Total Quality Management

15ME664

Prof. S R Kulkarni

Subject: TOTAL QUALITY MANAGEMENT

Module - 1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.

08 Hours

Module - 2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,

08 Hours

Module - 3

Customer Satisfaction and Customer Involvement:

Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.

08Hours

Module - 4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.

Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.

08 Hours

Module - 5

Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance. **08 Hours**

TEXT BOOKS

1.Total Quality Management: Dale.H.Bester field, Publisher- Pearson Education India, ISBN:8129702606

2.Total Quality management for Engineers: M. Zairi, ISBN- 1855730243 Publisher- Wood head publishing

REFERENCE BOOKS

1. Managing for Quality and Performance Excellence by James R.Evans and Williuam M Lindsay, 9th edition, Publisher Cengage Learning.
2 A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
3. Organizational Excellence through TQM, H. Lal, New age Publications, 2008

Internal Assessment: 20 Marks

Theoretical aspects as well as relevant sketches should be drawn neatly for questions asked in Internal Assessments

Scheme of Evaluation for Internal Assessment

Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests):20marks.

SCHEME OF EXAMINATION:

There are five modules two questions from each module

Student has to answer any five question choosing at least one questions from each module.

Max. Marks: 80Marks

COURSE OVERVIEW

Quality principles and tools can improve both manufacturing and general business processes; the goal is to exceed customer expectations to achieve business strategy. Total Quality Management is a structured system for satisfying internal and external customers and suppliers by integrating the business environment, continuous improvement, and breakthroughs with development, improvement, and maintenance cycles while changing organizational culture.

Total Quality Management is a management approach that originated in the 1950's and has steadily become more popular since the early 1980's. Total Quality is a description of the culture, attitude and organization of a company that strives to provide customers with products and services that satisfy their needs. The culture requires quality in all aspects of the company's operations, with processes being done right the first time and defects and waste eradicated from operations.

One of the keys to implementing TQM can be found in this definition. It is the idea that TQM is a structured system. In describing TQM as a structured system, means that it is a strategy derived from internal and external customer and supplier wants and needs that have been determined through Daily Management and Cross-Functional Management.

Pinpointing internal and external requirements allows us to continuously improve, develop, and maintain quality, cost, delivery, and morale. TQM is a system that integrates all of this activity and information.

When all of its elements are implemented properly, TQM is like a well-built house. It's solid, strong, and cohesive. If TQM is not planned for and implemented correctly, it will be structurally weak and will probably fail.

The challenge in engineering today is not just *how* to design and build, but *what* to design and build. Resource constraints mean you can't do everything at once. So how do you determine what gets done first? The TQM tools taught in this course will show you how .

After the completion of the course students shall develop the following skills and competencies:

Managing projects, people, and resources in a global setting.
Enhancing leadership and communications skills and understanding markets, product realization.

MODULE 1
Basic TQM Concepts

INTRODUCTION

This lesson will make students acquainted with the concept of quality.

Quality in Daily Life

Quality has been an age-old concern. The discerning customer in shops and market places has applied "quality techniques," prodding and turning fruits and vegetables testing for firmness, freshness and fitness for the purpose of consumption. If the products were not adequate, the purchase would not take place.

In the hustle and bustle of cattle markets farmers argued and bartered over the fitness of animals for breeding, dairy farming or consumption, providing evidence for their case by inspection against criteria learned from their forefathers. Those shoppers and farmers passed on their knowledge to their children and similarly it was passed on to their children's children.

I too learned the principles of inspection and learning from my mother as she scrutinized clothes and footwear, fruits and vegetables in our town market. Eager market traders would get short shrift from her if clothes had weak stitching, zips got stuck when zipping, fruits were marked and bruised or vegetables appeared old and unpalatable.

The issue of quality of goods and services is not new. Throughout history, society has demanded that providers of goods and services should meet their obligations. As long ago as 1700 BC King Hammurabi of Babylon introduced the concept of product quality and liability into the building industry of the time by declaring:

If a building falls into pieces and the owner is killed then the builder shall be put to death. If the owner's children are killed then the builders' children shall be put to death.

Quality in the Middle Ages

The maintenance of quality was one of the key functions of the craft guilds of the middle ages with only those workers who could achieve acceptable quality standards being admitted to membership. Until the advent of mass production, building quality into a product was the job of a craftsman, what Feigenbaum referred to as "operator quality control." Skilled craftsmen produced high quality products and had pride in their work. Tradesmen gained a reputation for quality products through skilled craftsmanship that was maintained over time by enforcing lengthy apprenticeship of newcomers to masters-of-the-trade. Tradesmen worked in small tightly knit and controlled firms. Monopolistic guilds were organized to ensure achievement of a high-level skill and quality throughout its membership and the trade.

Quality during the Industrial Revolution

The industrial revolution revolutionized the manufacturing of products. Mass production set in large factories employing armies of people gave rise to new management ways. There were workers, supervisors and foremen, and managers. The establishment of factories and of this new organizational structure led to the withering of many small business trades and the removal of apprentices and masters from positions.

Frederick Taylor's scientific management brought in efficient operations to increase output through mass production by breaking down jobs into parts with each part carried out by individual specialized workers. Practical use of Taylor's "scientific management," built around specialization and the division of labor, reached a high point with the advent of the mass production line with the workers performing repetitious tasks on a mammoth scale.

Mass Production and Scientific Management

Mass production techniques reaped impressive early dividends. Henry Ford (1863-1947) built on the increased productivity brought by mass production. There was, however, more to Ford than flow lines and workers doing mindlessly repetitive tasks. Instead of controlling costs, to produce lower prices, Ford set the price and challenged the organization to ensure costs were low enough to meet the figure. The trouble was that when other manufacturers add extras, Ford lost touch with the aspirations of customers.

Compare this with the approach of Ford's predecessors. The first carmakers, such as France's Panhard et Levassor, employed a small number of skilled craftsmen. The cars they produced were unique-- almost prototypes-- with parts being filed and cut to make them fit. As the parts were of varying sizes, craftsmanship was required. Ford bought in uniform and interchangeable parts. Skill departed and instead production was based round strict functional divides, i.e. demarcations. At the center of Ford's thinking was the aim of standardization-- something continually emphasized by the carmakers of today though they talk in terms of quality and Ford in quantity.

Scientific management emphasized the divorce of conception from execution and the substitutability of labor. The craftsmen concept disappeared with Taylorism and so did quality achieved through skilled craftsmanship. Inspection, thus, remained the sole guarantor of quality. Quality was no longer built into the product.

Quality between the World Wars

The effort of the First World War demanded yet more mass production. Quality became a pressing issue with forces requiring reliable products to arrive on time. With this came the recognition that quality had been central to the allies' success in the war. This led to the formation of associations and institutes, and to the publication of formalized ideas in quality. For example, in Britain, the Technical Inspection Association was formed in 1919, becoming incorporated as the Institution of Engineering Inspection in 1922.

In 1931, W. A. Shewhart of the famous AT&T Bell Laboratories, published *Economic Control of Quality of Manufactured Product*. This gave the Taylorian discipline a much sounder "scientific footing." It converted statistical methods into a manufacturing discipline. A precise and measurable definition of manufacturing control was worked out. Stringent techniques for monitoring and evaluating day-to-day production and improving quality were dictated.

In 1932, Shewhart visited the University of London to lecture and to discuss his and others' research ideas. This visit attracted significant interest which led to the formation of the Industrial and Agricultural Section of the Royal Statistical Society and the publication by the British Standards Institute (BSI) of the first standard on quality control.

Japanese businessman Konosuke Matsushita-- the founder of one of the world's largest electronics groups-- was greatly influenced by the work of Henry Ford.

> From Ford, Matsushita was inspired by the prospect of mass production and also the concept of using price reductions to generate more sales.
> Matsushita followed the Ford-like objective of producing "an inexhaustible supply of goods." But to this, he added "thus creating peace and prosperity throughout the land."
> Ford was obsessed with production and forgot the broader view. Matsushita saw the company as having a role in society.
> The broader view of Matsushita was as follows:
>
> > Employees are important – not mere functionaries ensuring a steady stream of products are produced.
> > Customers are of course important.
> > Suppliers are also important - Matsushita was visiting the factories of his suppliers in the 1930s and giving them advice on how to produce their products more effectively.
> > If there is an effective partnership, all sides win and society benefits from the prosperity generated.

Matsushita was not alone. Other Japanese managers and their organizations seized the initiative. After the war, they were guided by two Americans-- W. Edwards Deming (1900-93) and Joseph Juran (1904-)

Quality after the Second World War

The Second World War again knocked industry off-balance. Priority was given to meeting delivery dates at the expense of standards in the product. In the UK the SR 17 statistical advisory unit of the ministry of supply was established. This unit made an important contribution to the industrial war effort, but quality was to have lean years in the UK after the war was over.

In North America the wartime effort had a more profound and longer lasting effect. Thousands of quality specialists that had been trained mostly by the War Production Board formed the American Society for Quality Control (ASQC). ASQC expanded its membership to about 50000

in 29 specialist divisions. However, the real success story for quality thinking emerged in one of the defeated nations. The Japanese launched a new nationalistic drive for expansion, pursuing economic rather than military goals.

Following the Second World War Japan's industry was devastated and the goods it produced were known for their indifferent quality. For example, in the 50s and 60s Japanese cars were virtually impossible to sell in the United States or Europe. A major thrust in Japanese manufacturing was to tackle these difficulties by employing and developing quality approaches. After the war many top industrialists were sacked and their successors subsequently promoted from operational areas. Foreign lecturers were invited to present their quality initiatives and to offer courses and training for Japanese managers.

A famous guru who played a major role in this process of improvement was W. Edwards Deming, but there were others from the United States such as J. M. Juran . They had the benefit of an intimate involvement in working out sound quality techniques during the war and in the post-war period. The two had also worked in the mid-1920s in Western Electric Co. were both influenced by Shewhart.

The American Approach to Quality

The failure of American corporations to listen to Deming and Juran has often been commented on. In retrospect it appears to be one of the century's most profound errors. At the time, however, it was understandable. In terms of quality, American products were as good as European ones and far better than those produced in Japan. The American preoccupation was on lowering prices and the vehicle for achieving this was generally recognized to be lowering labor costs.

The innovation strategy favored by the United States in the post-war years was the only strategy in a period of low-cost resources, expanding markets and low international competition. At that time, quantity was more important than quality and management was more concerned with increasing sales than with reducing costs. Western industry believed this would last forever and ignored the quality-based teachings of experts such as W. E. Deming and Joseph Juran, who, consequently, decided to turn their attention to the East.

In *Harvard Business Review* article (1993), Juran also made much of the fact that his Japanese audiences in the early 1950s were the chief executives of major corporations, whereas his North American listeners were primarily engineers and quality inspectors. Juran's message was not, he admitted, new or revolutionary. Making things to a specific design and then inspecting them for defects was something the Egyptians had mastered 5000 years previously when building the pyramids. The American engineers weren't ready for history lessons.

Deming was similarly well received in Japan. In 1951, the first award ceremony for the now prestigious Deming Prize was held.

Japan's Approach to Quality

Japan, having been burned to the ground during the war, encouraged a climate of change from the start. Japanese managers took seriously the warnings about forthcoming changes in the customer's perception of quality and about the future demands for faster development of customer-oriented products and services. So they successfully combined the strategy of innovation with that of continuous quality improvement. This brought a reduction in costs, faster development times, prompt deliveries, customer satisfaction and enormous competitive advantage internationally. The Western approach was always based on the belief that innovation alone was enough for survival and growth. This has already been proved wrong on many occasions.

The timing of Juran and Deming in Japan was impeccable. But, it was not only a question of arriving at a time when the Japanese were striving to rebuild their economy. Their ideas struck a chord in the East. Their emphasis on groups rather than individuals was attractive to the Japanese, while it simply failed to ignite a spark in the United States. Western preoccupation with individual achievement meant that sublimating individual aspirations to group consciousness was a quantum leap rather than a logical progression.

Japanese industry was particularly receptive to the quality message for a number of reasons. Some of them are as follows:

> The long-established Japanese tradition of fine craftsmanship and attention to detail through miniaturization struck a chord with these concepts.
> The strongly statistical flavor of the early work with its emphasis on quantifying variation in quality fitted well with the Japanese penchant for numbers.

Quality was seen as a national "survival" strategy. It was felt that the only way Japan would be able to afford the food and materials that it needed, being poor in natural resources, was to export goods of high quality at low prices. Quality was thus a key objective.

The British Approach to Quality

Meanwhile, the British approach was slow and backward compared to the establishment of quality as an important managerial issue in North America and the tidal wave sweeping over Japan. Belatedly, in 1961, the National Council for Quality Reliability was set up as part of the British Productivity Council. The Council became defunct when the British Ministry of Technology withdrew financial support. Quality in Britain then found its home in the British Quality Association.

Development of the Importance of Quality Management

Up till now we have seen different country's approach to quality, now we will see about the development of the importance of quality management.

The success of Japanese manufacturers during the 1960s and 1970s changed the emphasis from a quality control approach to a quality assurance approach requiring more of the business functions to be involved in the management of quality and requiring longer implementation timescales.

By the 1970s the Japanese had become "masters" at achieving quality in their manufacturing sector. But they did not sit back on this achievement. They built on the technology transfer that had happened from the West to Japan. Even today, the Japanese remain hungry for new innovative ideas sending their senior academicians to leading research groups in the West. They have not given up their quest for superior production by continuous improvement in knowledge, methods and techniques.

The Japanese were well adept in switching commercial interests from competition in productivity to competitiveness in quality. In winning the quality challenge, the Japanese were able to achieve a massive increase in their export levels that rocked Western economies. Negative trade balances with Japan hit many Western countries. The Japanese quality revolution enabled them to achieve immense economic power, dominating world trade.

The Japanese success story urged some managers in Western and other countries to wake up to the quality issue. People recognized that Japanese success was not only due to national, cultural and social differences but also reflected strongly a new attitude and desire of Japanese management to ensure that consumers receive what is promised. By the 1980s Japan's huge success made evident the direct link between quality and viability of organizations and economies.

The 1980s, therefore, became an era of competitive challenge with increasing number of companies adopting quality management. Many consultancy companies latched on to quality training and intervention as main services they can offer. This added significantly to the general awareness of quality management. The development of International Quality Assurance Management System Standards in the 1980s also acted as a catalyst in many countries, setting-off joint management and quality thinking.

The Japanese rapidly went beyond quality in production, recognizing the importance of quality in management. They devised several strategies that formed the basis of much of today's international efforts. These are summarized below:

Senior managers should personally take charge of quality management implementation
Personnel from all levels and functions of an organization should undergo training in quality management
Quality improvement should be continuous
The workforce should participate in quality improvement

Culture is the key to understanding and implementing the lessons preached by both Deming and Juran. Deming appreciated that no matter how powerful the tool of mathematical statistics might be it would be ineffective unless used in the correct cultural context. This combination of culture and measurement eventually evolved into what is now labeled Total Quality Management. In

Total Quality Management everyone in the organization is involved in developing an improvement and prevention orientation which focuses upon the customer through teamwork. The 1990s has seen quality management become the international management philosophy continuing into the new millennium today.

Let us now try to understand what quality actually is.

What is quality?

It is a simple question, but with a not-so-simple answer. Infact, quality has proved to be a difficult concept to pin down. What is even more surprising is that despite the volume of writing on quality management, there has been only limited attention paid to defining exactly what is meant by the term "quality." This is important, not least because the lack of a clear definition makes it difficult to evaluate the effects of quality management on business outcomes. In part, at least, the neglect of defining quality stems from the difficulty in doing so.

The Oxford American Dictionary defines quality as "a degree or level of excellence." The definition of quality by the American National Standards Institute (ANSI) and the American Society for Quality Control (ASQC) is "the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs." Quality can be defined in many ways, depending on who is defining it and to what product or service it is related.

According to Garvin:

"Quality is an unusually slippery concept, easy to visualize and yet exasperatingly difficult to define."

The word "quality" normally conveys notions of nebulous factors that are not readily measured or tied down. Quality conveys a positive connotation to whatever it is applied. Thus,

Quality can be a compelling value in its own right. "It is robust enough to pertain to products, innovations, service standards, and caliber of people…. Everyone at every level can do something about it and feel the satisfaction of having made a difference. Making products that work, or providing first class service is something we can identify with from our own experience." (Pascale, 1991)

A wide variety of approaches to defining quality are evident. For example:

Quality is defined as being about value (Feigenbaum, 1983)
Quality is conformance to standards, specifications or requirements (Crosby, 1979)
Quality is fitness for use (Juran, 1989)
Quality as excellence (Peters and Waterman, 1982)
Quality is concerned with meeting or exceeding customer expectations (Parasuraman et al., 1985)
Quality means delighting the customer (Peters, 1989)

Each approach to defining quality has strengths in terms of generalizability, ease of measurement and utility. Thus, the "quality as conformance to standards" approach is more relevant in a manufacturing environment than in a high-contact personal service industry and is of great value in emphasizing efficiency and productivity. "Quality as excellence" is seen as particularly valuable as a motivational device in the general call to arms in a quality management campaign. Employees can take pride in working for an organization whose vision and mission statements emphasize being the best.

Each approach also has its weaknesses. Thus, a quality vision to "conform to standards every time" is unlikely to be as effective as "quality as excellence" in winning employee commitment to quality. However, "quality as excellence" is very difficult to measure or operationalize. "Quality as conformance" tends to have an internal focus and customers' views can thus be neglected while "quality as meeting customer expectations" is often plagued by complexity, difficulty and cost in measurement.

A Broader View of "What is quality"

Ask people this question and we get a diverse range of answers. A good answer given in a seminar on quality was "Quality" is a perception. Quality could be all things to all people. Quality like beauty lies in the eyes of the beholder. Quality like any other concept begins in the mind. Quality is found in great abundance in our daily life. We live in a quality age, in a quality home, fully of quality furniture. We buy quality goods and drive a quality car and demand quality service from others.

In our industry, this is the most commonly used word in day-to-day work. Infact we see a lot of posters espousing the cause of quality but posters by themselves cannot help unless everyone is educated about the meaning of quality. Without a clear understanding of the term quality, it is difficult to achieve it. Lack of understanding gives rise to the ambiguous use of the word "quality" and leads to variation in priorities, decisions, actions and attitude.

The oxford dictionary defines quality as "degree of excellence, relative nature or kind or character. General excellence."

