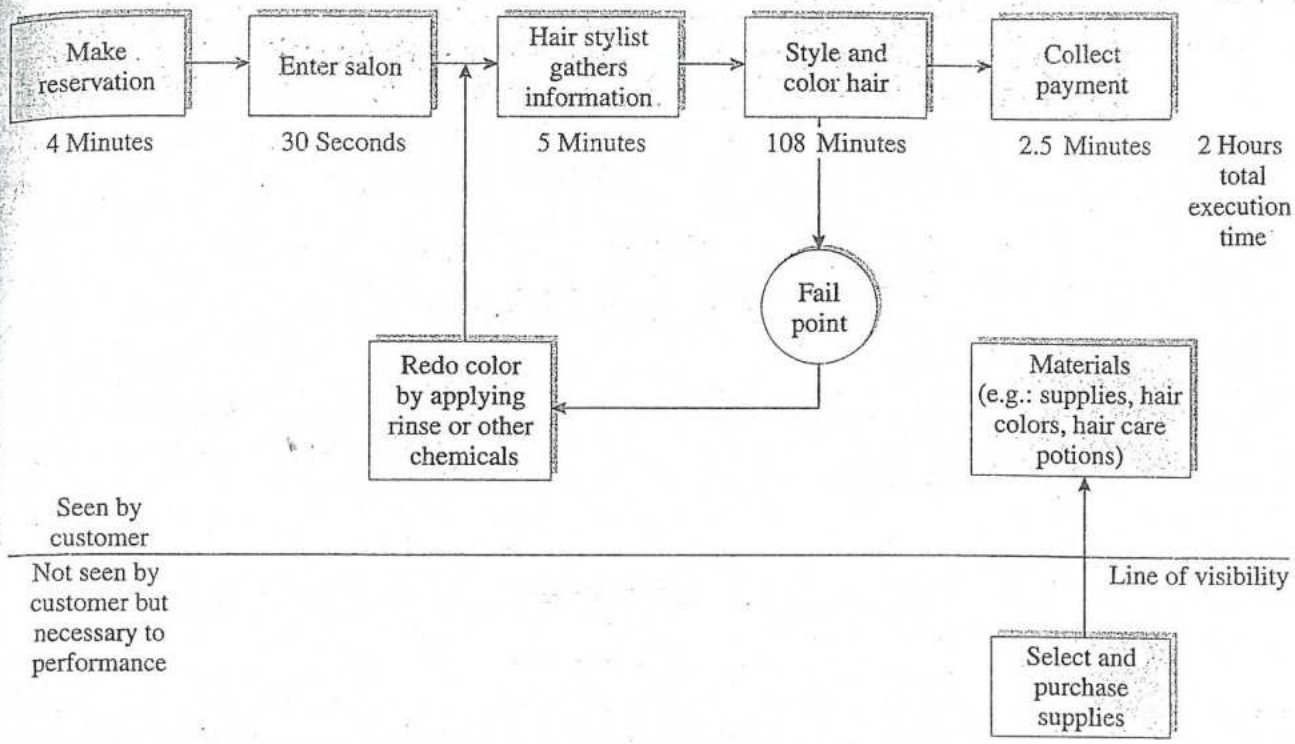


FIGURE 8-6 Services Blueprinting Example in a Hair Salon

3. ***Establish a time frame.*** In a hair salon operation, time is a major determinant of profitability. As a result, those steps that waste time result in lost income. The analyst observing this process should establish a standard time for each step in the process.
4. ***Analyze profits.*** The customer spends about two hours in the process. As errors occur in the process, the salon owner becomes liable, and other business is lost.

Notice also that Figure 8-6 includes a line of visibility. The activities below the line of visibility are not seen by the customer, but they influence performance. This is true in many organizations. Often, the area above the line of visibility is referred to as the *front office*, and the area below the line of visibility is referred to as the *back office*. Many times process improvements focus on back-office activities, whereas front-office activities that involve high customer interaction are ignored. Services process blueprinting places the focus on front-office activities.

To understand how you could apply services blueprinting, think about a restaurant. Typically, when you first enter a restaurant, you expect to be greeted at the door. Can you remember a time when you weren't? This has happened to all of us at some point. A restaurant can install sensors or provide backups for the greeter so that this breakdown never occurs. Services blueprinting is a tool to help with brainstorming activities that lead to customer service improvement.

Moments of Truth

The fail points in the services blueprints are often referred to as **moments of truth**. These are the times at which the customer expects something to happen. Remember the SERVQUAL items? Expectations are a major determinant of customer perceptions of service quality. Therefore, when the customer expects something to happen, it has to happen. It is that simple! Some companies list these moments of truth and define fail-safes and procedures to see that they result in satisfied customers.

Customers' contact with the business can occur in many different ways—face to face, over the Internet, by phone, through a machine such as an ATM, or through the mail. All these moments of truth result in either happy customers or lost customers. Moments of truth also can happen at various stages of the product life cycle, such as when the product is being used, when customer service queries arise, when the product needs repair, and when it is eventually disposed of. A Closer Look at Quality 8-2 considers the application of this approach in a health care process.