Other meanings associated with the word quality are as follows:

A good product
Sturdy
Durable
Made of best materials
Easy to operate
Nice in appearance and touch
Produced with care

These when translated into a broader sense mean as follows:

Description of consumer wishes
Observance of terms of delivery
Has good documentation
Is available at a reasonable price
A product meeting laid down specifications

Thus, the definition of quality should:

Take into account customer requirement and needs
Be customer oriented
Be aware of customer specifications

For example, when we buy a T.V., we look at the following parameters:

Brand
Sales talk/Sales brochure
Picture and sound quality
Size/dimensions
Appearances
Weight
Terms of payment
Maintenance cost
Terms of delivery
Installation
Servicing/skills

For example, when we go to a restaurant, we look at the following parameters:

Courtesy of staff
Layout of table/comfort
Lighting/Ambience/Atmosphere
Correct order taking
Services of the waiters
Neatness/Clean linen
Reasonably Quick service
Tasty food
Courteous serving
Proper billing

Quality, therefore, can be described as, “Meeting the stated and implied needs of the customer.” Kordupleski et al. (1993) proposes that it would help in the understanding of quality if we differentiate between customer-perceived quality, which they term “true quality” and business process quality, which they term “internal quality.”

This differentiation would then point up the internally focused nature of many quality management programmed offerings and show the need for paying more attention to “true quality,” and hence a more outward looking role. Success in quality management is seen as deriving from linking up both aspects of quality. Further, there may be a danger of excessive internal focus in calling everyone a customer. Here the problem in regarding employees as internal customers is again that the “real” customer, that is the one who pays for the service, can be overlooked.

Quality from the Consumer’s Perspective

A business organization produces goods and services to meet its customer’s needs. Quality has become a major factor in a customer’s choice of products and service. Customers know that certain companies produce better-quality products than others, so they buy accordingly. That means a firm should consider how the consumer defines quality. The consumer can be a manufacturer purchasing raw materials or parts, a storeowner or retailer purchasing products to sell, or someone who purchases retail products or services over the Internet.

W. Edwards Deming, author and consultant on quality, said, “The consumer is the most important part of the production line. Quality should be aimed at the needs of the consumer, present and future.”

From this perspective, product and service quality is determined by what the consumer wants and is willing to pay for. Since consumers have different product needs, they will have different quality expectations. This results in a commonly used definition of quality as a service or product’s fitness for use. How well does it do what the consumer or user thinks it is supposed to do and wants it to do?

Products and services are designed with intentional differences in quality to meet the different wants and needs of individual consumers. A Mercedes and a Ford truck are equally “fit for use,” in the sense that they both provide automobile transportation for the consumer and each may meet the quality standards of its individual purchaser. However, the two products have obviously been designed differently for different types of consumers. This is commonly referred to as the quality of design-- the degree to which quality characteristics are designed into the product. Although Mercedes and Ford are designed for the same use yet they differ in their performance, features, size and various other quality characteristics.

The dimensions of quality primarily for manufactured products which a consumer looks for in a product include the following:

Performance

The basic operating characteristic of a product is performance. For example, how well a car handles or its gas mileage etc.

Features

Features are the “extra” items added to the basic features, such as stereo CD or a leather interior in a car.

Reliability

Reliability is the probability that a product will operate properly within an expected time frame, e.g., a TV without repair for about 7 years.

Conformance

Conformance is the degree to which a product meets pre-established standards.

Durability

Durability tells how long a product lasts, i.e. its life span before replacement.

Serviceability

Serviceability is the ease of getting repairs, the speed of repairs, and the courtesy and competence of the repairperson.

Aesthetics

Aesthetics tells how a product looks, feels, sounds, smells or tastes.

Safety

Safety refers to assurance that the customer will not suffer injury or harm from the product. It is an especially important consideration for automobiles.

Other Perceptions

Other perceptions include the subjective perceptions based on brand name, advertising and the like.

A customer relative to the cost of the product weighs these quality characteristics. In general, consumers will pay for the level of quality they can afford. If they feel they are getting what they paid for, they tend to be satisfied with the quality of the product.

The dimensions of quality for a service differ somewhat from those of a manufactured product. Service quality is more directly related to time and the interaction between employees and customer. Evans and Lindsay identify the following dimensions of service quality:

Time and Timeliness

Time and timeliness tells how long a customer should wait for a particular service and if it is completed in time. For example, is an overnight package delivered overnight?

Completeness

Completeness answers, "Has everything a customer asked for been provided?" For example, is a mail order from a catalog company complete when delivered?

Courtesy

Courtesy tells how employees treat customers. For example, are catalog phone operators nice and are their voices pleasant?

Consistency

Consistency answers, "Is the same level of service provided to each customer each time?" Another example could be "is your newspaper delivered on time every morning?"

Accessibility and Convenience

Accessibility and convenience answers, "How easy it is to obtain the service?" For example, when you call BPL Mobile, does the service representative answer quickly?

Accuracy

Is the service performed right every time? Is your bank or credit card statement correct every month?

Responsiveness

How well the company reacts to unusual situations, which can happen frequently in a service company. For example, how well a telephone operator at a catalog company is able to respond to a customer's questions about a catalog item not fully described in the catalog.

All the product and service characteristics mentioned previously should be considered in the design process to meet the consumer's expectations for quality. This requires that a company accurately assess what the consumer wants and needs.

Consumer research to determine what kinds of products are desired and the level of quality expected is a big part of a company's quality management program. Once a consumer's needs

and wants have been determined by marketing, they are incorporated into the design of the product. Now it is upto operations to ensure that the design is properly implemented, resulting in product and services that consumer wants and have the expected quality.

Quality from the Producer's Perspective

Now we need to look at quality the way a producer or service provider sees it. We already know that product development is a function of the quality characteristics (i.e. the product's fitness for use) the consumer wants, needs and can afford.

Product or service design results in design specifications that should achieve the desired quality. However, once the product design has been determined, the producer perceives quality to be how effectively the production process is able to conform to the specifications required by the design referred to as the quality of conformance. What this means is quality during production focuses on making sure that the product meets the specifications required by the design.

Examples of the Quality of Conformance

If new tyres do not conform to specifications, they wobble. If a hotel room is not clean when a guest checks in, the hotel is not functioning according to the specifications of its design. It is a faulty service. From this producer's perspective, good-quality products conform to specifications. They are well made and on the other hand poor quality products are not made well. They do not conform to specifications.

Achieving quality of conformance depends on a number of factors. Some of them are as follows:

Design of production process (distinct from product design)
Performance level of machinery
Equipment and technology
Materials used
Training and supervision of employees
The degree to which statistical quality control techniques are used

Design specifications are generally not met in the following cases:

When equipment fails or is malfunctioned
When employees make mistakes
When material and parts are defective
When supervision is lax

The key personnel in achieving conformance to specifications include the engineering staff, supervisors and managers and the most important, employees.

An important consideration from the consumer's perspective of product quality is product or service price. From the producer's perspective an important consideration is achieving quality of conformance at an acceptable cost. Product cost is also an important design specification. If products or services cannot be produced at a cost that results in a competitive price, the final

product will not have acceptable value-the price is more than the consumer is willing to pay given the product's quality characteristics. Thus, the quality characteristics included in the product design should be balanced against production costs.

We approach quality from two perspectives, the consumer's and the producer's. These two perspectives are dependent on each other as shown in figure 1.1. Although product design is customer-motivated yet it cannot be achieved without the coordination and participation of production process. When a product is designed without considering how it will be produced, it may be impossible for the production process to meet design specifications or so costly to do so that the product or service may be priced prohibitively high.

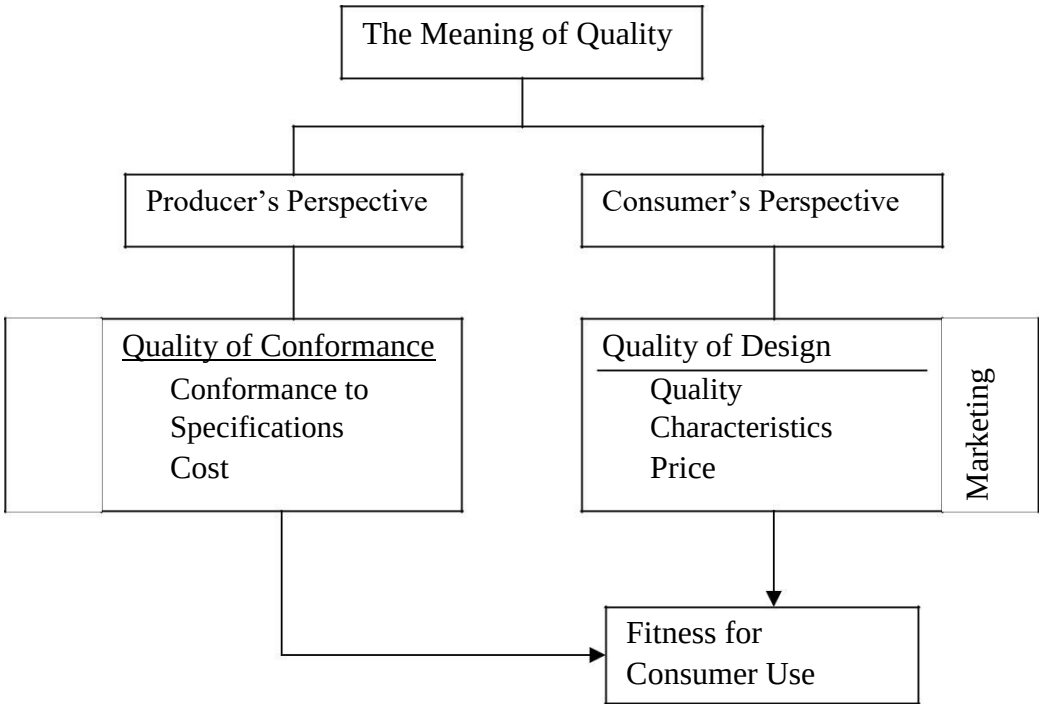


Figure 1.1-- Meaning of quality from the producer and consumer's perspectives

Figure 1.1 depicts the meaning of quality from the producer and consumer's perspectives. The final determination of quality is fitness for use, which is the consumer's view of quality. It is the consumer who makes the final judgment regarding quality and so it is the consumer's view that should dominate.

A few other definitions of quality are as follows:

> Products that are manufactured exactly to specifications.
>
> Products and services that totally satisfy our customers' needs and expectations in every respect on a continuous basis.

ISO-9000 Definition

"Quality the totality of features and characteristics of a product and service that bears on its ability to meet stated or implied needs."

Juran-- Quality is fitness for use
Crosby-- Conformance to requirements
Japanese-- Providing extraordinary customers satisfaction

Quality is customer's determination. It is based on the customer's actual experience with the product or service, measured against his or her requirement.

Quality consists of freedom from deficiencies.

Quality is prevention constructing solutions to problems before they occur and designing excellence into a product or service.

Quality is customer satisfaction the delight of the ultimate judge of how well products and services measure up.

Quality is productivity from employees who receive the training, tools and instruction they need to execute their jobs.

Quality is flexibility and willingness to change to meet demands.

Quality is efficiency of doing things quickly and correctly.

Quality is meeting a schedule and being on time.

Quality is a process of ongoing improvement.

Quality is an investment reaping a payoff because, in the long run, doing it right the first time is less expensive than correcting it later.

Quality (knol'e-te')-- A systematic approach to the search for excellence. (Synonyms: productivity, cost reduction, schedule performance, customer satisfaction, teamwork and the bottom line).

Quality always represents a moving target in a competitive market.

More Definitions of Quality

Quality is…

An attitude of mind
Advanced design

Engineering technology
Superior product
Close tolerance adherence
Precise manufacturing
Rigid process control
Customer service
Customer satisfaction
Fitness for use
Excellence in output
Statistical process control
Customer supplier partnership
Conformance to requirements
On time delivery
No room for error
Precisely measurable
Meeting our commitments
Consistently producing conforming products
Delivery at the optimum price
Zero defects as the standard

What does Quality mean to the Public?

Efficient, effective, above average, quality performance
Flawless or nearly flawless
The best of what you can get
Having something that I can depend on
Goes above and beyond what is considered average
Quality is functional
Something dine to the nest of your ability
Excellence
Quality is in the eye of the beholder
Something that will last
Good workmanship
Reliable, above standard, better than average, long lasting
Lives up to what is promised to do
Taking pride in your performance
Something tried and true, good reputation
Better than just normal
Quality time, giving 100% of ourselves without distractions
Really listening and responding with caring and respect
Making the most of your time as though it were truly precious
Providing training that develops human resources
Good enough so it won't break and will last a long time

You have it when you should
Things are just done right

"Quality is that elusive entity that everyone is talking about. Customers want it! The media promote it! Manufacturers, developers, providers, suppliers, etc, seek it! Unfortunately, to paraphrase …… true (quality) is like ghosts, which everyone talks about and few have seen."

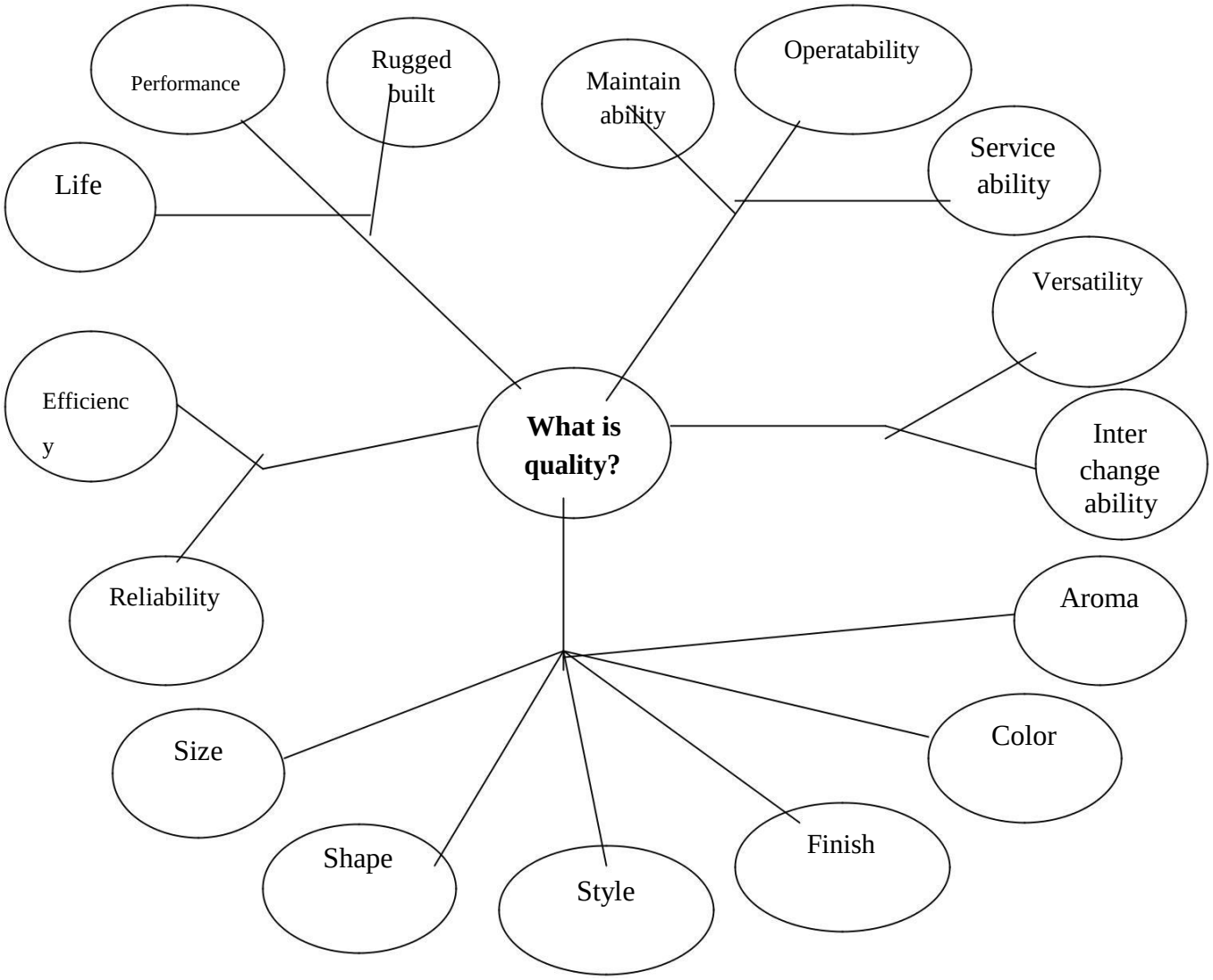


Figure 1.2-- Meaning of quality

Quality and its Expanding Influence

Fundamental aspects of quality	Quality of design (specifications, standards, grades) Quality of conformance
Measurable aspects of quality Consumer (marketable)	Fitness for use, performance, reliability, life, price, availability, delivery
Operational aspects of quality	Quality of management, operations, employees, system, maximum output, minimum waste and cost, optimum delivery
Conservational aspects of quality	Optimum use of resources (materials. Machines, money, land, energy, people)
Environmental aspects of quality	Ecology, clean air, unpolluted water, potable water, tolerable noise levels, safe waste, open space, landscape, recreation, beauty
Human aspects of quality	Quality of life, health, education, culture, society, freedom, ethical and moral values

Factors Affecting Quality

The quality of products and services are directly affected by many base factors. In today's, world these factors play a crucial role in an organization are listed below.

Markets

New products are hitting the market at an explosive rate. Many of these products are manufactured by material and methods unheard till a few years back. Customers demand and get better products today. As markets broaden in scope, the scope of goods and services become more and more specialized. Burners today should be very flexible and be able to a respond rapidly and appropriately in different markets worldwide.

Money

As competition has increased, profit margins have decreased. Automation forced companies to spend heavily on new equipment's and processes. To absorb these costs productivity has to the increased, which means loss production, reworks and scrap has to be kept to the minimum.

Quality costs have to be kept low which mean cost saving due to quality improvement has to be kept in prime focus.

Man

The rapid growth of technology and opening of new fields have created a great demand for workers with specialized knowledge. This specialization of people has created a need for persons who can bring together this knowledge to plan and create operating systems that will bring the desired results.

Materials

Due to high material costs engineers have to constantly keep coming up with ways to bring down the cost of material used. They also need to come up with new alternate materials that can replace costlier older material.

Machines

The demand to cut costs is forcing companies to use newer machines, which will deliver better quality and product using lesser cycle times. Further the machines need to deliver higher quantities also to keep production costs low. This means maintaining of these machines also becomes critical as any and only down time of these machines leads to increased costs.