A CLOSER LOOK AT QUALITY 8-2 Quality in Health Care[7]

Lynn Shostack's service blueprinting and failproofing processes can be applied in a wide variety of services settings. One area is health care management. Health care quality management is a vast topic. Many contingencies affect the practice of quality management in health care. For example, look at the wide variety of settings where health care is practiced: clinics, hospitals, trauma centers, doctors' offices, and in the field. Each of these settings requires differing approaches and has different standards for care.

Medical errors continue to be one of the leading causes of death in the United States. Medical needs are different for specific populations such as women, children, minorities, the aged, and those with chronic conditions. Delivery methods also vary with vehicles such as primary care, managed care, hospitals, health maintenance organizations, and others. Given this diversity of problems relative to health care quality management, much work is needed in this area.

Following is a list of 20 steps to improve health care from the U.S. Agency for Healthcare Research and Quality. Note how these steps appear to walk the patient through the entire health care process to isolate possible fail points.

1. Be an active member of your health provider team.
2. Make sure your doctor knows all medicines you are taking.
3. Let your doctor know about any allergies you have to medications.
4. Read the doctor's prescriptions.
5. Understand your medications.
6. Make sure you get the right medicine from your pharmacy. An estimated 88% of medicine errors involve the wrong drug or dosage.
7. Ask pharmacists about your medicines.
8. Ask how best to measure liquid medicines.
9. Understand your medicine's side effects so you are aware if they occur.
10. If possible, go to a hospital where they often perform the procedures or surgeries you need.
11. Ask your health care personnel if they have washed their hands before they touch you.
12. Understand your treatment plan when you are discharged from a hospital.
13. Understand any surgical procedures you will experience.
14. Speak up if you have questions or concerns.
15. Make sure your personal doctor is in charge of your care.
16. Make sure all of your health care providers know your health history.
17. Get others involved in your health care such as family members in case you are incapacitated.
18. Know that "more is not better." You may not need some care.
19. If you have a test, don't assume that no news is good news. They may have failed to contact you.
20. Learn more about your condition and treatments by asking your doctor and nurse and other reliable sources.

[7]Adapted from "20 Tips to Prevent Medical Errors—Patient Fact Sheet," Agency for Healthcare Research and Quality, 2008.

Poka-yoke

Dr. Richard Chase and Dr. John Grout have been influential in promoting the use of **poka-yokes** (fail-safes) in services.[8] The idea behind fail-safing is to ensure that certain errors will never occur. Just as many processes seem to be designed to fail, they also can be designed *not* to fail. In services, Chase defines different classifications for fail-safe devices. These are

Warning methods

Physical contact methods

Visual contact methods

Fail-safe methods can also be defined by the "**three Ts**" (see Figure 8-7):

Task to be performed

Treatment provided to the customer

Tangibles provided to the customer

These poka-yoke classifications and Ts occur in many different forms. Some examples include[9] beepers in ATM machines that warn you to remove your card, toilets and sinks that automatically flush and shut off, the mechanism that stops you from inserting a disk upside-down in a computer, surgical trays that have indentations for different instruments, needle removers that prevent accidental needle pokes, requirements that bank tellers enter a customer's eye color before beginning a transaction so that identity is confirmed, or a file cabinet that locks the other drawers when any one drawer is opened so the cabinet doesn't fall over.

Poka-yokes such as these represent a good amount of creativity and are very often used by Japanese and American companies to help ensure quality service. In a nutshell, you should isolate fail points in a process and then fail-safe the process to make sure that errors don't occur.

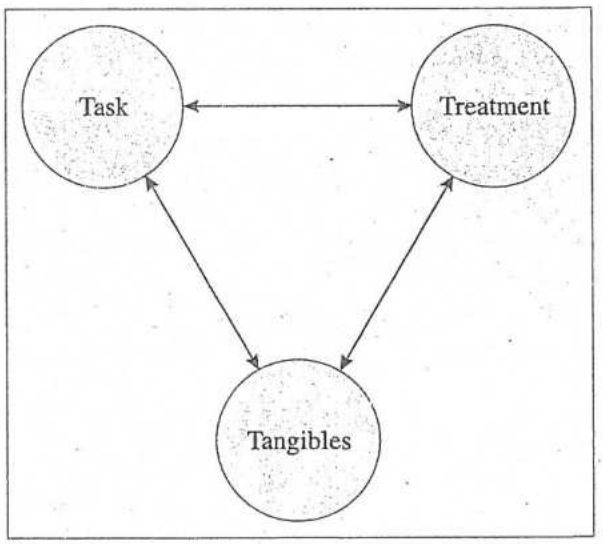


FIGURE 8-7 The Three Ts

[8]Chase, R., and Stewart, D., "Make Your Service Fail-Safe," *Sloan Management Review* 35, 3 (1994): 35–44.