Management

Today responsibility for product quality has to be distributed among, various functions. For example, design of design for quality of product design. Manufacturing for process quality, service for after sales quality and marketing for establishing the quantity of the new product required. This means that top management should ensure proper allocation of responsibilities to all to achieve the organization goals.

Motivation

The increased complexity of the product means that every employee has to give his best if quality is to be maintained. This requires that quality consciousnesses among employees are high. This can be achieved only through continuous education and motivation of the work force. Motivation, therefore, needs to be on the top of the agenda for any management team of an organization.

Modern Methods of Information

With the spread of computers, data collection, storage retrieval retrieved and transmission of information has become easy. This also means that the right information can be given to the right person at his workplaces be it on the machines or in the office.

From the above we see that there are many factors affecting quality and organization should continually change to keep pace with these requirements. As responsible citizens it is our duty to demand quality from our suppliers and deliver quality to our customers.

Quality is an endless journey. It is like walking toward the horizon. No matter how much far you walk, it does not change where the horizon is.

Exercise

Define quality? Explain quality in daily life, in middle age and during industrial revolution.

What was the importance of quality after Second World War?

What was the Japan, America and the Britain's approach toward quality?

What is quality according to a producer's point of view?

What is quality according to a consumer's point of view?

Basic Concepts of TQM

Total Quality Management (TQM)

Total Quality Management (TQM) is an enhancement to the traditional way of doing business. It is a proven technique guaranteeing survival in world-class competition. The culture and actions of an organization can be transformed by changing only the actions of management. Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback. Analyzing the three words, we have:

Total-- Make up of the whole
Quality-- Degree of excellence a product or service provides
Management-- Act, art, or manner of handling, controlling, directing etc.

Therefore, TQM is an art of managing the whole to achieve excellence. TQM is also defined as both a philosophy and a set of benchmarks that represent the foundation of a continuously improving organization. It is an application of quantitative methods and human resources to improve all the processes within an organization and exceed customer needs at present and in the future. TQM integrates fundamental management techniques, existing improvement efforts and technical tools under a disciplined approach.

Principles of Total Quality Management

TQM is based on the following principles:

Primary responsibility for product quality rests with top management-- Management should create an organizational structure, product design process, production process and incentive that encourages and rewards good quality. Juran has clearly stated, “The critical variable in Japanese quality leadership is the extent of active participation by senior managers.”

Quality should be customer focused and evaluated using customer-based standards-- A product is not easy to use and a service is not courteous and prompt unless customers say they are. This fact requires organizations to work closely with their customers to determine what the customers want in the products and how they receive value from the products.

The production process and work methods should be designed consciously to achieve quality conformance-- Using the right tools and equipment, mistake-proofing processes, training workers in the best methods and providing good work environment help to

prevent defects rather than catching them. In addition, tightly synchronized production systems with quick communication among workers promote quick identification and solution of quality problems.

Every employee is responsible for achieving good product quality-- This translates into self-inspection by workers themselves rather than by separate quality control personnel. It requires workers to cooperate in identifying and solving quality problems.

Quality cannot be inspected in a product, so make it right the first time-- Making it right or doing it right the first time should be the goal of every worker. Methods such as poka-yoke and structured machine setups which increase the chance of doing it right the first time should be utilized as much as possible.

Quality should be monitored to identify problems quickly and correct quality problems immediately-- Statistical methods can play a useful role in monitoring quality and identifying problems quickly. But self-inspection and assessment of work by employees and customer assessments of quality are important components of the quality monitoring mechanism.

The organization should strive for continuous improvement-- Excellent product quality is the result of workers striving to improve product quality and productivity on an ongoing basis using experience and experimentation. However, continuous improvement does not happen on its own. Organizational structures, work procedures and policies should be established to promote and accelerate continuous improvement.

A variety of organizational mechanisms have been used to promote continuous improvement, such as work teams, quality circles and suggestion systems. Each of these methods utilizes workers who are directly involved in the production process as a primary source for improvement ideas. Some experts, however, believe that separate improvement teams should be used to initiate and guide improvement projects.

Companies should work with their suppliers and extend TQM programs to them to ensure quality inputs-- For many manufacturing companies, purchased components and materials account for over 50% of their production costs. Similarly, over 80% of the costs are the costs of goods intended for resale. If suppliers are providing low-quality components, materials, or goods, the purchasing company will find it impossible to achieve a high level of quality in goods and services it produces. Infact, many companies now require suppliers to have quality management programs certified by customers or by a recognized certification organization, such as the International Organization for Standardization (ISO).

The success of Japanese in producing quality products can be attributed to the following:

Their willingness to borrow and synthesize ideas from many sources
The effort of each organization to customize the quality system to its own character.

Some companies use quality circles while others do not. Some have extensive suggestion systems while others do not. Some use statistical methods while others do not and some strive for zero defects while others simply seek continual improvement or more achievable goals such as one defect per 100,000 units. The success of these companies seems to be unrelated to which program they follow or which technique they use. Their success depends on whether they have a TQM program in place with policies and structures fitting in their own organizational culture and personnel.

Basic Approach

A committed and involved management should provide long-term top-to-bottom organizational support-- All employees should participate in a quality program. A quality council should be established to develop a clear vision, set long-term goals and direct the program. Quality goals are included in the business plan. An annual quality improvement program involves input from the entire workforce. Managers participate in quality improvement teams and also act as coaches to other teams. TQM is a continual activity and should be entrenched in the culture. It means that it is not just a one-shot program. TQM should be communicated to all people.

An unwavering focus on customers, both internally and externally-- The key to an effective TQM program is its focus on customers. An excellent place to start is by satisfying internal customers. One should always listen to the "voice of the customer" and emphasize on design quality and defect prevention. Do it right the first time and every time because customer satisfaction is the most important consideration.

Effective involvement and utilization of the entire work force-- TQM is an organization-wide challenge that is everyone's responsibility. All personnel should be trained in TQM, statistical process control (SPC) and other appropriate quality improvement skills to effectively participate in project teams. Including internal customers and, for that matter, internal suppliers on project teams is an excellent approach. Those affected by the plan should be involved in its development and implementation. They understand the process better than anyone else. Changing behavior is the goal. People should come to work not only to do their jobs but also to think about how to improve their jobs. People should be empowered at the lowest possible level to perform processes in an optimum manner.

Continuous improvement of business and production process-- There should be a continual striving to improve all business and production processes. Quality improvement projects such as on-time delivery, order entry efficiency, billing error rate, customer satisfaction, cycle time, scrap reduction and supplier management are good areas to begin. Technical techniques such as SPC, benchmarking, quality function development, ISO 9000 and designed experiments are excellent for problem solving.

Treating suppliers as partners-- On an average, 40% of the sales dollars is the purchase of product or service, therefore, the supplier quality should be outstanding. A partnering relationship rather than an adversarial one should be developed. Both parties have as much to gain or lose based on the success or failure of a product or service. The focus

should be on quality and life-cycle costs rather than on price. Suppliers should be few in number so that true partnering can occur.

Establish performance measures for the processes-- Performance measures such as uptime, percent nonconforming, absenteeism and customer satisfaction should be determined for each functional area. These measures should be posted for everyone to see. Quantitative data are necessary to measure the continuous quality improvement activity.

The purpose of TQM is to provide a quality product and/or service to customers which will, in turn, increase productivity and decrease cost. With a higher quality product and lower price, competitive position in marketplace will be enhanced. This series of events will allow an organization to achieve its objectives of profit and growth with greater ease. In addition, the workforce will have job security which will create a satisfying place to work.

As previously stated, TQM requires a cultural change. Table 2.1 compares the previous state with the TQM state for typical quality elements. This change is substantial and will not be accomplished in a short period of time. Small organizations will be able to make the transformation much faster than large organizations.

New and Old Cultures

Quality Element	**Previous State**	**TQM**
Definition	Product-orientated	Customer-oriented
Priorities	Second to service and cost	First among equals of service and cost
Decisions	Short-term	Long-term
Emphasis	Detection	Prevention
Errors	Operations	System
Responsibility	Quality control	Everyone
Problem Solving	Managers	Teams
Procurement	Price	Life-cycle costs, partnership
Manager's Role	Plan, assign, control	Delegate, coach facilitate and
enforce	and mentor	

Table 2.1-- New and old cultures

Framework of TQM

Figure 2.1 shows the framework for a TQM system. It begins with the knowledge provided by quality gurus-- Shewhart, Deming, Juran, Figenbaum, Ishikawa, Crosby and Taguchi. As the figure shows, they contributed to the development of principles and practices and/or the tools and techniques. Some of these tools and techniques are used in the product and/or service realization activity. Feedback from internal/external customers or interested parties provides information to continually improve an organization's system, product and/or service.

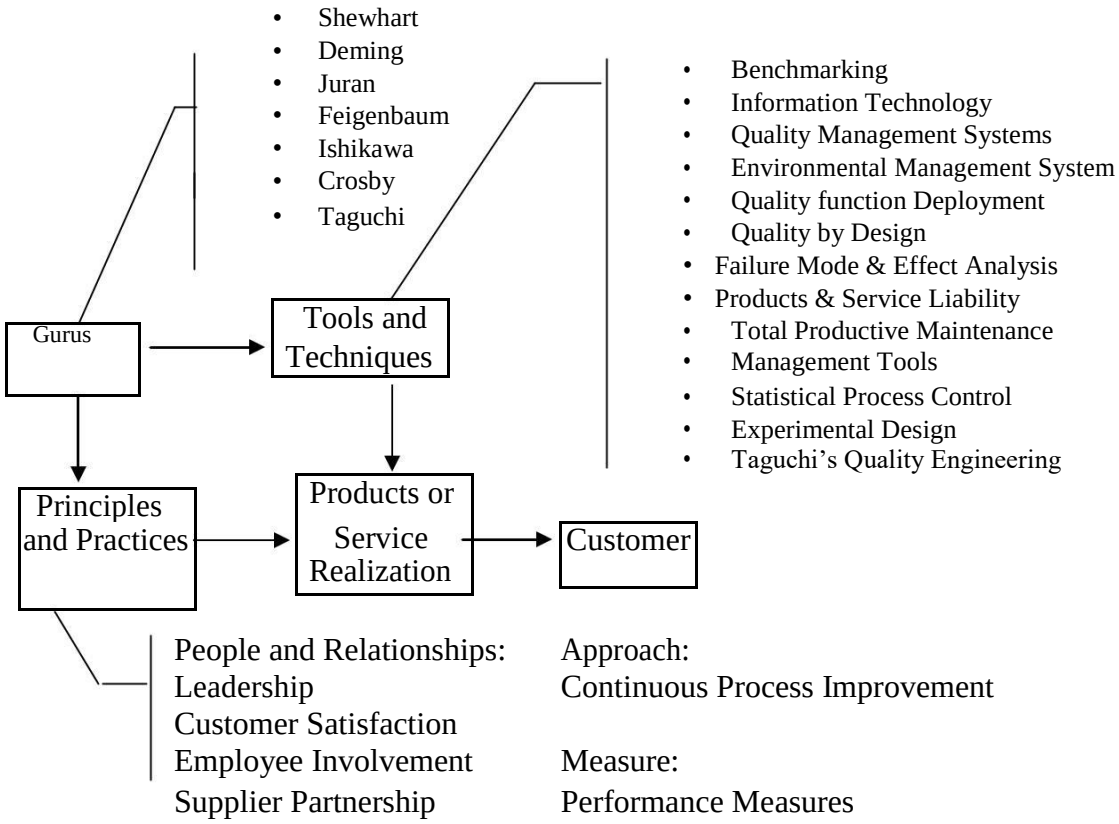


Figure 2.1-- Framework of TQM

Awareness

An organization will not begin the transformation to TQM until it is aware of the fact that the quality of product or service should be improved. Awareness comes when an organization loses market share or realizes that quality and productivity go hand-in-hand. It also occurs if TQM is mandated by a customer or if management realizes that TQM is a better way to run a business and compete in domestic and world markets.

Automation and other productivity enhancements might not help a corporation if it is unable to market its products or services because of their poor quality. The Japanese learned this fact from practical experience. Prior to World War II, they could sell their products only at ridiculously low prices and even then it was difficult to secure repeat sales. Until recently, corporations have not recognized the importance of quality. However, a new attitude has emerged-- quality first among the equals of cost and service. To sum it up, a customer wants value.

Gain in Productivity with Improved Quality

Item	Before improvement 10% nonconforming	After improvement 5% non-conforming
Relative total cost for 20 units	1.00	1.00
Conforming units	18	19
Relative cost for nonconforming units	0.10	0.05
Productivity increase		(100) (1/18)=5.6%
Capability increase		(100) (1/18)=5.6%
Profit increase		(100) (1/18)=5.6%

Table 2.2-- Gain in productivity with improved quality

Quality and productivity are not mutually exclusive. An improvement in quality can lead directly to increased productivity and other benefits. Table 2.2 illustrates this concept. In the table, the improved quality results in a 5.6% improvement in productivity, capacity and profit. Many quality improvement projects are achieved with the same workforce, same overhead and no investment in new equipment.

Recent evidence shows that more and more corporations are recognizing the importance and necessity of quality improvement in order to survive domestic and worldwide competition. Quality improvement is not limited to the conformance of a product or service to specifications. It also involves an inherent quality in the design of a system. The prevention of product, service and process problems is a more desirable objective than taking corrective action after the product is manufactured or a service rendered.
TQM does not occur overnight. There are no quick remedies. It takes a long time to build an appropriate emphasis and technique into culture. Overemphasis on short-term results and profits should be set aside and long-term planning and constancy should be allowed to prevail.

Obstacles

Many organizations, especially small ones with a niche, feel comfortable with their current state. They are satisfied with the amount of work being performed, the profits realized and the perception that the customers are satisfied. Organizations with this culture see little need for TQM until they begin to lose market share. Once an organization embarks on TQM, it faces some obstacles to its successful implementation. Some of the obstacles are as follows:

Lack of Management Commitment

In order to make an organizational effort successful, there should be substantial management commitment of management time and organizational resources. The purpose should be clearly and continuously communicated to all personnel. Management should consistently apply the principles of TQM.

Robert Galvin of Motorola said that only the CEO can ensure, even in times of great pressure, that quality and customer satisfaction are preserved. In a survey, out of 188 quality professionals, 66% reported that management's compensation is not linked to quality goals such as failure costs, customer complaints and cycle time reduction.

Inability to Change Organizational Culture

Changing an organization's culture is difficult and requires as much as five years. Individuals resist change as they become accustomed to doing a particular process and it becomes the preferred way. Management should understand and utilize the basic concepts of change which are as follows:

People change when they want to and to meet their own needs.
Never expect anyone to engage in behavior that serves an organization's values unless adequate reason (way) has been given.
For change to be accepted, people should be moved from a state of fear to trust.

It is difficult for individuals to change their way of doing things. It is much more difficult for an organization to make cultural changes. Management by exhortation and inspiration fails. Speeches, slogans and copings to motivate people remain effective for a short period of time. Impediments to a cultural change are ineffective communication and emphasis on short-term results. Organizations that spend more time in planning for the cultural aspects of implementing a TQM program will improve their chances of success.

Improper Planning

All constituents of an organization should be involved in the development of an implementation plan and any modifications that occur as the plan evolves. Of particular importance is the two-way communication of ideas among all personnel during the development of plan and its implementation. The goal should be to achieve customer satisfaction not to achieve any financial or sales goals. Peterson Products, a metal stamping firm near Chicago, improved on-time delivery which resulted in a 25% increase in sales. Focus on quality and the other goals are considered thereafter.

Lack of Continuous Training and Education

Training and education is an ongoing process for everyone in an organization. Needs should be determined and a plan should be developed to achieve those needs. Training and education are the most effective when senior management conducts the training on the

principles of TQM. Informal training occurs by communicating the TQM efforts to all personnel on a continual basis.

In a study by Tamimi and Sebastianelli, lack of training in group discussion and communication techniques, quality improvement skills, problem identification and the problem-solving methods was the second most important obstacle.

5. Incompatible Organizational Structure and Isolated Individuals and Departments

Differences between departments and individuals can create implementation problems. The use of multi-functional terms help to break down long-standing barriers.

The process of restructuring in order to make an organization more responsive to customer needs may be desired. Individuals who do not embrace the new philosophy can be required to leave the organization. Adherence to the six basic concepts will minimize the problem over time.

At Spartan Light Metal Products, Inc. in Sparta, IL, product support teams composed of three members, each from design, quality and production, are assigned to each customer segment.

6. Ineffective Measurement Techniques and Lack of Access to Data and Results

The key characteristics of an organization should be measured in order to make effective decisions. In order to improve a process, one needs to measure an effect of improvement ideas. Access to data and quick retrieval is necessary to make a process effective.

People Bank of Bridgeport, CT found that extra inspection, training and encouragement of management did not help a high error rate. Finally, the bank investigated the root causes of the problem and corrected them which virtually eliminated the problem.

Paying Inadequate Attention to Internal and External Customers

Organizations need to understand the changing needs and expectations of their customers. Effective feedback mechanisms that provide data for decision making are necessary for this understanding. A way to overcome this obstacle is to give the right people a direct access to the customers. Ingersol Rand of Princeton, NJ had designed its team of marketing, engineering and manufacturing to conduct focus groups of customers throughout the country. It resulted in its ability to develop a new grinder in one-third the usual cycle time. When an organization fails to empower individuals and teams, it cannot hold them responsible for producing results.

Inadequate Use of Empowerment and Teamwork

Whenever possible, teams need to have the proper training and, atleast in the beginning, a facilitator and the team’s recommendations should be followed. Individuals should be empowered to make decisions affecting the efficiency of their process or the satisfaction of

their customers. Solar Turbines, Inc. flattened its organization by restructuring into work teams and delegating authority to the point of customer contact or to the work performed.

Failure to Improve Continually

It is tempting to sit back and rest on your laurels. However, a lack of continuous improvement of the process, product and/or service will even leave the leader of the pack in the dust. Will Rogers said, "Even if you're on the right track, you'll get run over if you just sit there." Even though Champion Mortage's 1998 business volume increased to 59%, it continues to address culture, staff and services issues.

Questions

What is TQM? Explain the principles on which TQM is based.
What is the basic approach to achieve TQM?
What are the dimensions of quality? Describe them in your own words.
Compare and contrast the quality aspects of manufacturing goods and services.
What are the obstacles in implementing TQM? Describe them.

MODULE 2

Leadership

Definitions

There is no universal definition of leadership and indeed many books have been devoted to the topic of leadership. In his book *Leadership,* James MacGregor Burns describes a leader as one who instills purposes and not one who controls by brute force. A leader strengthens and inspires the followers to accomplish shared goals. Leaders shape, promote, protect and exemplify the organization's values. Ultimately, Burns says, "Leaders and followers raise one another to higher levels of motivation and morality… leadership becomes moral in that it raises the level of human conduct and ethical aspiration of both the leader and the led and thus has a transforming effect on both." Similarly, Daimler Chrysler's CEO Bob Eaton defines a leader as "… someone who can take a group of people to a place they don't think they can go." Leadership is we, not me, mission, not my show, vision, not division and community, not domicile. As can be understood, leadership is difficult to define in anything other than lofty words.

The Malcolm Baldrige National Quality Award has a more grounded definition of leadership in its core values. As stated in its core values and concepts, visionary leadership is as follows:

"An organization's senior leaders should set directions and create a customer focus, clear and visible values, and high expectations. The directions, values and expectations should balance the needs of all your stakeholders. Your leaders should ensure the creation of strategies, systems and

methods for achieving excellence, stimulating innovation and building knowledge and capabilities. The values and strategies should help guide all activities and decisions of your organization. Senior leaders should inspire and motivate your entire workforce and should encourage all employees to contribute, to develop and learn, to be innovative and to be creative.

Senior leaders should serve as role models through their ethical behavior and their personal involvement in planning, communication, coaching, development of future leaders, review of organizational performance and employee recognition

As role models, they can reinforce values and expectations while building leadership, commitment and initiative throughout your organization."

Leadership can be difficult to define. However, successful quality leaders tend to have certain characteristics.

Characteristics of Quality Leaders

There are 12 behaviors or characteristics that successful quality leaders demonstrate. These are as follows:

They give priority attention to external and internal customers and their needs. Leaders place themselves in the customers' shoes and service their needs from that perspective. They continually evaluate the customers' changing requirements.

They empower, rather than control, subordinates. Leaders have trust and confidence in the performance of their subordinates. They provide the resources, training and work environment to help subordinates do their jobs. However, the decision to accept responsibility lies with the individual.

They emphasize improvement rather than maintenance. Leaders use the phrase "If it isn't perfect, improve it" rather than "If it ain't broke, don't fix it." There is always room for improvement, even if the improvement is small. Major breakthroughs sometimes happen, but it is the little ones that keep the continuous process improvement on a positive track.

They emphasize prevention. "An ounce of prevention is worth a pound of cure" is certainly true. It is also true that perfection can be the enemy of creativity. We cannot always wait until we have created the perfect process or product. There should be a balance between preventing problems and developing better, but no perfect, processes.

They encourage collaboration rather than competition. When functional areas, departments or work groups are in competition, they may find subtle ways of working against each other or withholding information. Instead, there should be collaboration among and within units.

They train and coach, rather than direct and supervise. Leaders know that the development of human resource is a necessity. As coaches, they help their subordinates learn to do a better job.

They learn from problems. When a problem exists, it is treated as an opportunity rather than something to be minimized or covered up. "What caused it?" and "How can we prevent it in the future?" are the questions quality leaders ask.

They continually try to improve communications. Leaders continually disseminate information about the TQM effort. They make it evident that TQM is not just a slogan. Communication is two way-- ideas will be generated by people when leaders encourage them and act upon them. For example, on the eve of Operation Desert Storm, General Colin Powell solicited enlisted men and women for advice on winning the war. Communication is the glue that holds a TQM organization together.

They continually demonstrate their commitment to quality. Leaders walk their talk-- their actions, rather than their words, communicate their level of commitment. They let the quality statements be their decision-making guide.

They choose suppliers on the basis of quality, not price. Suppliers are encouraged to participate in project teams and become involved. Leaders know that quality begins with quality materials and the true measure is the lifecycle cost.

They establish organizational systems to support the quality effort. At the senior management level, a quality council is provided and at the first-line supervisor level, work groups and project teams are organized to improve the process.

They encourage and recognize team effort. They encourage, provide recognition to and reward individuals and teams. Leaders know people like to know that their contributions are appreciated and important. This action is one of the leader's most powerful tools.

Leadership Concepts

In order to become successful, leadership requires an intuitive understanding of the human nature-- the basic needs, wants and abilities of people. To be effective, a leader understands the following:

People, paradoxically, need security and independence at the same time.
People are sensitive to external rewards and punishments and yet are strongly self-motivated.
People like to hear a kind word of praise. Catch people doing something right, so you can pat them on the back.
People can process only a few facts at a time. Thus, a leader needs to keep things simple.
People trust their gut reaction more than statistical data.
People reject a leader's rhetoric if the words are inconsistent with his actions.

Leaders need to give their employees independence and yet provide a secure working environment, one that encourages and rewards successes. A working environment should be provided that fosters employee creativity and risk-taking by not penalizing mistakes.

A leader will focus on a few key values and objectives. Focusing on few values or objectives gives the employees the ability to discern on a daily basis what is important and what is not. Employees, upon understanding the objectives, should be given personal control over the task in order to make the task their own and thereby something to which they can commit. A leader, by giving the employees a measure of control over an important task, will tap into the employees' inner drive. Employees, led by the manager, can become excited participants in the organization.

Having a worthwhile cause such as total quality management is not always enough to get employees to participate. People (and, in turn, employees) follow a leader, not a cause. Indeed, when people like the leader but not the vision, they will try to change the vision or reconcile their vision to the leader's vision. If the leader is liked, people will not look for another leader. This is especially evident in politics. If the leader is trusted and liked, then the employees will participate in the total quality management cause. Therefore, it is particularly important that a leader's character and competence, which is developed by good habits and ethics, be above reproach. Effective leadership begins on the inside and moves out.

The Seven Habits of Highly Effective People

Stephen R. Covey has based his foundation for success on the character ethics. This includes things like integrity, humility, fidelity, temperance, courage, justice, patience, industry, simplicity, modesty and the golden rule. The personality ethic-- personality growth, communication skills training and education in the field of influence strategies and positive thinking-- is secondary to the character ethics. What we "are" communicates far more eloquently than what we "say" or "do."

A paradigm is the way we perceive, understand and interpret the world around us. It is a different way of looking at people and things. To be effective we need to make a paradigm shift. Most scientific breakthroughs are the results of paradigm shifts such as Copernicus viewing the sun as the center of the universe rather than Earth. Paradigm shifts are quantum changes, whether slow and deliberate or instantaneous.

A habit is the intersection of knowledge, skill and desire. Knowledge is the "what to do" and the "why," skill is the "how to do," and desire is the "motivation" or "want to do." In order for something to become a habit, you have to have all three of the above. The seven habits are a highly integrated approach that moves from dependency (you take care of me) to independence (I take care of myself) to interdependence (we can do something better together). The first three habits deal with independence-- the essence of character growth. Habits four, five and six deal with interdependence-- teamwork, cooperation and communication. Habit seven is the habit of renewal.

The seven habits are in harmony with a natural law that Covey calls the "P/PC Balance." Here P stands for production of desired results and PC stands for production capacity, the ability or asset. For example, if you fail to maintain a lawn mower (PC), it will wear out and not be able to mow the lawn (P). You need to maintain a balance between the time spent mowing the lawn (desired result) and maintaining the lawn mower (asset). Assets can be physical, such as the lawn mower example; financial, such as the balance between principal (PC) and interest (P); and human, such as the balance between training (PC) and meeting schedule (P). You need the balance to be effective. Otherwise, you will have neither a lawn mower nor a mowed lawn.

Habit 1-- Be Proactive

Being proactive means taking responsibility for your life-- the ability to choose the responses to a situation. Proactive behavior is the outcome of conscious choice based on values whereas reactive behavior is based on feelings. Reactive people let circumstances, conditions or their environment tell them how to respond. Proactive people let carefully thought-about, selected and internalized values tell them how to respond. It is not what happens to us but our response that differentiates the two behaviors. No one can make you miserable unless you choose to let him or her.

The language we use is a real indicator of our behavior. Comparisons are given in the table 13.1 below.

Reactive	**Proactive**
There is nothing I can do.	Let us look at our alternatives.
She makes me so mad.	I control my own feelings.
I have to do that.	I will choose an appropriate response.
I cannot.	I choose.
I must.	I prefer.
Things are getting worse.	What initiative can we use?

Table 13.1-- Comparison between reactive an proactive behavior of an individual.

Habit 2-- Begin with the End in Mind

The most fundamental application of this habit is to begin each day with an image, picture or paradigm of the end of your life as your frame of reference. Each part of your life can be examined in terms of what really maters to you-- a vision of your life as a whole.

All things are created twice-- there is a mental or first creation and a physical or second creation to all things. To build a house you first create a blueprint and then construct the actual house. You create a speech on paper before you give it. If you want to have a successful organization, you begin with a plan that will produce the appropriate end. Thus, leadership is the first creation and management is the second. Leadership means doing the right things and management means doing things right.

In order to begin with the end in mind, develop a personal philosophy or creed. Start by considering the examples mentioned below:

Never compromise with honesty
Remember the people involved
Maintain a positive attitude
Exercise daily
Keep a sense of humor
Do not fear mistakes
Facilitate the success of subordinates
Seek divine help
Read a leadership book monthly

By centering our lives on correct principles, we create a solid foundation for the development of the life support factors of security, guidance, wisdom and power. Principles are fundamental truths. They are tightly interwoven threads running with exactness, consistency, beauty and strength through the fabric of life.

Habit 3-- Put First Things First

Habit one says, “You’re the creator. You are in charge.” Habit two is the first creation and is based on imagination-- leadership based on values. Habit three is practicing self-management and requires habits one and two as prerequisites. It is the day-by-day, moment-by-moment management of your time.

The “time management matrix” is shown in table 13.2.

	Urgent	Not Urgent
Important	**I** Crises, firefighting Pressing problems Deadline driven projects	**II** Prevention, PC Relationship building Recognizing new opportunities Planning, recreation
Not Important	**III** Interruptions, pressing matters Some mail, calls, report Some meetings, proximate	**IV** Trivia, busy work Time wasters Pleasant activities

Table 13.2

Urgent means it requires immediate attention and important has to do with results that contribute to your mission, goals and values. Effective, proactive people spend most of their time in quadrant II, thereby reducing the time spent in quadrant I. Four activities are necessary to be effective. First, write down your key roles for the week (such as research manager, United Way Chairperson and parent). Second, list your objectives for each role using many quadrant II activities. These objectives should be tied to your personal goals or philosophy developed in habit 2. Third, schedule time to complete the objectives. Fourth, adapt the weekly schedule to your daily activities.

Habit 4-- Think Win-Win

Win-win is a frame of mind and heart that constantly seeks mutual benefit in all human interactions. Both sides come out ahead. In fact, the end result is usually a better way. If win-win is not possible, then the alternative is no deal. It takes great courage as well as consideration to create mutual benefits, especially if the other party is thinking win-lose.

Win-win embraces five interdependent dimensions of life-- character, relationships, agreements, systems and processes. Character involves the following traits:

Integrity

Maturity-- a balance between being considerate of others and the courage to express feelings

Abundance mentality (there is plenty out there for everyone)

Relationship means that the two parties trust each other and are deeply committed to win-win. Agreements require the five elements of desired results, guidelines, resources, accountability and consequences. Win-win agreements can only survive in a system that supports it-- you cannot talk win-win and reward win-lose. In order to obtain win-win, a four-step process is needed. It is as follows:

See the problem from the other viewpoint.
Identify the key issues and concerns.
Determine acceptable results.
Seek possible new options to achieve those results.

Habit 5-- Seek First to Understand, then to be Understood

Seek first to understand involves a paradigm shift since we usually try to be understood first. Empathic listening is the key to effective communication. It focuses on learning how the other person sees the world, how they feel etc. The essence of empathic listening is not that you agree with someone. It is that you fully and deeply understand the person, emotionally as well as intellectually. Next to physical survival is the greatest need of a human being of psychological survival-- to be understood, affirmed, validated and appreciated.

The second part of the habit is to be understood. Covey uses three sequentially arranged Greek words-- ethos, pathos and logos. Ethos is your personal credibility or character, pathos is the empathy you have with the other person's communication and logos is the logic or reasoning part of your presentation.

Habit 6-- Synergy

Synergy means that the whole is greater than the parts. Together, we can accomplish more than any of us can accomplish alone. This can best be exemplified by the musical group "The Beatles." They as a group created more music than each individual created after the group broke up. The first five habits build toward habit six. It focuses the concept of win-win and the skills of empathic communication on tough challenges that bring about new alternatives which did not exist before. Synergy occurs when people abandon their humdrum presentations and win-lose mentality and open themselves up to creative cooperation. When there is a genuine understanding, people reach solutions that are better than they could have achieved acting alone.

Habit 7-- Sharpen the Saw (Renewal)

Habit seven is taking time to sharpen the saw so that it will cut faster. It is personal PC-- preserving and enhancing the greatest asset you have, which is you. It is renewing the four dimensions of your nature-- physical, spiritual, mental and social/emotional. All four dimensions of your nature should be used regularly in wise and balanced ways. Renewing the physical dimension means following good nutrition, rest and relaxation, and regular exercise. The spiritual dimension is your commitment to your value system. Renewal comes from prayer, meditation and spiritual reading. The mental dimension is continuing to develop your intellect through reading, seminars and writing. These three dimensions require that time be set aside-- they are quadrant II activities. The social and emotional dimensions of our lives are tied together because our emotional life is primarily, but not exclusively, developed out of and manifested in our relationship with others. While this activity does not require time, it does require exercise.

In the his book, Covey states that correct principles are natural laws and that God, the Creator and the Father of us all, is the source of them and also the source of our conscience. He submits

that to the degree people live by this inspired conscience, they will grow to fulfill their natures; to the degree that they do not, they will not rise above the animal plane.

Ethics

Ethics is not a precept that is mutually exclusive from quality. Indeed, quality and ethics have a common care premise, which is to do the right things right.

Definition

Ethics is the body of principles or standards of human conduct that govern the behavior of individuals and organizations. It governs the actions and helps one to decide what is the right thing to do. Some people learn it while growing up and some do it during an organization's ethics training program. Ethics can mean differently to different people, especially when given an organization's international workforce and the varying cultural norms. Because individuals have different concepts of what is right, the organization will need to develop the standards or code of ethics for the organization.

The Root Causes of Unethical Behavior

Much of the unethical behavior in organizations occur in the following cases:

Organizations favor their own interests above the well being of their customers, employees or the public.
Organizations reward behavior that violates ethical standards, such as increasing sales through false advertising.
Organizations encourage separate standards of behavior at work than at home, such as secrecy and deceit versus honesty.
Individuals are willing to abuse their position and power to enhance their interests, such as taking excessive compensation for themselves off the top before other stakeholders receive their fair share.
Managerial values exist that undermine integrity, such as the pressure managers exert on employees to cover up mistakes or to do whatever it takes to get the job done, including cutting corners.
Organizations and individuals overemphasize the short-term results at the expense of themselves and other in the long run. For example, behavior is good based on the degree of utility, pleasure or good received, regardless of the effect on others.
Organizations and managers believe their knowledge is infallible and miscalculate the true risks, such as when financial managers invest organizational funds in high-risk options trading.

Tendency toward unethical behavior most likely comes from the interaction of the root causes of pressure, opportunity and attitude.

Unethical behavior is especially prevalent if employee morale is low. For example, poor working conditions, employee downsizing, unacknowledged good work and denied promotions can all contribute to an employee's poor attitude.

Ethics Management Program

An ethics management program needs to address pressure, opportunity and attitude. Managing ethical behavior requires commitment, new policies and procedures, continuous improvement and investments in appraisal, prevention and promotion.

The first step is appraisal. It is the analysis of the costs associated with unethical behavior. These costs can be divided into the three root causes of pressure, opportunity and attitude.

Costs from pressure are those costs from well-intended but unethical decisions made under pressure. They include but are not limited to errors, waste, rework, lost customers and warranties.
Costs from opportunity are the costs from intentional wrongdoing. They include but are not limited to theft, overstated expenses, excessive compensation and nepotism.
Costs from attitudes are those costs from mistaken beliefs in unethical forms of behavior. They include but are not limited to errors, waste, rework, lost customers and health care.

The second step is prevention. It is the development of a system that will minimize the costs. Because management has a good idea of the appraisal costs, this step can proceed concurrently with step 1.

Pressure can be addressed by being involved in the development of goals and values and developing policies that allow for individual diversity, dissent and decision-making input.
Opportunity can be addressed by developing policies that encourage and protect whistleblowers. It requires the existence of ombudsmen who can work confidentially with people to solve ethical problems internally.
Attitude can be addressed by requiring ethics training for all personnel, recognizing ethical conduct in the workplace, requiring performance appraisals to include ethics and encouraging open discussion concerning ethical behavior issues.

The third step is promotion. It is the continuous advertising of ethical behavior in order to develop an ethical organizational culture that is clear, positive and effective.

To be clear, the philosophy needs to be written with input from all personnel and posted. Standardized ethics training should be given to everyone for the following purposes:

To teach them how to clarify ethical issues
To encourage them to get the facts before acting
To encourage them to consider all the consequences before acting
To show them how to test their actions in advance

This testing can be accomplished by asking the following questions:

Is it legal?
Is it right?
Is it beneficial for all involved?
How would I feel if it was published on the front page of a newspaper?

To be positive, the culture should be about doing what is right, encouraging principled organizational dissent and rewarding ethical behavior.

To be effective, the philosophy should be set and adopted by senior management, with input from all personnel. Senior management should act in the same manner as they want others to act and make no exceptions.

Final Comment

Quality is dependent on ethical behavior. Doing what is right in the first place is a proven way to reduce costs, improve competitiveness and create customer satisfaction. Many companies are hiring ethics consultants to help them achieve their goals.

Unethical behavior by Enron and WorldCom executives in 2002 resulted in bankruptcy for those companies.

MODULE 2
Leadership-II

The Deming Philosophy

Deming's philosophy is given in the 14 points. Most of these points were given in a seminar for 21 presidents of leading Japanese industry in 1950. The rest were developed and the original ones were modified over a period of three decades.

Create and Publish the Aims and Purposes of Organization

Management should demonstrate constantly their commitment to this statement. It should include investors, customers, suppliers, employees, community and a quality philosophy. The statement is a forever-changing document requiring input from everyone. Organizations should develop a long-term view of atleast ten years and plan to stay in business by setting long-range goals. Resources should be allocated for research, training and continuing education to achieve the goals. Innovation is promoted to ensure that a product or service does not become obsolete. A family organizational philosophy is developed to send the message that everyone is the part of organization.