[9]For an extensive literature review and interesting information about poka-yoke, check out Dr. John Grout's homepage on the Internet (facultyweb.berry.edu/jgrout/pokayoke.html). He has devoted a great deal of time to developing this resource, and it is the most concise one on poka-yoke available. Grout is currently Dean of the Campbell school of Business at Berry College in Mount Berry, Georgia.

Thinking back to Lynn Shostack's hair salon process, how would you fail-safe the process so that the wrong color would never be applied?

THE CUSTOMER BENEFITS PACKAGE

Just as many organizations have employee benefits packages, services firms can develop **customer benefits packages (CBPs)**. A customer benefits package consists of both tangibles that define the service and intangibles that make up the service. The tangibles are known as *goods-content*. Intangibles are referred to as *service-content*. The only difference between an employee benefits package and a services benefits package is the ultimate recipient of the benefits package.

CBPs are important not only in that they help define what it is that your service firm *will* provide to the customer but also in helping to define what *will not* be provided to the customer. More and more, firms are focusing on better defining the niches that they serve. As a result, the question of what they *will not* provide the customer is often as important as what they *will* provide the customer. By helping to answer this question, CBPs provide a foundation for developing a service strategy. The four stages of the service benefit package design process are as follows (see Figure 8-8):

1. Idea/concept generation
2. The definition of a services package
3. Process definition and selection
4. Facilities requirement definition

As defined by David Collier,[10] a professor at Florida Gulf Coast University, the objectives of customer benefits package design are to

- Make sure the final CBP attributes you are using are the correct ones.
- Evaluate the relative importance of each attribute in the customer's mind.
- Evaluate each attribute in terms of process and service encounter capability.
- Figure out how best to segment the market and position CBPs in each market.

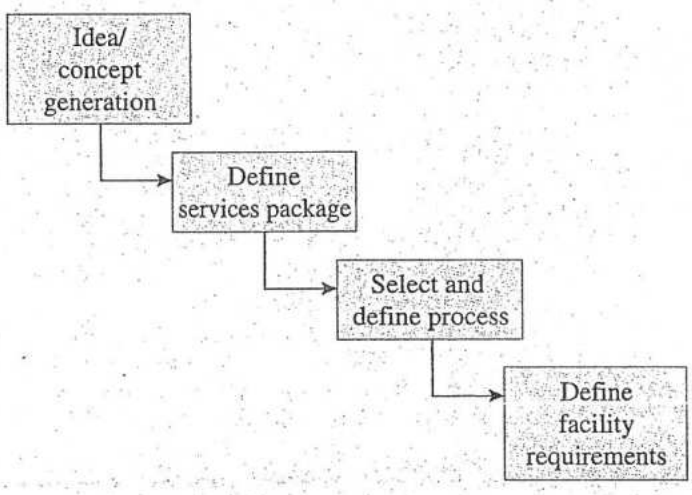


FIGURE 8-8 CBP Design Process

[10]Collier, D., *The Service/Quality Solution* (Milwaukee, WI: Irwin/ASQC, 1994).

Services Process Structure	Services Package Structure: Unique services packages	Selective services packages	Restricted services packages	Generic services packages
Expert service	Doctor's office			
Service shop		Mass entertainment		
Service factory				Home repair

FIGURE 8-9 Service Process/Service Benefits Package Matrix *Source:* Based on D. Kellogg and W. Nie, "A Framework for Strategic Service Management," *Journal of Operations Management* 13, 4 (1995): 323–327.

- Avoid CBP duplication and proliferation.
- Bring each CBP, and associated process and service encounters, to market as quickly as possible. Use the CBP framework and final attributes to design facilities, processes, equipment, jobs, and service encounters.
- Maximize customer satisfaction and profits.

The CBP is defined largely by the degree of freedom allowed by the firm in the customization of the services package. Deborah Kellogg and Winter Nie[11] provided a services process/services package matrix. As shown in Figure 8-9, firms will offer **unique services packages**, **selective services packages**, **restricted services packages**, or **generic services packages**. Generic services packages are of the one-size-fits-all variety. Unique services packages are especially tailored for each customer. Your firm's ability to custom-tailor a benefits package depends on the amount of flexibility you have as a service provider. Strategic issues such as organizational flexibility, top-management skill, employee motivation, training, hiring practices, culture of the service customer, nature of the service, and technological choice affect your ability to provide unique services packages.

Table 8-3 shows a customer benefits package from the Slide-Master firm. Notice that Slide-Master has taken great care in defining tangibles and intangibles for its CBP. Slide-Master evaluates its CBP performance using monthly surveys of employees and customers.

SERVICE TRANSACTION ANALYSIS

Because we have now discussed design of services processes and improving services processes, we can now present **service transaction analysis (STA)**.[12] This is a service improvement technique that allows managers to analyze their service processes at a very detailed level. As we stated, Crosby views service encounters as a series of transactions (or moments of truth). STA is a method for identifying these transactions and evaluating them from the customer's perspective to determine if there is a gap between service design and what the customer perceives as the service.

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[11]Kellogg, D., and Nie, W., "A Framework for Strategic Service Management," *Journal of Operations Management* 13, 9 (1995): 323–337.

[12]Johnston, R., "Towards a Better Understanding of Service Excellence," *Managing Service Quality* 14, 2/3 (2004): 129–134.

TABLE 8-3 Final CBP Attributes for Slide-Master

Tangible (Goods-Content)	Intangible (Service-Content)
Slides	*Convenience and timeliness*
Quality, durable, clean, new film, and cardboard	Facility close to downtown
High-resolution pictures and slides	Pickup and delivery service
Multiple color combinations (6 million)	Telephone/fax order capability
Slide properly centered and focused	Standard 3-day service
	Rush 1-day service
Equipment/technology	Really try to handle last-minute customer changes
Latest computer hardware	Accurate, itemized billing by fifth working day of each month
State-of-the-art software	
High-quality camera	*Professionalism*
Superior maintenance of all equipment	Absolutely confidential services
Well-maintained delivery vehicles with ads on the sides	Emphasis on telephone courtesy
Flexible for custom designs	Refer to client by name
People	Client order documentation correctly filled out and processed
Clean and very well groomed	Flexible to customer needs
Attractive uniforms	*Consulting services*
Packaging	Artistic expertise
Heavy, clear, high-quality sleeves	History of previous jobs
Sequenced and numbered properly	Technical knowledge
Loaded in attractive boxes or slide carousels	Nonbusiness hours on-call professional
Facilities	*Service attitude*
Ample parking spaces	User-friendliness
Secure parking lot	Polite, responsive attitude
Attractive signs	Do exactly what we promise
Clean, attractive building—outside	Script dialogues for order taking and postpurchase callbacks
Upscale indoor wall pictures and decor	Confident but relaxing behavior
Reception area and service counter—clean and professional appearance	
Soft, relaxing background music	
Plush furniture	
Bright lighting	
Complimentary coffee and soft drinks	
Restrooms, soap, etc.—clean	

Source: Adapted from David Collier, *The Service/Quality Solution* (Milwaukee, WI: Irwin/ASQC, 1994). Used with permission of David Collier.

Figure 8-10 shows a service transaction analysis sheet. This sheet is a tool in STA. Once you have specified the service process to be studied, "mystery shoppers," or independent consultant-customers, walk through the entire process. After receiving the service, they then rate each transaction in the process with either a "+" (delighting), "0" (satisfactory), or "–" (unsatisfactory). The rationales for these scores are entered into the right side of the sheet, and an overall evaluation is provided in the bottom of the sheet. Using these sheets, service designers, managers, and staff can attempt to understand why the customer did not like certain aspects of the service and use this as an input into improving the process.

SERVICE TRANSACTION ANALYSIS SHEET

Legal Firm:	Lawyer			Service concept: General legal services for personal customers in a user-friendly, sympathetic, and nonintimidating way
Process:	Reception			
Customer type:	Personal client			
	Score:			
Transaction	+	0	−	Message
Imposing oak entrance door, firmly shut.				"Trustworthy, professional but a little formidable."
Second door with advertisement for a lending company.				"They like constructing barriers." "They may not be impartial."
Carpeted corridor but no sign of receptionist.				"Homey but is this the right place?" "Unhelpful."
Receptionist behind desk ignores customer and continues typing.				"They don't seem to care about me." "They don't think I am important."
She says, "Yes?"				"Not very welcoming." "I feel like I am intruding on her work."
Phone rings, which receptionist answers.				"I am not important." "Other people have prority on her time."

Overall evaluation
Poor service design. Little thought or concern for clients. Unfriendly and intimidating service.

FIGURE 8-10 STA Sheet

EXAMPLE 8-3 Service Transaction Analysis in Action

In the transaction analysis sheet in Figure 8-10, the large oak door, although professional, looks forbidding. When going to this lawyer's office, the client is probably nervous about approaching the attorney and can find the décor daunting and scary. The message on the second door made it appear that the attorneys may not provide impartial advice due to their relationships with a lending company. The not-so-subtle message sent by the rude receptionist demonstrated a mismatch

between the service design and execution . . . and so forth. The application of this technique alerted the partners to what was really going on in their own office. Changes were made to address these problems.

IMPROVING CUSTOMER SERVICE IN GOVERNMENT

If customer service is the battlefield for business in the twenty-first century, then government is probably the last frontier. There are some evidences of improvement in several aspects of government. The National Productivity Review[13] reports that some federal government agencies have adopted quality management (see A Closer Look at Quality 8-3). Quality professionals know that the military has long been an early adopter of statistical quality techniques. Many standards have been established. The government has developed a searchable list of 4,000 customer service standards for 570 federal departments and agencies. This effort started with an executive order for a "customer-driven government that matches or exceeds the best service available in the private sector." In the first year, only three agencies responded with agreements to commit to service standards. These early adopters were the Social Security Administration, the IRS, and the Postal Service.

A CLOSER LOOK AT QUALITY 8-3 Government Service Quality: A Stop-and-Go Process[14]

Quality improvement in the U.S. government has been a hit-or-miss proposition. Serious and significant efforts have been implemented since the Reagan administration. Whereas the Reagan and Bush (GHW) administrations promoted the Baldrige and Deming approaches to improvement, Clinton emphasized improvement via Executive Order. The G.W. Bush administration did little to improve government service quality.