Learn the New Philosophy

Top management and everyone should learn the new philosophy. The organizations should seek never-ending improvement and refuse to accept non-conformance. Customer satisfaction should always be the number one priority because dissatisfied customers will not continue to purchase non-conforming products and services. An organization should concentrate on defect prevention rather than on defect detection. By improving the process, quality and productivity will also improve. Everyone in an organization including union should be involved in quality journey and change his or her attitude regarding quality. A supplier should be helped to improve quality by providing statistical evidence of conformance and shared information relative to customer expectations.

Understand the Purpose of Inspection

Management should understand that the purpose of inspection is to improve the process and reduce its cost. For most of the part, mass inspection is costly and unreliable. Where appropriate, it should be replaced by never-ending improvement using statistical techniques. Statistical evidence is required of self and supplier. Every effort should be made to reduce and then eliminate acceptance sampling. Mass inspection is managing for failure and defect prevention is managing for success.

4. Stop Awarding Business based on Price Alone

An organization should stop awarding business based on the low bid because price has no value without quality. The goal is to have a single supplier for each item to develop a long-term relationship between loyalty and trust, thereby providing improved products and services. Purchasing agents should be trained in statistical process control and require it from suppliers. They should follow the materials throughout the entire life cycle in order to examine how customer expectations are affected and provide feedback to the suppliers regarding the quality.

5. Improve Constantly and Forever the System

Management should take more responsibility for problems by actively finding and correcting problems so that quality and productivity could be continually and permanently improved and costs could be reduced. The focus is on preventing problems before their occurrence. Variation is expected but there should be a continual striving for its reduction using control charts. Responsibilities are assigned to teams to remove the causes of problems and continually improve the process.

6. Institute Training

Each employee should be oriented toward the organization's philosophy of commitment to never-ending improvements. Management should allocate resources to train employees to perform their jobs in the best possible manner. Everyone should be trained in statistical methods and these methods should be used to monitor the need for further training.

7. Teach and Institute Leadership

A responsibility of management is to improve supervision. It should provide supervisors with training in statistical methods and these 14 points so the new philosophy can be implemented. Instead of focusing on a negative and fault-finding atmosphere, supervisors should create a positive and supportive one where pride in workmanship can flourish. All communication should be clear from top management to supervisors to operators.

8. Drive Out Fear, Create Trust and a Climate for Innovation

Management should encourage open and effective communication and teamwork. Fear is caused by a general feeling of being powerless to control important aspects of one's life. Ti is caused by a lack of job security, possible physical harm, performance appraisals, ignorance of organization goals, poor supervision and not knowing the job. Driving fear out of the workplace involves managing for success. Management can begin by providing workers with adequate training, good supervision and proper tools to do the job as well as removing physical dangers. When people are treated with dignity, fear can be eliminated. As the result, people start working for the welfare of the organization. In this climate, they will provide ideas for improvement.

9. Optimize the Efforts of Teams, Groups and Staff Areas

Management should optimize the efforts of teams, work groups and staff areas to achieve the aims and purposes of the organization. Internally, barriers do not exist not only within departments but also among the following:

Levels of management
Departments
Shifts

Externally, they exist between the organization and its customers and suppliers. These barriers exist because of the following reasons:

Poor communication
Ignorance of the mission of organization
Competition
Fear
Personal grudges or jealousies

To break down the barriers, management needs a long-term perspective. It should opt for the following changes in order to break down the barriers:

All the different areas should work together
Change in attitude
Opening of communication channels
Project teams organized
Training in teamwork implemented

Multi-functional teams such as used in concurrent engineering are an excellent method.

Eliminate Exhortations for the Work Force

Exhortations that ask for increased productivity without providing specific improvement methods can handicap an organization. They do nothing but express desires of management. They do not produce a better product or service because workers get limited by the system. Those goals should be set that are achievable and are committed to the long-term success of the organization. The improvements in a process cannot be made without the availability of tools and methods.

11a. Eliminate Numerical Quotas for the Work Force

Instead of quotas, management should learn and institute methods for improvement. Quotas and work standards focus on quantity rather than quality. They encourage poor workmanship in order to meet their quotas. Quotas should be replaced with statistical

methods of process control. Management should provide and implement a strategy for never-ending improvements and work with work force to reflect new policies.

11b. Eliminate Management by Objective

Instead of management by objective, management should learn the capabilities of processes and the procedure to be employed for their improvement. Internal goals set by management without a method are a burlesque. Management by numerical goal is an attempt to manage without knowledge of what to do. An excellent analysis supporting this point is given by Castellano and Roehm.

12. Remove Barriers That Rob People of Pride of Workmanship

Loss of pride in workmanship exists throughout an organization because of the following reasons:

Workers do not know how to relate themselves to the organization's mission.
They are being blamed for system problems.
Poor designs lead to the production of junk.
Inadequate training is provided.
Punitive supervision exists.
Inadequate or ineffective equipment is provided for performing the required work.

Restoring pride will require a long-term commitment by management. When workers are proud of their work, they will grow to the fullest extent of their job. Management can perform the following tasks to restore the pride of their workers:

Giving their employees operational job descriptions.
Providing the proper tools and materials.
Stressing on a workers' understanding regarding his/her role in the total process

By restoring pride, everyone in the organization will be working for the common good. A barrier for people on salary is the annual rating of performance.

13. Encourage Education and Self-Improvement for Everyone

An organization needs people who improve with education. Management should commit itself to continuously train and educate people. Deming's 14 points and the organization's mission should be the foundation of education program. Everyone should be retrained because of the fact that an organization's requirements change to meet the changing environment.

Take Action to Accomplish the Transformation

Management has to accept its primary responsibility for the never-ending improvement of the process. It has to create a corporate structure to implement the philosophy. A cultural change

is required from the previous "business as usual" attitude. Management should be committed, involved and accessible if the organization is to succeed in implementing the new philosophy. Hillerich & Brads by Co., the makers of Louisville Slugger baseball bat, have used Deming's 14 points since 1985 and now have 70% of the professional baseball bat market.

Role of TQM Leaders

Everyone is responsible for quality, especially senior management and the CEO. However, only the latter can provide the leadership system to achieve results. For instance, in the 1980s, General Electric's CEO, Jack Welch, instituted leadership training courses at all levels of the organization. The General Electric training courses taught leadership approaches and models and provided the opportunity for teams to develop solutions for real business problems. Many of the solutions the teams developed were implemented. Jack Welch supported the development of a leadership system whereas quality control leaders were developed at all levels and in all functions of the organization including research, marketing, manufacturing, sales, finance and human resources. Senior managers need to be provided with the skills to implement quality control techniques and actively participate in the quality council.

Senior management has numerous responsibilities. It should practice the philosophy of Management by Wandering Around (MBWA). Management should get out of the office and visit customers, suppliers, departments within the organization and plants within the organization. That way, managers learn what is happening with a particular customer, supplier or project. MBWA can substantially reduce paperwork. Encourage subordinates to write only important messages that need to be part of the permanent record. For example, Kinko's executives perform normal operating duties for two or three days at one location. This approach is an excellent technique for gaining firsthand information.

The idea is to let employees think for themselves. Senior management's role is no longer to make the final decision, but to make sure the team's decision is aligned with the quality statements of the organization. Push problem solving and decision making to the lowest appropriate level by delegating authority and responsibility.

Senior managers should stay informed on the topic of quality improvement by reading books and articles, attending seminars and talking to other TQM leaders. The leader sends a strong message to the subordinates when he/she asks if they have read a particular book or article.
The needed resources should be provided to train employees in the TQM tools and techniques, the technical requirements of the job and safety. Resources in the form of the appropriate equipment to do the job should also be provided.

Senior managers should find time to celebrate the success of their organization's quality efforts by personally participating in award and recognition ceremonies. This activity is an excellent opportunity to reinforce the importance of the effort and to promote TQM. A phone call or handshake combined with a sincere "thank your for a job well done" is a powerful form of recognition and reward. One of the duties of the quality council is to establish or revise the recognition and reward system. In particular, senior management's incentive compensation

should include quality improvement performance. Also, provisions should be made to reward teams as well as creative individuals.

Senior managers should be visible and actively engaged in the quality effort by serving on teams, coaching teams and teaching seminars. They should lead by demonstrating, communicating and reinforcing the quality statement. As a rule of thumb, they should spend about one-third of their time on quality.

A very important role of senior managers is listening to internal and external customers and suppliers through visits, focus groups and surveys. This information is translated into core values and process improvement projects.

Another very important role is communication. The objective is to create awareness of the importance of TQM and provide TQM results in an ongoing manner. The TQM message should be "sold" to personnel, for if they do not "buy" it. TQM will never happen. In addition to internal efforts, there should be external activities with customers and suppliers, media and advertising in trade magazines and interaction with the quality community.

By following the preceding suggestions, senior mangers should be able to drive fear out of the organization, break down barriers, remove system roadblocks, anticipate and minimize resistance to change, i.e. in general change the culture. Only with the involvement of senior management can TQM be a success.

Implementation

The TQM implementation process begins with senior management and, most importantly, with the CEO's commitment. The importance of the senior management's role cannot be overstated. Leadership is essential during every phase of the implementation process and particularly at the start. In fact, indifference and lack of involvement by senior management are frequently cited as the principal reasons for the failure of quality improvement efforts. Delegation and rhetoric are insufficient. Instead, involvement is required.

Senior management needs to be educated in the TQM concepts. In addition to formal education, managers should visit successful TQM organizations, read selected articles and books and attend seminars and conferences. The next step is for senior management to develop an implementation plan.

Timing of the implementation process can be very important. Is the organization ready to embark on the total quality journey? There may be some foreseeable problems, such as a reorganization, change in senior management personnel, interpersonal conflicts, a current crisis, or a time-consuming activity. These problems may postpone implementation to a more favorable time.

The next step is the formation of the Quality Council. initiation of these duties is a substantial part of the implementation of TQM. The development of core values, a vision statement, a

mission statement and a quality policy statement, with inputs from all personnel, should be completed first.

The active involvement of middle managers and first-line supervisors is essential to the success of the TQM effort. They are accountable for achieving many of the organization's performance goals and objectives. They form enduring links in the communication chain from senior management to the front-line workers. Without middle management's early and active support, the TQM effort could fail. Senior management needs to ensure that managers at all levels have an opportunity, as soon as possible, to develop ownership in the TQM effort. It should also be ensured that they have a chance to acquire the insight and skills necessary to become leaders. A way to accomplish this concept is to have a retreat. The retreat will focus on TQM training, leadership skills and active involvement in the development of the organization's statements.

If there is a union, there should be early discussions with the representatives on TQM. Managers should involve union leaders by sharing with them implementation plans for TQM. As the quality effort progresses, managers and union leaders should work together on quality improvement activities. For example, the United Auto Workers have worked closely with the big three automakers in their TQM activities.

At this stage of the implementation process, it is important to communicate TQM to the entire organization. Communication is important throughout the implementation stage and is necessary to create TQM awareness, interest, desire and action.

Everyone needs to be trained in quality awareness and problem solving. This training is conducted when the employee is placed in a project team or the work group is ready for the training.

Customer, employee and supplier surveys should be conducted to benchmark the attitudes of these three stakeholders. Information from these surveys provides ideas for quality improvement projects. The quality curricle determines the quality improvement projects. In addition, the council establishes the project teams and work groups and monitors their progress. The organization has to be patient and should not rush the teams for solutions that do not eliminate the root causes. There is often a tendency to rush the implementation process. TECSTAR, a small business, was able to achieve savings of more than $3 million the first year of its TQM program. On the other hand, Karlee, a Malcolm Baldrige National Quality Award Winner, did not achieve result until the third year but then there was more than a 300% increase in the organization’s bottom line.

Quality Council

In order to build quality into the culture, a Quality Council is established to preside over all direction. It acts as a driver for the TQM engine.

In a typical organization, the council is composed of the CEO, the senior managers of the functional areas such as design, marketing, finance, production and quality and a coordinator or consultant. If there is a union, consideration should be given to having a representative in the

council. Some organizations such as Friendly Ice Cream of Wilbaham, MA, include front-line representatives from every area. A coordinator is necessary to assume some of the added duties that a quality improvement activity requires. The individual selected for the coordinator's position should be a bright young person with executive potential. That person will report to the CEO.

The responsibility of the coordinator is to build two-way trust, propose team needs to the council, share council expectations with the team and brief the council on team progress. In addition, the coordinator will ensure that the teams are empowered and know their responsibilities. The coordinator's activities are to assist the team leaders, share lessons learned among teams and have regular leaders' meetings.

In smaller organizations where managers may be responsible for more than one functional area, the number of members will be smaller. Also, a consultant would most likely be employed rather than a coordinator.

In general, the duties of the Quality Council are as follows:

Develop, with input from all personnel, the core values, vision statement, mission statement and quality policy statement.
Develop the strategic long-term plan with goals and the annual quality improvement program with objectives.
Create the total education and training plan.
Determine the performance measures for the organization approve those for the functional areas and monitor them.
Continually determine those projects that improve the processes, particularly those that affect external and internal customer satisfaction.
Establish multi-functional project and departmental or work group teams and monitor their progress.
Establish or revise the recognition and reward system to account for the new ways of doing business.

In large organizations, quality councils are also established at lower level of the corporation. Their duties are similar but relate to that particular level in the organization. Initially, these activities will require additional work by council members. However, in the long term, their jobs will be easier. These councils are the instruments for perpetuating the idea of never-ending quality improvement.

Once the TQM program is well established, a typical meeting agenda might include the following things:

Progress report on teams
Customer satisfaction report
Progress on meeting goals
New project teams
Recognition dinner

Benchmarking report

Eventually, within three to five years, the Quality Council activities will become so ingrained in the culture of the organization that they will become a regular part of the executive meeting. When this state is achieved, a separate Quality Council is no longer needed. Quality becomes the first item on the executive's meeting agenda.

Corning's Telecommunications Products Division's (TPD) leadership system or quality council duties are shown in figure 14.1.

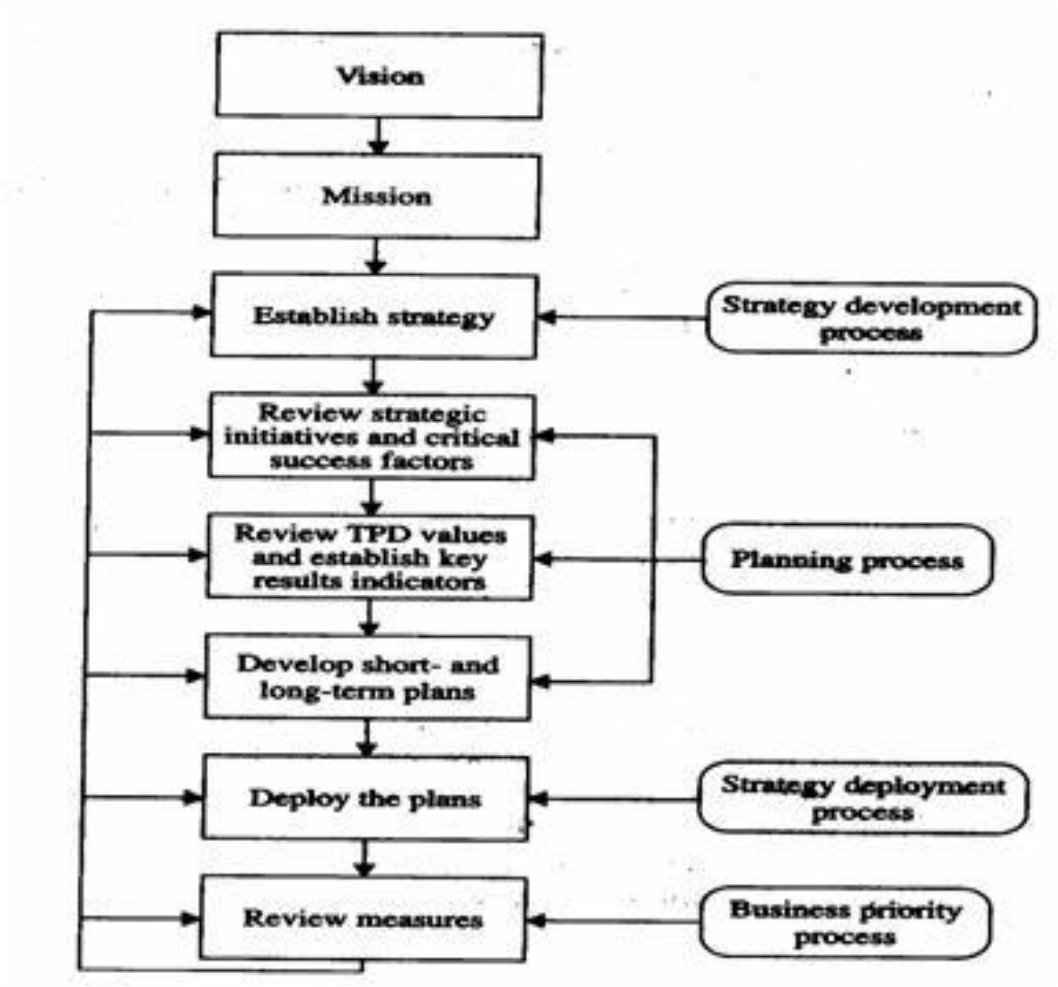


Figure 14.1-- Corning's TPD's leadership system/quality council duties

Core Values, Concepts and Framework

Unity of purpose is a key to leadership system. Core values and concepts provide that unity of purpose. The core values and concepts enable a framework for leaders throughout the organization to make the right decisions. They foster TQM behavior and define the culture. Each

organization will need to develop its own values. Given here are the core values, concepts and framework for the Malcolm Baldrige National Quality Award. They can be used as a starting point for any organization as it develops its own.

Visionary Leadership

An organization's senior leaders need to set directions and high expectations and create a customer-oriented clear and visible quality values. Values, directions and expectations need to address all stakeholders. The leaders need to ensure the creation of strategies, systems and methods for achieving excellence. Strategies and values should help guide all activities and decisions of the organization. Senior leaders should commit to the development of the entire workforce. Further, they should encourage participation, learning, innovation and creativity by all employees. Through their personal roles in planning, communications, review or organization performance and employee recognition, senior leaders serve as role models, reinforcing the values and expectations and building leadership and initiative throughout the organization.