During the Obama administration, governmental improvement has not been a top priority but has followed six main themes:

- Putting performance first with a new performance improvement and analysis framework.
- Ensuring responsible spending.
- Focusing on retaining and recruiting federal employees who are ready to implement twenty-first century systems.
- Partnering with private and nonprofit organizations.
- Reforming federal contracting and acquisition emphasizing competition.
- Increasing transparency in government.[15]

During the Clinton administration, the major improvement effort was called "Reinventing Government." Among the triumphs of **reinventing government** were the IRS TeleFile program and the Social Security Administration telephone answer lines. However, the reinventors also avoided contact with traditional good-government groups, such as the National Academy of Public Administration and the Council for Excellence in Government, and wanted little to do with the Office of Management and Budget, the Office of Personnel Management, the federal inspectors general, and the General Accounting Office, all of which they viewed more as part of the problem than of the solution. Created as a quasi-independent unit appended to the vice president's office, the campaign to reinvent the government

[13]Milakovich, M., "The State of Results-Driven Customer Service Quality in Government," *National Productivity Review* 17, 2 (1998): 47–54.
[14]Based on "Requiem for Reinvention, Government Executive," www.govexec.com/dailyfed/0201/021201ff.htm, 12 February, 2001.
[15]Based on Balutis, A., "The Obama Agenda: Five Steps Towards Transformation," *Public Manager* 38, 4 (2009): 43–47.

operated with enormous autonomy. Its leaders could not, and would not, testify before Congress, and its directives were kept in virtual space at a Web site whose days were numbered when the Bush administration arrived.

Convinced that statutory reform was either impossible or unnecessary, the reinventors were left with a number of weak devices for spurring change. Reinventing was poorly linked, if at all, to the employee performance appraisal process and carried few, if any, budgetary or personnel consequences. It simply did not matter to the things that matter to agencies—money and headcounts. Federal employees could earn Hammer awards for reinventing government but not bigger budgets or a more forgiving congressional committee.

Customer satisfaction surveys were the one piece of reinvention to have survived in the Bush administration. Few would expect the administration to interview the same customers, however. The Environmental Protection Agency surveyed reference librarians under Clinton, for example, but a survey of regulated parties was more plausible under Bush.

According to Paul C. Light, vice president and director of governmental studies at the Brookings Institution, the experience from reinventing government suggests at least three ingredients needed for more vibrant efforts in future administrations:

- ***Statutes.*** Although congressional action is always difficult, it outlives the ends of administrations in a way that executive directives cannot.
- ***Structure.*** The federal hierarchy is just as thick today as it was prior to reinventing government. Indeed, considerable evidence suggests that the most senior levels of the hierarchy are even thicker. This is the cost of letting a thousand flowers bloom without doing any weeding.
- ***Bipartisanship.*** Reinventing government would be alive today if it had been rooted in a bipartisan agreement on the need for big-government reforms. It is a lesson well worth remembering for future efforts.

States are also jumping on the bandwagon. By 2011, 32 states had established quality award programs. Many state agencies around the country have adopted quality techniques. However, many of these implementations appear to be in the early stages. Overall, government is lagging behind the private sector in quality adoption. Although the results are mixed, it is clear that private-sector quality management practices are being adopted in government. Why is this progress occurring? Many used to question whether the government had the inclination to adopt quality techniques, given the lack of profit motive. However, several factors seem to be driving this change:

- People want and desire to do good quality work.
- Because quality management is associated with improved employee satisfaction, there is a major impetus to improve.
- Government leaders are mandating standards, strategic plans, and new levels of performance at all levels of government. These standards are being adopted in government agencies because of the mandates.
- Demand for government services is growing at a faster rate than funding for them. The natural reaction is to simplify processes that have become bloated.
- Finally, the threat of privatization in government has led to an improvement in service in many areas.

QUALITY IN HEALTH CARE

Another area of services that is receiving much attention is health care. Several factors have contributed to this phenomenon:

- Health care is facing the same "cost squeeze" that government is facing.
- A move toward health maintenance organizations (HMOs) is causing hospitals to streamline operations.
- There is increasing diversity in health care.

In some cases, insurers such as Blue Cross are encouraging the use of quality management approaches. Health care workers are becoming increasingly knowledgeable about quality management practices and concepts. In fact, the very nature of health care requires careful and well-planned procedures.

Many health care customers, however, are uncomfortable with these changes to government and health care. If quality approaches are applied, it is probably best that efforts not focus entirely on efficiency. Reliability and empathy are dimensions that can only be good for health care.