Customer-Driven Excellence

Quality is best judged by the customers. All product and service characteristics that contribute value to the customer and lead to customer satisfaction, preference and retention should be the focus of an organization's management system. Customer-driven excellence has both current and future components-- understanding today's customer desires and marketplace offerings as well as future innovations. Value and satisfaction may be influenced by many factors throughout the customer's overall purchase, ownership and service experiences. These factors include the organization's relationship with customers that help build trust, confidence and loyalty. This concept of quality includes not only the product and service characteristics that meet basic customer requirements but also those features and characteristics that differentiate them from competing offerings. Such differentiation may be based upon new or modified offerings, combinations of product and service offerings, customization of offering, rapid response, or special relationships.

Customer-driven quality is thus a strategic concept. It is directed toward customer retention, market-share gain and growth. It demands constant sensitivity to changing and emerging customer and market requirements and the factors that drive customer satisfaction and retention. It also demands awareness of the developments in technology and of competitors' offerings and the rapid and flexible responses to customer and market requirements.

Success requires more than defect and error reduction, merely meeting specifications, or reducing complaints. Nevertheless, defect and error reduction and the elimination of causes of dissatisfaction contribute to the customers' view of quality and these are important parts of the customer-driven quality. In addition, the organization's success in recovering from defects and errors (making things right for the customer) is crucial to building customer relationships and to retaining customers.

Organizational and Personal Learning

Achieving the highest levels of performance requires a well-executed approach to organizational and personal learning. Organizational learning refers to both continuous improvement of existing approaches and adaptation to change, leading to new goals and approaches. Learning needs to be embedded in the way the organization functions. Learning should be:

An integral part of daily work

Practiced at personal and organizational levels

Directed at solving problems

Focused on sharing knowledge throughout the organization

Driven by opportunities to effect significant change and to do better

Sources for learning include employees' ideas, Research and Development (R&D), customers' input, best practice sharing and benchmarking.

Organizational learning can result in the following:

Enhancing value to customers through new and improved products and services
Developing new opportunities
Reducing errors, defects, waste and related costs
Improving responsiveness and cycle time performance
Increasing productivity and effectiveness in the use of all resources
Enhancing your organization's performance in fulfilling its public responsibilities and services as a good citizen

Employees' success depends largely on having opportunities for personal learning and practicing new skills. Organizations invest in employees' personal learning through education, training and other opportunities for continuing growth, such as job rotation. On the job training offers a cost effective way to train and to better link training to your organizational needs and priorities.

Personal learning can result in the following:

More satisfied and versatile employees who stay with the organization
Organizational cross-functional learning
An improved environment for innovation

Thus, learning is directed not only toward better products and services but also toward being more responsive, adaptive and efficient. This gives your organization marketplace sustainability and performance advantages.

Valuing Employees and Partners

An organization's success depends increasingly upon the skills, knowledge, creativity and motivation of its employees and partners. Valuing employee's means committing to their satisfaction, development and well-being. Increasingly, this involves more flexible, high performance work practices tailored to employees with diverse workplace and home life needs. Major challenges in the area of valuing employees include the following:

Demonstrating your leaders' commitment to your employees' success
Recognition that goes beyond the regular compensation system
Development and progression within your organization
Sharing your organization's knowledge so that your employees can better serve your customers and contribute to achieving your strategic objectives
Creating an environment that encourages risk-taking. For example, Southwest Airlines always puts customers second and employees first. Southwest lives up to its promises to employees, so there is no sense of betrayal to keep people from enthusiastically contributing. It refuses to layoff employees even when airline workers are laid off industry wide. It has the most productive workforce servicing twice the number of passengers per employee of any other airline

Organizations need to build internal and external partnerships to better accomplish overall goals. Internal partnerships might involve creating network relationships among your work units to improve flexibility, responsiveness and knowledge sharing.

External partnerships might be with customers, suppliers and education organizations. Strategic partnerships or alliances are increasingly important. Such partnerships might offer entry into new markets or a basis for new products or services. Also, partnerships might permit the blending of your organization's core competencies or leadership capabilities with the complementary strengths and capabilities of partners. For instance, because of Southwest Airlines spirit of cooperation with co-workers, they requested three advertising companies to work together to develop Southwest's marketing campaign.

Successful internal and external partnerships develop longer-term objectives, thereby creating a basis for mutual investments and respect. Partners should address the key requirements for success, means for regular communication, approaches to evaluating progress and means for adapting to changing conditions. In some cases, joint education and training could offer a cost effective method for employee development.

Agility

Success in global markets demands agility. All aspects of e-commerce require and enable more rapid, flexible and customized responses. Organizations face ever-shorter cycles for the introduction of new and improved products and services, as well as for faster and more flexible response to customers. Major improvements in response time often require simplification of

work units and processes and the ability for rapid changeover from one process to another. Cross-trained and empowered employees are vital assets in such a demanding environment.

major success factor in meeting competitive challenges is the design-to-introduction cycle time. To meet the demands of rapidly changing markets, organizations need to carry out stage-to-stage integration. For example, Southwest Airlines reduced each plane's time at the terminal to ten minutes because of concurrent engineering of activities, from the research concept to commercialization.

All aspects of time performance are critical and cycle time has become a key process measure. Time improvements often drive simultaneous improvements in organization, quality, cost and productivity. For example, minutes after a court ruling forced Southwest to sell one of its four planes, the ten-minute turn allowed Southwest to continue its four plane schedule with only three planes and also helped the company achieve the best on time performance in the airline industry. One less plane translates into a 25% reduction in operating expenses.

Focus on the Future

Focus on the future requires understanding the short- and long-term factors that affect an organization and the marketplace. Pursuit of sustainable growth and market leadership requires a strong future orientation and a willingness to make long-term commitments to key stakeholders. An organization's planning should anticipate many factors such as the following:

Customers' expectations
New business and partnering opportunities
The increasingly global marketplace
Technological developments
The evolving e-commerce environment
New customer and market segments
Evolving regulatory requirements
Societal expectations
Strategic moves by competitors

Strategic objectives and resource allocations need to accommodate these influences. A focus on the future includes developing employees and suppliers, creating opportunities for innovation and anticipating public responsibilities.

Managing for Innovation

Innovation means making meaningful change to improve an organization's products, services and processes, and to create new value for the organization's stakeholders. Innovation should lead an organization to new dimensions of performance. Innovation is no longer strictly the purview of research and development departments. It is important for all aspects of the business

and its processes. Organizations should be led and managed so that innovation becomes part of the culture and is integrated into daily work.

Management by Fact

Organizations depend on the measurement and analysis of performance. Such measurements should derive from business needs and strategy, and should provide critical data and information about key processes, outputs and results. Many types of data and information are needed for performance management. Performance measurement should include the following:

Customer, product and service performance
Comparisons of operation, market and competitive performance
Supplier, employee and cost and financial performance

Analysis refers to extracting larger meaning from data and information to support evaluation, decision-making and operational improvement. Analysis entails using data to determine trends, projections and cause and effect relationships that might not otherwise be evident. Analysis supports a variety of purposes such as the following:

Planning
Reviewing overall performance
Improving operations
Change management
Comparing your performance with competitors' or with "best practices" benchmarks

A major consideration in performance improvement and change management involves the selection and use of performance measures or indicators. A comprehensive of measures or indicators tied to customer and/or organizational performance requirements represents a clear basis for aligning all activities with your organization's goals. Through the analysis of data, measures or indicators themselves may be evaluated and changed to better support an organization's goals.

Public Responsibility and Citizenship

An organization's leaders should stress the need to practice good citizenship. Basic expectations to adhere to business ethics and protection of public health, safety and the environment should be maintained. Protection of health, safety and the environment includes an organization's operations as well as the life cycles of products and services. Also, organizations should emphasize resource conservation and waste reduction at the source. Planning should anticipate adverse impacts from production, distribution, transportation, use and disposal of products. Effective planning should prevent problems, provide for a forthright response if problems occur and make available information and support needed to maintain public awareness, safety and confidence.

For many organizations, the product design stage is critical. Effective design strategies should anticipate growing environmental concerns and responsibilities. Organizations should not only meet all local, state and central laws and regulatory requirements but they should treat these and related requirements as opportunities for improvement "beyond mere compliance."

Practicing good citizenship refers to leadership and support of publicly important purposes within the limits of an organization's resources. Leadership as a rate citizen also entails influencing other organizations. For example, an organization might lead or participate in efforts to help define the obligations of its industry to its communities.

Focus on Results and Creating Value

An organization's performance measurements need to focus on key results. Results should be used to create and balance value for key stakeholders-- customers, employees, stockholders, suppliers and partners, public and community. By creating value for key stakeholders, an organization builds loyalty and contributes to growing the economy. To meet the sometimes conflicting and changing aims that balancing value implies, organizational strategy should explicitly include key stakeholder requirements. This will help ensure that actions and plans meet differing stakeholder needs and avoid adverse impacts on any stakeholder. The use of a balanced composite of leading and lagging performance measures offers an effective means to communicate short- and long-term priorities, monitor actual performance and provide a clear basis for improving results.

Systems Perspective

The Baldrige criteria provides a systems perspective for managing an organization to achieve performance excellence. The core values form the building blocks and the integrating mechanism forms the system. However, successful management of overall performance requires organization-specific synthesis and alignment. Synthesis means looking at an organization as a whole and build upon key business requirements, including strategic objectives and action plans. Alignment means using the key linkages among requirements given in the Baldrige categories, including the key measures/indicators.

Alignment includes senior leaders' focus on strategic directions and customers. It means that senior leaders monitor, respond to and manage performance based on business results. Alignment includes using measures/indicators to link key strategies with key processes and align resources to improve overall performance and satisfy customers.

Thus, a systems perspective means managing the whole organization as well as its components to achieve success.

Quality Statements

In addition to the core values and concepts, the quality statements include the vision statement, mission statement and quality policy statement. Once developed, they are only occasionally reviewed and updated. They are the part of strategic planning process. The utilization of the three statements varies considerably from organization to organization. In fact, small organizations

may use only the quality policy statement. Additionally, there may be considerable overlap among the statements. One of the common characteristics of Malcolm Baldrige National Quality Award winners is that all have a vision of what quality is and how to attain it.

Vision Statement

Vision statement is the short declaration of what an organization aspires to be tomorrow. It is the ideal state that might never be reached but which you continually strive to achieve. Successful visions are timeless, inspirational and become deeply shared within the organization, such as IBM's service, Apple's computing for the masses, Disney theme park is the happiest place on earth and Polaroid's instant photography. These shared visions usually emerge over time. Ideally, visions are elevated to a cause.

Successful visions provide a succinct guideline for decision-making. Having a concise statement of the desired end provides criteria for sound decision making. Tim Frye of Motorola Inc. once remarked that he used the company's vision statement when faced with difficult decisions in gray areas that were not covered by company policy. It is important that the leader articulate and act upon the vision and employees understand the vision and can connect their work to the well-being of the organization. A way to reinforce the significance of the vision statement is to include it (or a portion of it) on employee badges.

An example of a simple, one-sentence vision statement is as follows:

"We will be the preferred provider of safe, reliable and cost-effective products and service that satisfy the electric-related needs of all customer segments."-- Florida Power & Light Company

An example of a more elaborate vision statement is as follows:

Customers receive what they order without nonconformities, on time, in the right quantity, shipped and billed on time.
Suppliers meet our requirements.
Salespeople determine customer needs.
New products or processes are developed to agree upon requirements, as scheduled, and at lower costs.
People enjoy their work.
The organization makes a profit.

Mission Statement

The mission statement answers the following questions:

Who we are?
Who are the customers?
What we do?
How we do it?

This statement is usually one paragraph or less in length, is easy to understand and describes the function of the organization. It provides a clear statement of purpose for employees, customers and suppliers.

An example of a mission statement is as follows:

Ford Motor Company is a worldwide leader in automatic and automotive-related products and services as well as the newer industries such as aerospace, communications and financial services. Our mission is to improve continually our products and services to meet our customers' needs, allowing us to prosper as a business and to provide a reasonable return to our shareholders, the owners of our business.-- Ford Motor Company.

An example of a simpler mission statement is as follows:

To meet customers' transportation and distribution needs by being the best at moving their goods on time, safely and damage free.-- Canadian National Railways

The last statement defined the activities as transportation and distribution rather than as a railroad. Therefore, Canadian National Railways can operate barges, containerized shipments, trucks, aircraft and ocean-going vessels.

Quality Policy Statement

The quality policy is a guide for everyone in the organization as to how they should provide products and services to the customers. It should be written by the CEO with feedback from the work force and be approved by the quality council. Common characteristics of the quality policy are as follows:

Quality is first among equals
Meet the needs of the internal and external customers
Equal or exceed the competition
Continually improve the quality
Include business and production practices
Utilize the entire work force

A quality policy is a requirement of ISO/QS 9000.

An example of a simple quality policy is as follows:

Xerox is a quality company. Quality is the basic business principle for Xerox. Quality means providing our external and internal customers with innovative products and services that fully satisfy their requirements. Quality is the job of every employee.-- Xerox Corporation

An example of a more elaborate quality policy statement is as follows:

M. Wiegmann is committed to on-time, error-free delivery of products and services that meets customer expectations 100% of the time. We believe quality is listening carefully to both our employees and our customers, establishing a clear understanding of the requirements before doing anything and then doing what we have agreed to do, exactly. Quality comes first, profits will follow. A commitment to total quality is the best way to ensure a profitable future. Total quality is a journey rather than a goal. It is a continuous improvement of organization.-- E. M. Wiegmann

Summary

The quality statements consist of the core values and concepts given in the vision statement, the mission statement and the quality policy statement. The core values and concepts should be condensed considerably for simplicity and publication.

An example of a statement that includes vision, mission, quality policy and core values is as follows:

Geon has a clear corporate vision … to be the benchmark company in the polymers industry through superior performance, demonstrated by:

Living up to its established principles of excellence in environmental protection, health and safety
Fully satisfying the expectations of its customers
Developing and commercializing innovative polymer technology
Utilizing all resources productively
Continually improving processes and products
Generating sustained value for customers, employees, suppliers and
investors Creating an environment of trust, respect, openness and integrity

-- The Geon Company

MODULE 2

Deming-I

W E Deming

William Edwards Deming was born in Sioux City, Iowa, on October 14, 1900. His father, a not-very-successful rural attorney, was from Woodbury county and his mother was from around Perry. When he was 4, the family moved to a 300-acre farm near Polk City owned by his grandfather. Two years later, the family moved to Powell, Wyoming. Although his family was poor yet he worked hard and received a bachelor's degree in electrical engineering from the University of Wyoming. He also earned a Master of Science degree in physics from the University of Colorado in 1924. He taught physics at CU and the Colorado School of Mines before going to earn a Ph.D. in physics from Yale in 1927.

The early hardscrabble days left a deep impression on Deming. Although he earned millions in fees in his later years yet he never lost his aversion to waste. He drove a 1969 Lincoln Continential and took the bus or subway until he began needing a wheelchair. He worked out of his modest Washington D. C. home in a basement office around the corner from a washer and dryer. He had one full-time assistant, Cecilia "Ceil" Kilian, who was with him for 39 years. When his health permitted, he worked six days a week, usually from 7 a.m. to 7 p.m. He used a felt tip pen to date the eggs in his refrigerator to ensure the oldest were used first and no egg ever went bad.

Deming became interested in the pioneering work of Shewhart in applying statistical methods to the control of variation in industrial production. Deming’s approach to quality built on Shewhart’s work.

During the period 1939-45, the American Bureau of Census and the US weapons industry were greatly benefited by his advice on the techniques of sampling and statistical control. There was a manifold increase in productivity and cost savings. However, despite Deming's initial efforts and successes, the importance of correctly diagnosing the most important sources of variation and then controlling or eliminating them as the best way of improving quality was not appreciated enough by American managers. This was perhaps because the management did not want to accept such a high level of responsibility (at least 85%) for the quality improvement effort, as Deming insisted. Or perhaps because after World War II, there was an open market for everything produced and no particular attention was paid to high quality. This made Deming turn his efforts to teaching the Japanese who listened to him eagerly.

Deming in Japan

Deming is generally credited with the post- war introduction of quality concepts to Japan, although the reality is much more complicated. There is considerable evidence that he learned as much from Japanese thinkers like Kaoru Ishikawa and Taichi Ohno as he taught them.

He had first gone to Japan in 1947 to help the US occupation prepare for the 1951 Japanese census. While there, he met and socialized with a number of members of the Japan Union of Scientists and Engineers (JUSE), Japan's most important quality control organization, founded in 1946.

He first visited Japan in 1946 as a representative of the Economic and Scientific Section of the US Department of War and returned there in 1948. Thousands of scientists and engineers attended Deming's courses on statistical process control, which started in 1950 after an invitation from the Union of Japanese Scientists and Engineers (JUSE). Deming spoke directly to the leaders and top industrialists of Japanese companies, who immediately took his philosophy seriously and applied his teaching enthusiastically. Nowadays, Dr Deming's managerial and technical methods are widely accepted as being responsible for the turnaround of Japanese industrial fortunes.

In fact, when Deming made his dinner speech on statistical process control before Tokyo's Industry Club in the summer of 1950, SPC was already being widely promoted in Japanese industry. It had been introduced as part of the post-war reconstruction effort.

Shortly after Japan's surrender, the Civil Communications Section (CCS) was established by the Allied Command to help rebuild the country's telecommunications infrastructure. General MacArthur urgently wanted Japan to mass -produce radios so that occupation authorities could reach every Japanese village quickly. The section's small Industrial Division was assigned to work with Japanese manufacturers of communications equipment whose products at that time were highly unreliable.

Deming's Real Contribution

Knowing Japan's poverty, Deming refused any payment for his 1950 lectures. He used the proceeds from reprints to create the Deming Application Prize and the Deming Prize. The Deming Application Prize is a prestigious award given annually since 1951 to companies with outstanding total quality programs, following a rigorous audit of their operations. On the other hand, the Deming Prize is an award given to outstanding individuals. The awards-- medals bearing Deming's likeness-- are given each year with great fanfare and attendant publicity.

Each year since 1951, Japanese industry has awarded the highly valued Deming Prize to a company or individual that or who has actively contributed to the spreading and development of statistical techniques for quality improvement. Recipient companies include Nissan, Toyota, Hitachi and Nippon Steel. Florida Power and Light became the first non-Japanese company to win the Deming Prize (in 1989). Companies like Texas Instruments, Nashua Corporation, Ford Motor Company, AT&T, Dow Chemicals and General Motors are changing their ways to fit with

Deming's principles. Dr. Deming holds the Second Order Medal of the Sacred Treasure, bestowed on him by the late Emperor Hirohito in 1960, for valuable contributions to Japan's economy. He has received numerous other awards, honorary doctorates and medals, including the National Medal of Technology from the US President. He has authored a number of books including *Out of the Crisis and Quality, Productivity and Competitive Position* as well as 161 scholarly studies. He has been credited as being the father of the third wave of the industrial revolution. But despite all this fame, Deming still modestly preferred to be known as a consultant in statistical studies.

Despite that measure of fame, Deming might well have remained relatively unknown in his own country had he not been "discovered" in 1980 by Claire Crawford-Mason, a veteran news reporter and TV producer. Mason was putting together a documentary on the decline of American competitiveness for NBC called "If Japan Can ...Why Can't We?"

On the suggestion of a faculty member at American University in Washington, Mason looked for Deming in his basement office in American University Park. She was amazed to find a man who seemed to know the answer to the program's provocative question, living and working about five miles from the White House. Best of all, from the viewpoint of a TV producer in search of an exclusive, virtually nobody outside the rather arcane world of quality control had ever heard of him.

"If Japan Can ...Why Can't We?" aired on June 24, 1980. The final 15 minutes were devoted to Deming and his consulting work at Nashua Corporation, a New Hampshire manufacturer of carbonless paper.

Among other things, Deming told the interviewer, "I think people here expect miracles. American management thinks that they can just copy from Japan. But they don't know what to copy."

The show was one of the most successful business documentaries ever and it turned Deming into a celebrity literally overnight. The next day, his office was bombarded with phone calls. This was in 1980 and a lot of American companies were looking for something, infact anything that might help them stem the tide of red ink. Deming's message was a wake-up call for American industry. Across the nation, the best senior executives heard the alarm. Among the early callers was Ford, which credits Deming's philosophy with spearheading its amazing comeback in the 1980s. Besides Ford, notable Deming disciples include K Mart, Hospital Corporation of America and Florida Power and Light, the utility that in 1989 became the first US entrant to win the Deming Prize for Overseas Companies, an offshoot of the Japanese annual award.

In the decade that followed, after a delay of over thirty years, Deming's philosophy was, at last, spreading in the West. Numerous Deming user groups in America, the MANS Foundation in Holland, the Deming Institute in New Zealand, the British Deming Association and the Association Française E. Deming have been formed to promote awareness and understanding of Deming's work. Their aim is also to help group members toward the implementation of his principles. His teachings are currently attracting a greater number of followers than ever before.

He is also increasingly recognized as being the man with the most profound influence on the world's industrial history to date.

The Deming Philosophy

Deming's philosophy is given in 14 points. Most of these points were given in a seminar for 21 presidents of leading Japanese industries in 1950. The rest were developed and the original ones modified over a period of three decades.

Deming does not consider it as sufficient merely to solve problems, big or small. He seeks a major transformation in the current practices of Western management. He suggests that a basis for this transformation is provided by his fourteen points, whose adoption and implementation would be a sign that the management intends to stay in business and aims to protect investors and jobs. The fourteen points also provide the basis for a theory of management. There is no excuse any more for ignoring or misusing the science of managing for quality. An applicable theory does exist, a theory that has already been successfully put into practice by the Japanese. Deming's theory of management defines the steps required for transforming a company's quality culture, but also extends to the definition of what he calls the deadly sins and diseases that are crippling virtually every company in the West.

What has to be clearly appreciated before any attempts are made at implementing Deming's philosophy is the level of corporate cultural change required. The quality initiative has to start at the top and many traditional views have to be substantially altered. A management commitment to a complete transformation of the current (bad) practices is absolutely necessary for survival and competitive success in this new economic age. This necessity is revealed by almost all of Deming's fourteen points.

Create Constancy of Purpose for Continual Improvement of Product and Service

Management should demonstrate constantly their commitment to this statement. Set the course today in order to be in business tomorrow, to become more competitive and to provide more jobs. Provide for long-term needs rather than short-term profits. Investment on preventive maintenance today can avoid major operational problems tomorrow. Investment in quality and innovation now is certain to ensure the existence and competitiveness of the company ten, twenty or thirty years from now. This is because quality in processes and products always results in less scrap, less reworking, reduced inspection and warranty costs and higher productivity and customer satisfaction. On the other hand, innovation guarantees the consumer's repeated return and the company's enhanced reputation and market share.

Long-term constancy of purpose for continuous improvement and innovation is an obligation that management should accept as a number one priority. Management should confront any deviations from this direction and immediately deal with them. Resources have to be allocated for long-term planning with the faith that there will be a future. This faith has to be demonstrated continuously on a day-to-day basis by top management in order to motivate employees and convince them of the seriousness of their efforts. Convincing can become easier if genuine long-term aims about quality are properly communicated in the form of

clear policies which leave no doubt about their long-term purpose. In this way, nobody will be in any doubt about why the company is in business and what the future holds in store. If the thinking is only short-term, decline is guaranteed.

The right balance has to be found in the allocation of efforts for dealing, on the one hand, with the problems of today and, on the other, with the problems of tomorrow. While you firefight for the sake of today, your competitor does not stand still.

The investment in innovative methods and techniques, in new skills and materials, in research and education and in continuous improvement in the design of products and services are the elements that can demonstrate constancy of purpose for survival, today and tomorrow. Constancy of purpose for competitive success is demonstrated by continuous consumer research. Without it, a manufacturer can hardly hope to stay ahead of the competition. As Deming says, it is not merely enough to satisfy the customer. If you do not want to lose the customer to a competitor, you should completely delight him/her with your product or service, so that she/he can boast about it and bring more customers. Investigating what the customer needs or will need tomorrow should be an integral part of production activities. Consumer research has to continue after a product has been sold. This has to be done in order to investigate whether the product fulfils its purpose, what the user thinks of it and perhaps more importantly, why the non-user has not bought it. Valuable information thus gained could make all the difference between future success and failure for the company. This information can make it easier to make predictions, a necessity for proper future planning. But no prediction is possible without stability.

Stability combined with innovation leaves the consumer more satisfied and the manufacturer assured both of new customers and of the old customers' willingness to return. But only top management can initiate the long process of researching, discovering and then meeting or predicting the customer's needs and expectations. It is their responsibility to create and maintain the constancy of purpose for never-ending improvement and innovation, and to provide the road map that the rest of the organization can follow.

Learn and Adopt the New Philosophy

A change is necessary in the old management methods which are no longer effective for today's business environment. Without innovation you can never lead. If you just try to meet the competition, you will not survive in the new economic age. This new age has been created by Japan. We can no longer live in the days when quantity was more important than quality. But what has to be realized is that higher quality costs less. Western management should fully appreciate the Eastern challenge and accept the obligation for change. They should accept change in order to become (economically) stable. We do not live any more in the 1950s and 60s when Western-manufactured goods dominated the world market. Today's business environment is much more complex and unpredictable, more competitive and more than ever in need of constant innovation. Markets are now global and people have a choice. Deming regards the current style of management as totally unsuited to the new world of dependence and interdependence that we are in now. If this style is not changed, the cost is bound to be loss of competitive position and destruction of the individual.

Of course, the change cannot happen overnight. There should be a constant movement in the direction of the philosophy of ever-improving quality in all systems and processes. To start with, the current management system, style and operating attitudes have to be realistically examined. This should be done in order to determine whether they support or inhibit continuing improvement in quality and productivity. When the damage caused by current practices is appreciated, top managers have to be bold enough to accept that a total transformation is needed in their current style of management.

Managers also have to be humble enough to admit that the days when management only needed to think and the workforce only needed to do, have passed. A company trying to survive on the intelligence of only a handful of managers has no chance in the new economic age. A mobilization of every bit of all the employees' intelligence is definitely needed. The breaking down of barriers through adequate communication can achieve this mobilization. Top managers have to face up to a new philosophy of pulling together the intellectual resources of all the employees for the benefit of the company.

The new management philosophy is not just an additional new technique to supplement existing ones. It is a radical philosophy advocating a complete change. As Deming says, a completely new strategy is needed to halt the continued decline of Western industry. This fact needs to be accepted as a first step in the right direction.

Top management and everyone should learn the new philosophy. Organizations should seek never-ending improvement and refuse to accept nonconformance. Customer satisfaction is the number one priority because dissatisfied customers will not continue to purchase nonconforming products and services. The organization should concentrate on defect prevention rather than defect detection. By improving the process, the quality and productivity will improve. Everyone in the organization, including the union, should be involved in the quality journey and change his or her attitude about quality. The supplier should be helped to improve quality by requiring statistical evidence of conformance and shared information relative to customer expectations.

Understand the Purpose of Inspection

Management should understand that the purpose of inspection is to improve the process and reduce its cost. For most of the parts, mass inspection is costly and unreliable. Where appropriate, it should be replaced by never-ending improvement using statistical techniques. Statistical evidence is required of self and supplier. Every effort should be made to reduce and then eliminate acceptance sampling. Mass inspection is managing for failure and defect prevention is managing for success.

Build quality into the product at the development/design stage through offline quality control. Maintain it or improve further during normal production through online quality control of the process that produces the product. Insist that the same procedures are being followed by the company's subcontractors and suppliers to ensure trustworthy incoming materials and supplies. Mass inspection cannot compensate for useless incoming materials,

bad design or less than optimal process maintenance. If possible, everything has to be made right first time so that there is no need for rectification later. But “do it right first time” should not be just a slogan, targeting only the workforce. It should be supported by genuine management efforts in improving supplier-customer relationships and the system of education and maintenance. Only then will the importance of inspection schemes eventually diminish, so that “right first time” can become a reality.

Unfortunately, mass inspection is still a way of life in most of the industries. But this implies that defects and mistakes should always be expected. It is an attitude born out of a failure to control and continually improve the process. According to Deming, routine 100% inspection is the same thing as planning for defects. It is an acknowledgment that the process cannot function correctly, or that the specifications made no sense in the first place. It focuses on the negative, without offering any means for quality improvement, as though it is part of a program of managing for failure, not for success. There is a need to replace the practices of mass inspection and defect detection with practices of defect prevention and continuous improvement.

Statistical evidence can be utilized to build in quality in both manufacturing and purchasing functions. Statistical techniques for process’ quality control, which involve the necessary level of sampling inspection at the right point of the process, can achieve consistent high standards before or during production. This is to ensure that confidence in the process' capability is increased, thus reducing the importance of and necessity for a final mass inspection.

Of course, an amount of inspection might always be necessary. In small scale production, inspection might not be costly. On certain occasions, full inspection, for example, before shipping an important product, might be an absolute necessity. But every important item consists of parts and components which are massively produced. Mass inspection of those parts, with rare exceptions, is unreliable, ineffective and does not guarantee quality.
It is a waste of time and effort simply to check goods with no consideration of how to make them better. Such an activity is often unreliable, as it is prone to mistakes and to variability in accuracy from the many inspectors involved, due to boredom and fatigue. The usual reaction to the inspection problems is to put on more inspectors and to increase the inspection effort yet again, a certain cause of even more problems. Deming calls this the fallacy of divided responsibility. Indeed, many inspectors can be the cause of complacency. Each inspector usually relies on all the others to do what should be done and eventually, nobody does it properly. Divided responsibility is actually reduced responsibility.

All this effort can instead be directed toward a continuous online examination and improvement of the processes through a defect prevention program for which everybody should be responsible. This in the long run costs much less, results in high-quality end products and minimizes the need for inspection or after sale service.

Stop Awarding Business based on Price Alone

The organization should stop awarding business based on the low bid alone, because price has no meaning without quality. The goal is to have single suppliers for each item to develop a long-term relationship of loyalty and trust, thereby providing improved products and services. Purchasing agents should be trained in statistical process control and require it from suppliers. They should follow the materials throughout the entire life cycle in order to examine how customer expectations are affected and provide feedback to the suppliers regarding the quality.

Like every individual in all managerial ranks, the purchasing managers have a new job to perform in the new economic age. They should end lowest tender contracts. Instead, they should always require meaningful measures of quality for the supplies. Supplies which do not meet with statistical evidence of quality should not be used. It is not the fault of the process operator if faulty output is produced when the supplied materials (a management responsibility) were cheap and faulty in the first place. A spirit of partnership with suppliers has to replace confrontation, conflict and mistrust.

Initial specifications and the price of incoming materials do not tell the whole story about performance. The suppliers that should be trusted are the ones which can provide evidence of sustained statistical control. An SPC chart showing past and current performance levels can provide this evidence. It can also prove that the supplier under consideration is actually using the appropriate quality tools and therefore can be trusted.

The savings that can result from a relationship with a reliable supplier can by far outstrip the savings attainable by merely going for the lowest price. The objective should be to reduce the total costs, not just the initial costs. Total cost should include the cost of subsequently using the incoming materials in addition to their initial purchase price. Indeed, the long-term costs incurred as a result of using cheap, unreliable and low quality input are possibly incalculable. A lowest tender contract might eventually turn out to be the most expensive of all the proposed contracts. It is common practice for a dishonest supplier to offer a low bid with the sole purpose of ensuring the business. After this has been achieved, at a convenient time when it is too late for the purchaser to make other arrangements, an excuse will be found for the price of the materials, regrettably, to double.

It is probably worthwhile to stick to a single supplier for any one item, in a long-term business association of loyalty and trust. Looking forward to long-term business with the purchaser, the supplier will be encouraged and more easily convinced to adopt a philosophy of continuing improvement, open and honest communication and feedback, and prompt delivery for quality supplies at a price reflecting the true value of the materials. If necessary, the supplier should be appropriately trained in quality techniques at the purchaser's expense. This expense is justified if one views the supplier as the initial and thus, very important part of the whole manufacturing process.

The advantages of a single, reliable and cooperative supplier are many. This option, apart from decreasing the administrative and material inspection costs, also minimizes the variability otherwise caused when different suppliers deliver parts which, even if they are within specifications, are not the same. Many components from different suppliers, however good they are individually, when combined can produce a mediocre result due to their inflated (combined) tolerance. Deming's advice is to choose a single supplier for each item on the basis of statistical evidence from the supplier's process feedback loop. In this way, what is bought is not only the outcome product, but also the process that produces it. A measure of quality is also bought. As Walter Shewhart says, price has no meaning unless a measure of quality is purchased at the same time.

Improve Constantly and Forever the System of Production and Service

Management should take more responsibility for problems by actively finding and correcting them so that quality and productivity are continually and permanently improved and costs are reduced. The focus is on preventing problems before they happen. Variation is expected, but there should be a continual striving for its reduction using control charts. Responsibilities are assigned to teams to remove the causes of problems and continually improve the process.

Search continually for problems in order to improve quality and productivity constantly and decrease costs. Always try to reduce the variability of products and services in order to achieve the highest quality at lowest cost. Never be satisfied with simply meeting current standards or specifications.

It is the management's job to work continually on the system design, research and development, incoming materials, maintenance, process improvement, training, communication and supervision. They should not turn a blind eye to chronic problems or let things ride until they become problematic, by which time it is usually too late. Always anticipate trouble and never be content. Seek out potential ills and solve them before they cause harm. Prevent rather than firefight.

Testing and retesting for quality should always take place in the laboratory, even during production. Statistical techniques exist to help in any area, manufacturing or not. A program of total quality control for products, processes and services should be initiated and should take place continually. The process of quality improvement should never stop and should spiral toward a specific objective-- customer’s absolute satisfaction with the purchased product and the customer’s return. This can be achieved not by simply meeting the customer's current expectations, but by predicting and exceeding the customer's future needs. Innovation is as important as improvement.

The main responsibility of the management is to constantly improve the system so that innovation can materialize more easily. This itself is not easy because the system covers everything as follows:

Choice of suppliers
Procurement

Transport
Funding for research
Design
Engineering
Tools and techniques
Maintenance and improvement
Capital investment
Allocation of human effort
Training and retraining
Selection of new employees
Sales and methods of distribution
Supervision and internal communications
Accounting and payroll
Contact with and service to customers

Every part of the system is prone to deterioration and waste as soon as the efforts for improvement cease. Effort is required just to maintain the attained quality level, let alone to improve it.

There is always a variability around every target and this is why there is always a room for further improvement. This is a departure from the traditional supposition that as long as the product meets the specification limits, there is nothing to worry about. But the effects of uncontrollable factors in the user's environment can very easily cause the product whose components were too close to the specification to fail. So, the inadequacy of the attitude "conformance to spec" can very easily slip through the manufacturing operation to the customer. And when the customer suffers, the whole company will eventually suffer. This is because the customer is the most important part of the process. On the other hand, preventive maintenance and continuous process improvement, in the form of minimization of variability around the target, are the best ways to achieve and sustain the highest quality at the lowest cost.

6. Institute Training on the Job

Each employee should be oriented to the organization's philosophy of commitment to never-ending improvements. Management should allocate resources to train employees to perform their jobs in the best manner possible. Everyone should be trained in statistical methods and these methods should be used to monitor the need for further training.

A continuous program of on-the-job training needs to be instituted and this should include managers. If top managers make themselves subject to education and training, they can provide an example for the rest of the employees to emulate. Efficient and modern methods of training help a company to make better use of all its employees. Training and education are the cornerstones of greater consistency. Investment in proper training of all new employees will ensure that the newcomers will immediately start contributing to their full capacity, knowing exactly what is expected from them.

Management should understand and fully appreciate the concept of variation and its negative consequences. They should also understand the ways to tackle it. This requires training in statistical techniques which can deal with the reduction and control of variability. Many changes are taking place in methods, materials, machinery and design. Adequate training at the appropriate time helps to keep up with any new developments and to provide the basis for advancing the state of the art in any area.

Unfortunately, training is often regarded as non-productive by many managers. It is either overlooked or is the first to be cut when finances become tight. How wrong this attitude is becomes very obvious if one calculates how small the cost of some proper training is in comparison to the total costs associated with an employee over the years. Frequently, even when training is taking place, due to pressures from above to catch up with the work piled up, the new material learned is not immediately put into practice. Consequently, it is quickly forgotten, with the initial effort and training cost being wasted. Management should remove the barriers which inhibit the effective implementation of the lessons learned.

Of course, the bad practices associated with the concept of training do not originate only from top management. Many shop-floor supervisors often rely only on their past knowledge and experience and are reluctant to accept new ideas and innovations concerning process improvement methods. Deming suggests that the only past knowledge which is valid and useful is the one gained through the application of simple statistical techniques before and during production. Also, it is based on unbiased process data and real information, not gut feelings or prejudiced expectations.