SUPPLY CHAIN QUALITY IN SERVICES

As we have talked about before, one of the major differences between services and manufacturing is the involvement of the customer in the process. As shown in Figure 8-11, service supply chains are bidirectional. This means that service customers actually provide inputs to the supply chain. Many times, these inputs can be information or, in some cases, labor—as in the case of a self-service gas station. Therefore, effective communication is necessary between customers and suppliers to prevent inadequate fulfillment of customer expectations. The concept of garbage in, garbage out implies that the quality of a service supply chain will be limited by the quality of the supplied inputs. Even if customers provide poor inputs (inaccurate information), they may still expect accurate outputs. This expectation has implications for service design. In an integrated supply chain, the service provider still has greater responsibility for verifying customer inputs to ensure they are accurate. In some cases, the service provider may be able to initiate communication of customer-input delivery expectations, such as through reservation systems. This may be complicated by the fact that many times, service delivery systems are inherently just-in-time. Of course, in services, there are other suppliers besides the customers. Often, these are managed in a more traditional supply-chain manner. However, the customer-supplier linkage makes services unique.

A THEORY FOR SERVICE QUALITY MANAGEMENT

As we studied in Chapter 2, theory development in the area of quality is an important work that continues. Dr. Scott Sampson of Brigham Young University is a researcher who is developing theory in services management. His **unified theory for services management** provides interesting insights for quality management.[16] This theory consists of several propositions. These



FIGURE 8-11 Bidirectional Services Supply Chain *Source:* S. E. Sampson, "A Customer-Supplier Paradigm for Service Science," in (refereed) *Proceedings of the DSI Services Science Miniconference,* Pittsburgh, PA, May 2007.

[16]Sampson, S., "Understanding Service Supply Chains," *Proceedings of the 3rd International Conference on Operations and Supply Chain Management,* Wuhan, China, 2009, p. 54.

propositions are based on the definitions of services that were introduced early in this chapter. Some of the propositions are as follows:

Proposition 1: The Unified Services Theory. "With services, the customer provides significant inputs into the production process. With manufacturing, groups of customers may contribute ideas to the design of the product; however, individual customers' only part in the actual process is to select and consume the output. Nearly all other managerial themes unique to services are founded in this distinction."

Proposition 2: The Unreliable Supplier Dilemma. "With services, the customer-suppliers often provide unreliable inputs."

"The Unreliable Supplier Dilemma" occurs because service customers provide themselves, their belongings, and/or their information as process inputs (by the Unified Services Theory). This simultaneous relationship as supplier and customer makes it difficult for the service provider to control the supplied inputs.

Proposition 3: Capricious Labor. "With services, customer-labor may ignore, avoid, or reject technologies or process improvements which are intended to increase quality and productivity. As a result, customer buy-in to process changes must be carefully addressed."

Capricious labor occurs because many services customers provide themselves as labor inputs into the production process. In manufacturing organizations, labor is expected to conform to corporate policy. If the manufacturer mandates that a quality initiative be implemented, labor is generally expected to conform, even when labor thinks the initiative is a bad idea.

Imagine a manufacturer who invests in technology that will improve quality of production. Then imagine that some of the employees reject the technology, stating, "I am more comfortable doing it the old way," even though the old way is inefficient and results in poor quality. How would management respond to those self-willed employees? Unless those employees were children of the owner, one might suspect their jobs would be in jeopardy. In services, much labor is performed by customers who coproduce. Therefore, they can adopt or reject what they don't like. For example, customers don't have to stand in line if they don't wish.

Proposition 4: Everyone Presumes to Be an Expert. "With services, the customer often provides product specifications (what to make) and process design (how to make it), often without the invitation of the service provider."

"Everyone thinks they're an expert" occurs because the necessity for customer inputs in service processes means that most customers have extensive experience with the service process. This experience breeds process knowledge and ideas for improvement. The words of Richard Chase capture this idea well: "Everyone is an expert on services. We all think we know what we want from a service organization and, by the very process of living, we have a good deal of experience with the service creation process."[17]

Summary

In this chapter we have studied quality in services. Because services involve intangibles, they are different from manufacturing. Because of the lack of hard measures, statistical quality control techniques are not always as successful in services as they are in manufacturing. This doesn't mean that statistical thinking is not extremely useful in services.

[17] Jacobs, H., and Chase, R., *Operations and Supply Chain Management* (Homewood, IL: Irwin, 2010), p. 56.

Services definitions and classifications were presented that help us better understand services. We have provided tools for services such as SERVQUAL, services blueprinting, moments of truth, poka-yokes, and customer benefits packages.

The bottom line is a satisfied customer. Customers pay the bills. They are the object of our efforts. At times, all the customer wants is a caring ear to bend. In our race for profits, efficiencies, and better processes, let's not forget the human touch.

Key Terms

Contact personnel
Customer benefits packages (CBPs)
Customer contact
Customer coproduction
Customer expectations
Customer perceptions
External services
Gap
Gap analysis
Generic services packages
Heterogeneous
Intangible
Internal services
Involuntary service
Malpractice
Moments of truth
Poka-yoke
Product liability
Reinventing government
Restricted services packages
Selective services packages
Service transaction analysis (STA)
Services blueprinting
SERVQUAL
Three Ts
Unified theory for services management
Unique services packages
Voluntary services

Discussion Questions

1. Discuss the ways in which services are unique in comparison with manufactured goods. How do these differences affect the management of service quality?
2. Can a service firm rely on customer coproduction and still keep a high customer focus? Support your answer with examples.
3. Are quality techniques in the service industry well developed or still fairly immature? If you believe that they are immature, why do you think this is the case?
4. What are the challenges for increasing the labor productivity in the service sector?
5. Discuss the distinction between voluntary services and involuntary services. Why is this distinction important in our understanding of service quality?
6. Are the Baldrige criteria applicable to service situations? If so, how?
7. List Zeithamel, Parasuraman, and Berry's five dimensions of service quality. Is the list identical for every service provider, or does it vary from company to company? Explain your answer.
8. Discuss some of the qualities of an effective leader in a service context.
9. What is SERVQUAL? How does SERVQUAL help a firm assess its service quality?
10. What are the advantages of the SERVQUAL instrument?
11. Discuss the concept of gap analysis in the context of a SERVQUAL assessment.
12. What is a services blueprint? How is a services blueprint developed?
13. Describe the concept of moment of truth in a service context. Describe a moment of truth that you recently experienced as a consumer. Was your service experience satisfactory or unsatisfactory? Explain your answer.
14. How can the moment-of-truth concept be used as a training tool in a service setting?
15. What is a customer benefits package? What is the purpose of developing customer benefits packages in a service context?
16. In what ways will the globalization of services alter the way that businesses manage their service quality?

17. Discuss the initiatives that the U.S. government has taken to increase its emphasis on service quality. Are they effective?
18. Discuss several of the factors that have contributed to an increase in attention directed toward quality in health care.
19. Discuss the unified theory for services management developed by Dr. Scott Sampson. Do you agree or disagree with the principles underlying Sampson's theory? Explain your answer.
20. In your judgment, will the management of "service quality" ever progress as far as the management of "manufactured goods quality"? Make your answer as substantive as possible.

Problems

1. A national electronics retail chain charges $350 for a service contract. Of this, the company sends $120 to an insurer. Calculate the profit margin for the service contract.
2. Using the example of the service transaction analysis (STA) worksheet in Figure 8-10, chart and evaluate the transactions for your university or college advising office. Report your findings and overall evaluation.
3. Develop a consumer benefits package for a service business in your community. Be exhaustive and explicit in your package identification.
4. Develop a services blueprint for a local car wash. Identify possible fail points, back-office processes, and fail-safes.
5. Recently, a medical office administered the SERVQUAL survey to its customers as a way to determine where it should focus the process improvement. Forty surveys were administered to customers before and after they were treated. On the basis of the 40 responses, averages were computed for each item. Using the averages in the table that follows, compute dimension averages. Based on your findings, which dimensions should be emphasized?

Item	Perception Average	Expectation Average	Differences
1	5.5	2.3	3.2
2	5.4	2.4	3.0
3	5.9	2.2	3.7
4	5.8	2.8	3.0
5	3.2	3.2	0
6	4.4	4.1	0.3
7	4.3	5.3	−1.0
8	2.5	4.9	−2.4
9	4.6	5.6	−1.0
10	6.2	3.4	2.8
11	6.5	3.2	3.3
12	6.6	3.4	3.2
13	6.8	3.6	3.2
14	3.1	3.2	−0.1
15	4.5	3.3	1.2
16	3.3	3.4	−0.1
17	3.1	3.2	−0.1
18	3.2	3.5	−0.3
19	1.6	6.5	−4.9
20	1.8	6.6	−4.8
21	1.5	6.4	−4.9
22	1.4	6.3	−4.9

6. For the data in Problem 5, perform a two-dimensional differencing analysis. Do your results differ from your answer in Problem 5?
7. The averages for different dimensions of service quality were computed by averaging the items pertaining to the dimension. Use the following data to determine which dimensions to emphasize.

	Perceptions	Expectations
Tangibles =	5.40	1.42
Reliability =	3.20	6.40
Responsiveness =	2.45	2.30
Assurance =	5.60	3.30
Empathy =	1.90	6.40

   a. Using simple differencing, determine which dimensions should be emphasized.
   b. Use two-dimensional differencing to determine which dimensions should be emphasized.
   c. Based on your findings, choose the most important dimension and describe how you would develop a process improvement program to address the dimension that needs to be improved.
8. A state university wants to perform a gap analysis to determine what student traits corporate CEOs find most important. The exercise is to be administered to CEOs and involves two surveys: an expectations survey and a perceptions survey. All questions are answered on a 10-point scale. The attributes the CEOs are asked to rate are propensity for lifelong learning, ability to work in teams, innate ability, and cognitive ability. The results of nine surveys are synopsized in the following table:

	Lifelong Learning		Teamwork		Innate Abilities		Cognitive Abilities	
Respondent	Expectations	Perceptions	Expectations	Perceptions	Expectations	Perceptions	Expectations	Perceptions
1	8	0	8	10	2	5	3	9
2	7	4	9	9	6	5	4	8
3	9	2	9	10	4	5	2	7
4	10	5	10	9	7	4	3	8
5	5	1	8	7	5	6	4	9
6	9	1	7	9	2	7	2	10
7	9	3	9	10	2	5	3	10
8	8	2	10	10	3	6	2	10
9	7	0	9	10	2	5	4	9
Average	8.00	2	8.78	9.33	3.67	5.33	3.00	8.89

   Perform a gap analysis by developing a two-dimensional differencing plane, and evaluate the results.
9. Following is a transaction analysis for a movie theater. Please answer the following questions:
   a. Based on the service transaction analysis, what is your assessment of the movie theater?
   b. In what areas can the movie theater improve?
   c. Are there any additional customer touch points you can think of in this process? What could the company do to make them a positive experience?
10. Following is a service transaction analysis for a lube shop. Answer the following questions:
   a. Based on the service transaction analysis, what is your assessment of the lube shop?
   b. In what areas can the lube shop improve?
   c. Are there any additional customer touch points you can think of in this process? What could the company do to make them a positive experience?

SERVICE TRANSACTION ANALYSIS SHEET FOR PROBLEM 9

Organization:	Movie Theater			Service Concept: Provide comfortable experience in viewing today's current releases.
Process:	Buying Ticket			
Customer Type:	Movie Goer			
Transaction	Score: +	0	−	Message
Exterior façade with movie posters.				"See what is playing or coming soon." "We are showing the movies you want to watch."
A single, windy ticket line with multiple tellers at the end.				"Everyone is herded together." "Ticket booth was crammed in the corner of theater." "They just wanted my money."
Ticket collectors near ticket booth tell where the theater is.				"Employees very knowledgeable and care that I get to the correct theater." "They want me to enjoy the movie/experience right away."
Concession stand in the middle of open area and brightly lit.				"They want me to spend more money." "The movie won't be the same without snacks and drinks."
Large displays of coming attractions posted at theater entrance. Some movies have offensive words and pictures.				"I feel like this is the movie I'm supposed to see next. The company doesn't care if it is good, as long as I come and see it." "The movie display was offensive and not appropriate for all ages."
Movie theater has food on floor and is sticky.				"Only the big items are worth our time to pick up." "Cleanliness isn't as important in the movie-going experience." "Once I start watching the movie, they don't care as much about the experience."

Overall Evaluation:
The movie theater is about selling tickets. They are helpful until I am done spending my money. More consideration is needed to keep me coming back to this theater.

an energetic 19-year-old, James (Jim) E. Casey, started the American Messenger Company in Seattle. Although the company began with a small staff and faced stiff competition, it did fairly well, primarily because of Casey's strict policies. He built his business on four principles: customer courtesy, reliability, around-the-clock service, and low rates.

Casey's company eventually became United Parcel Service, or UPS. The name United Parcel Service was chosen to draw attention to the words *United*, to emphasize the fact that shipments were consolidated to increase efficiency, and *Service*, because the company recognized that service was all it had to sell. UPS grew quickly through the years and became well known for its chocolate-colored delivery vans and courteous drivers. The public also liked UPS's business concept. It was convenient to send packages by UPS, and people trusted UPS to deliver packages safely to their destinations. All kinds of people and businesses used UPS's services, from pharmaceutical companies that shipped lifesaving drugs across country to grandparents who sent their grandchildren birthday presents and boxes of candy at Christmas.

Although UPS has always been a friendly company, until the mid-1980s it relied primarily on technology to maintain efficiency, keep prices low, and provide new services. A major internal change took place at UPS in the mid-1980s when the company decided to shift its emphasis from technology to satisfying customer needs. This shift represented a recognition that UPS customers were becoming more sophisticated and had a variety of needs the company was uniquely equipped to satisfy. Paramount among these were an increased need for information, a desire to move packages even more quickly and efficiently, tremendous competitive pressure from Federal Express, and a demand for customized prices and services.

UPS moved quickly to satisfy its customers' needs by developing new service products. For example, TotalTrack, which is available at UPS's Web site, can instantly provide customers with tracking information on all bar-coded UPS packages. This service helps vendors know when their buyers have received their shipments. Inventory Express is a contract logistics management service in which UPS stores a customer's merchandise and then ships it when it is needed, often on a just-in-time basis.

UPS also has improved its basic package pickup and delivery services. Customers with urgent shipments can telephone UPS to take advantage of On-Call Air Pick Up, which provides fast pick up at the customer's home and overnight delivery of packages. To accommodate customers who ship to sparsely populated areas in the United States and abroad, UPS has improved its geographic reach to every address in the United States and locations in more than 185 countries and territories.

Discussion Questions

1. Based on the description of UPS, what do you believe are UPS's strengths and weaknesses?
2. How has UPS used technology in its design of quality services? Make your answer as substantive as possible.
3. Describe a positive or negative experience that you have had with UPS (or one of its competitors such as FedEx or the U.S. Postal Service). If the experience was positive, reflect on whether the experience is consistent with UPS's new emphasis on customer needs. If the experience was negative, what could UPS have done to better satisfy your needs?