The majority of the techniques needed are easy to learn and implement immediately. They can provide a basis for action, indicate clearly what the next step should be and supply the necessary experience for the future. They can also provide the basis of what Deming calls a system of profound knowledge, a necessity in the training curriculum of any manager. The four ingredients of the system of profound knowledge which are necessary to learn and practice are as follows:

a. Knowledge of (or Appreciation of) the System and the Theory of Optimization

Emphasis should be laid on the optimization of the system rather than the sub-optimization of the subsystems. According to Deming, any system that results in an “I win, you lose” structure is less than optimal. The aim should be for everybody to gain (win-win) in the long run company, employees, customers, suppliers, shareholders, the community and the environment. Proper appreciation of the system can only come from adequate understanding of the capability of the system and that, in turn, can only come from the second ingredient.

b. Some Knowledge of Statistical Theory (or the Theory of Variation)

Adequate knowledge of uncertainty and its different sources (special and common) will reveal whether the system is stable or not, what the system's controlled and uncontrolled components are and how stability can be attained. Then the capabilities of the system can be assessed and reliable predictions made. All this can only be achieved with the aid of statistical theory, which brings us to the need for the third ingredient.

c. Some Theory of Knowledge

There is no knowledge without prediction and theory. Experience may provide the answer, but the question can only come from theory. Experience and example are of no help in management unless studied with the aid of theory. Transformation can come with the aid of theory, which can also teach the management about the psychology of change and the difficulties associated with it. This reveals the need for the fourth ingredient.

d. Some Knowledge of Psychology

When it comes to managing people, one needs some knowledge of psychology. It can help one to understand people and the interactions between one person and the other (all people are different) and between a person and the system. This knowledge, like any other associated with the system of profound knowledge, can only be attained through appropriate training. As Deming says, “We don't install Knowledge - I wish we could.”
Indeed, there is no substitute for knowledge. Top management has to appreciate that proper training always equips the employee with a better understanding of the job and its requirements. This can only lead to the job being completed in better time and more adequately. It is to the company's advantage, with the worker not only gaining the satisfaction of doing a good job but also acquiring the incentive to continue improving even further.

7. Adopt and Institute Modern Methods of Leadership

Improving supervision is management’s responsibility. They should provide supervisors with training in statistical methods and these 14 points so the new philosophy can be implemented. Instead of focusing on a negative, faultfinding atmosphere, supervisors should create a positive, supportive one where pride in workmanship can flourish. All communication should be clear from top management to supervisors to operators.

Efforts should be focused on helping people and machines to do a better job. Supervisors should ensure that immediate action is taken on reports of defects, poor tools and conditions detrimental to quality.

In this new economic age, supervisors should be more than just overseers. They should also be teachers of the latest developments in their area of responsibility. They should counsel and not judge. They should be actively involved in the effort to improve the system that they and their people work in. They should be aware of the perils of variation and they should appreciate that the best way to diminish variation between people is to improve the system. They should be supportive, sympathetic, encouraging and helpful to everyone. This is the only way to ensure continual improvement in the work that the employees are doing, which, in turn, will assure a level of high quality in products and services.

Leadership and supervision should concentrate on making the workers take more interest in their work. An interested worker will want to do the job well and will accept advice, training and help for doing it better. If this is achieved, the worker's interest will increase further. On the other

hand, insisting through patronizing posters and slogans that workers deliver the impossible without any indication of how this could be achieved, results in a bad job being done, in a loss of interest and in demotivation. This results in a yet poorer job and so on in a vicious circle.

Modern leadership means continually ensuring that quality, productivity and the performance of people and processes are improved. It requires awareness and respect for differences between individuals. Variety among different people should be regarded as an asset and taken advantage of rather than as an inhibiting factor. Their various abilities should be identified and properly utilized for the benefit of the company. Today's leaders should do the following:

Lead and motivate by example rather than fear
Teach and counsel rather than judge and supervise
Use mistakes to learn from rather than to blame
Understand the difference between random and special variation (so that people in need of special help are recognized)
Promote teamwork and mutual trust
Provide innovative methods to accomplish the improvement

Drive Out Fear and Create Trust and a Climate for Innovation

Management should encourage open, effective communication and teamwork. Fear is caused by a general feeling of being powerless to control important aspects of one's life. It is caused by a lack of job security, possible physical harm, performance appraisals, and ignorance of organization goals, poor supervision and not knowing the job. Driving fear out of the workplace involves managing for success. Management can begin by providing workers with adequate training, good supervision and proper tools to do the job, as well as removing physical dangers. When people are treated with dignity, fear can be eliminated and people will work for the general good of the organization. In this climate, they will provide ideas for improvement.

Two-way communication should be encouraged so that fear is driven out of the organization. Ideas should be actively sought and eagerly listened to. In this way, everybody may work more effectively and more productively for the company. This can only be achieved if a secure environment is created where uncertainty, ambiguity and randomness in management practices are eliminated. Those working in fear of their superiors try to withdraw from attention, with the aim not to be noticed. In this way, people's true potential is lost for ever. Fear is a barrier to improvement and innovation. Successful joint working relationships, based on mutual respect and cooperation, can achieve much more than isolated individual efforts.

Deming believes that an atmosphere of fear makes the implementation of most of his other management points impossible. In other words, he does not believe that any real improvement is possible unless fear, the cause of enormous waste, is eliminated and replaced by mutual respect, trust and cooperation. An atmosphere of fear is always counterproductive. It is a stumbling block to continuing improvement and reduces positive competitiveness and innovation. In an environment of fear, new and promising ideas will never surface and the necessary questions will never be asked. A fear of failure induces both resistance to innovation and an attitude embodied in the maxim, "Stick to what you know." If they fear being blamed by their own superiors, some

supervisors might even paint a false picture of success for their processes, hiding their inadequacies and defect rates, which will thus continue to multiply. A fear of appearing ignorant makes many managers reluctant to undertake further education. Some even fear the possibility of an added responsibility that the new knowledge may bring.

Some managers prefer to create a climate of fear. They create a fear motive in their suppliers through an emotional and complaints-oriented attitude, in the hope of gaining a price advantage. Some believe that they will appear more important if their employees are afraid of them. They also believe that workers will perform better if they feel insecure or anxious about their jobs. So, they introduce the fear of redundancy.

The truth is that the weapon of fear or anxiety is an automatic admission of a failure to manage. The result is demotivation, stress, work being done deliberately wrongly, fiddling of the figures, time wasted in looking and applying for other jobs and valuable personnel being lost, usually to a competitor. Efforts and actions are directed more toward personal survival rather than toward the achievement of business objectives. Management by fear does not serve the best interests of the company. It leads to a reduction in efficiency and in decision quality. Time and energy are then wasted trying to bury the evidence, rather than solving the problem and learning from past mistakes. This can lead to premature release of untested designs and products which may well turn out to be defective. On the whole, a combination of fear and ignorance is a well-proved formula for stagnation and failure.

9. Break Down Barriers between Departments and Individuals

Management should optimize the efforts of teams, work groups and staff areas to achieve the aims and purposes of the organization. Barriers exist internally among levels of management, among departments, within departments and among shifts. Externally, they exist between the organization and its customers and suppliers. These barriers exist because of poor communication, ignorance of the organization’s mission, competition, fear and personal grudges or jealousies. To break down the barriers, management will need a long-term perspective. All the different areas should work together. Attitudes need to be changed, communication channels opened, project teams organized and training in teamwork implemented. Multifunctional teams, such as used in concurrent engineering, are an excellent method.

Every individual from research and development to production and sales should work as a team so as to foresee problems before they arise or to tackle them if they happen to arise. Destructive competition within the same company has to be replaced with cooperation. This will help to solve individual problems which can actually be very common in their nature.

The performance of any individual department should be evaluated in terms of its contribution to the company as a whole and not for its individual profit or any other measure that promotes competitiveness. Lack of proper communication inhibits the company-wide development of the innovative idea, which, thus, remains just an idea. The common language of simple statistical techniques is extremely effective in enabling people to appreciate each other's problems and contribute to their solution. For example, a chart showing the monthly performance of a quality characteristic has exactly the same structure irrespective of whether the quality characteristic is

monthly sales or monthly defects. And it does not require a genius to appreciate that monthly defects do affect the monthly sales, or that the number of defects is directly proportional to the effort put into process control and to the quality of the incoming purchased materials. Everybody is a customer of somebody else along the process line and the sooner this is fully appreciated, the better the chance for team spirit to flourish.

Deming believes that the common causes of problems which affect everybody amount to more than 85% of the total causes. They are part of the system and affect every individual and division irrespective of the nature of their work. They can be dealt with by management action on the system itself. This action should start by eliminating inner conflict and by encouraging communication. If the power of a common (statistical) language is adequately appreciated and made use of, management will be more capable in breaking down the barriers to communication. This will, in turn, enable the workforce to contribute more to the actual solution of problems for the benefit of the company. Of course, for this to happen, the "fear of communicating" has to be driven out, which makes Deming's point 9 closely allied to point 8.

The close cooperation of many diverse organizations within the same company is imperative for the eventual market success of a particular product. The apparently different departments contributing to the development of just a single product could include the following:

Market research
Product planning and design
Materials purchasing
Engineering and manufacturing
Quality control and improvement
Sales and marketing
Advance product planning and research

The people involved in all the above need to realize that they each have much to contribute to the common goal of satisfying the customer's needs and expectations, and eventually to the success of their company. They can do so in a barrier-free atmosphere of mutual trust and cooperation.

10. Eliminate the Use of Slogans, Posters and Exhortations for the Work Force

Exhortations that ask for increased productivity without providing specific improvement methods can handicap an organization. They do nothing but express management's desires. They do not produce a better product or service because the workers are limited by the system. Goals should be set that are achievable and are committed to the long-term success of the organization. Improvements in the process cannot be made unless the tools and methods are available.

Eliminate slogans which demand zero defects and new levels of excellence without providing the methods. People should be given the means to "work smarter, not harder." Arbitrary objectives not accompanied by a road map to help in their accomplishment can be counterproductive.

If there are problems of high defect rates and low productivity, slogans such as “Zero defects,” “Do it right first time” and “Increase productivity by 10%” are not going to achieve anything. They never helped anyone to do a better job. Most of the causes of low quality and unsatisfactory productivity are beyond the power of the workforce. They belong to the system and can be dealt with by changing management practices. How, for example, can somebody make something right first time if the incoming material, probably purchased on the basis of its (low) price tag, is defective, or if the equipment is in need of better maintenance and calibration? Verbally insisting that somebody should be a quality worker is at best patronizing and at worst the cause of frustration and resentment, especially when it is obvious that the insistence does not originate from a quality manager.

Deming believes that people are already doing their best. No substantial improvement, apart from the elimination of some obvious special problems (a minority of all problems), can result from management gimmicks. Given the chance, the workers will gladly do things right the first time. But most of the time, a handicapping system does not give people a chance.

People can only improve through proper training. There is no substitute for knowledge. Productivity can only improve through the provision of statistical aids for quality, better equipment, trustworthy materials and adequate time. Provide the appropriate tools only. Only then can reasonable requests for improvement be made. Unreasonable requests through hectoring slogans and posters, without the provision of the necessary tools for those requests to be met, can only create adverse relationships, mistrust toward management, isolation and increased anxiety.

11. Eliminate Numerical Quotas for the Work Force

Instead of quotas, management should learn and institute methods for improvement. Quotas and work standards focus on quantity rather than quality. They encourage poor workmanship in order to meet their quotas. Quotas should be replaced with statistical methods of process control. Management should provide and implement a strategy for never-ending improvements and work with the work force to reflect the new policies.
Instead of management by objective, management should learn the capabilities of the processes and how to improve them. Internal goals set by management, without a method, are a burlesque. Management by numerical goal is an attempt to manage without knowledge of what to do.

Eliminate management by objective (MBO) by numbers and by numerical goals. Focus on quality, not on quantity. The attainment of a target should not be viewed as the ultimate success, because there is always room for further improvement. MBO neglects the variation in the processes and it is an invitation to short-tern thinking. The only way to increase quality and productivity (and joy in work) is to replace work standards with competent leadership.

With respect to pre-specified targets, one of the following could happen:

> If the target is reasonable and is eventually achieved, the individuals involved will probably become complacent and have a well-earned rest. No greater efforts are likely to be made for further improvement in the attitude that has no place in today's competitive world.

> If the target is unreasonable, either it will not be attained (resulting in unfair blame, increased anxiety and demoralization), or it will be attained by cutting corners, by fiddling the figures or by lowering quality standards. This is something that is bound to affect the customer and eventually the future of the whole company.

So what is the use of numerical targets? Numerical goals can never be right except (very occasionally) by accident. The focus should be on continuous improvement and on customer satisfaction. Numerical targets and goals mean only concentrating on the short-term results and are inhibitors to long- term, lasting success. Most of the time, MBO expects a performance which exceeds the true, but unknown, capability of the system. It is not difficult to find out what the system is capable of. But before this is done, arbitrary objectives can only damage the system.

Of course, Deming does not tell us to manage without numbers. After all, individuals should have goals, aspirations, aims and intentions. Companies need budgets, forecasts etc. for planning and allocation of resources. But they should not be arbitrary, nor should they become so. Only statistical data, properly selected and analyzed, can show what is achievable and what the next step should be for further improvement. Simple statistical methods and charts can immediately show the manager the current capabilities of the processes, of the system and of the existing procedures and what can be reasonably expected of the workforce.

One should never forget the frequently demonstrated truth of the ratio 15:85 concerning “the workforce: management's responsibilities” for quality improvement. One of the goals that can reasonably be expected of the workforce is to bring a process into statistical control (i.e. to take care of the special causes of variation-- 15% of all causes). Once this stability is achieved, the workers can do no more. Even if they try, they would only tamper with the process. Targets will never help because a stable process will only deliver tomorrow whatever it delivered today and yesterday. The situation is predictable-- nothing more or less can be expected. For further improvement, management should act on the system in order to take care of the common problems (85% of the total) which inhibit progress in all processes. So, in a stable system, targets do not make sense because one can only get what the system can deliver. In an unstable system, there is no point setting a target either. This is because such a system is incapable and unpredictable, and there is no way of knowing what the next effort will bring. Any action usually distorts the system even further and causes extra trouble elsewhere. Any success can only be temporary and unrepresentative of the system's true capability. Such a success can cause illusions of improvement-- figures can easily appear to improve after a certain amount of fiddling.

According to Deming, “Management by numerical goal is an attempt to manage without knowledge of what to do, and in fact is usually management by fear.” Indeed, it would be better if MBO or MBR (management by results) were replaced with MBIO-- management by improvement objectives. If there is an objective to be set, it should be that of constancy of purpose for continuous quality improvement of products, processes and services, an objective which is not specific in detail in the form of a numerical target in isolation. This objective should always be a real consensus rather than a top-down mandate. It should be supported by continuous training and sustained cooperation involving everybody from the top manager down.

12. Remove Barriers that Rob People of Pride of Workmanship

Loss of pride in workmanship exists throughout organizations because of the following reasons:

Workers do not know how to relate to the organization's mission.
They are being blamed for system problems.
Poor designs lead to the production of "junk."
Inadequate training is provided.
Punitive supervision exists.
Inadequate or ineffective equipment is provided for performing the required work.

Restoring pride will require a long-term commitment by management. When workers are proud of their work, they will grow to the fullest extent of their job. Management should give employees operational job descriptions, provide the proper tools and materials, and stress the workers' understanding of their role in the total process. By restoring pride, everyone in the organization will be working for the common good. A barrier for people on salary is the annual rating of performance.

It is widely accepted that eliminating physical and mental obstacles facilitates communication, encourages cooperation and improves the overall morale of employees. The most serious of mental obstacles are those which do not allow pride in workmanship. Management by objective is one of them. The annual merit rating (performance appraisal) is another. Admittedly, these practices are so ingrained in the culture of the majority of organizations that any attempts to abolish them in one go would instantly provoke resistance and would probably generate a vacuum. Some other obstacles are not so difficult to overcome, such as absence of communication, poor incoming materials, inappropriate tools and inadequate training. But the fact remains that the main consequence of these obstacles is to rob hourly workers of the right to be proud of their work, a birthright as far as Deming is concerned.

Indeed, one cannot expect workers to be proud of their output when it consistently turns out to be defective because of faulty purchased materials, faulty equipment or poor working environment, the provision of which is a management's responsibility. Everybody wants to do a good job and feel proud of it. But how can one improve an inadequate process if no time is allowed for improvement activities, no quality tools are given, no adequate documentation is provided to show employees what is expected from them, or no appropriate training is offered for self-education and development? How can the hidden potential of the workforce reveal itself if no one dares to bring into the open valuable ideas for improvement from fear of being laughed at, or of being considered as a subversive element wishing to stir things up?

It results in frustration and loss of interest and pride when a brilliant suggestion, already admitted by many to be useful, goes unnoticed and wasted because of poor communication channels to the higher management. And no one can feel proud of his/her work if, in order to meet an arbitrary target or an unreasonable management objective, he/she is obliged to cut corners, hide the truth or manipulate the final figures. These kill pride in workmanship and without pride there is no joy in work. No one can feel proud of work which is deliberately done in a particular way so that it is

well appraised at the end of the year. This brings us to the worst mental obstacle of all-- the yearly performance appraisal.

Deming strongly recommends the abolition of the annual merit rating because it destroys teamwork, fosters mediocrity, increases variability in the performance of the appraised and focuses on the short term. Indeed, the practice of merit rating is so subjective and such a serious cause of isolation and negative competitive feelings that it ceases to be of any use at all. It is an admission that the whole career of an employee depends on the personal opinion of the employee's immediate superior. This opinion may be due to reasons completely irrelevant to the true value of the employee. The final appraisal might, in fact, depend on the current level of friendliness between the appraiser and the appraised. Or it might depend on a current rating system, for the validity of which there is no guarantee. Some people may even be over rated just because the appraiser wishes to show that all is well in his/her department. After all, the appraisers have to survive a performance appraisal on themselves.

Even assuming an objective system of merit rating, there are other problems associated with it, as in the following examples:

> It causes excessive internal competition and isolation. Of course, some healthy competition is always desirable, but this assumes a healthy team spirit. The chances are that in the presence of a strict and secretive merit rating system, the team spirit or cooperation among departments and even among individuals is lost forever.
> It reduces initiative and risk-taking. People prefer to stick to what they know, because otherwise the fear of failure becomes more acute. They spend their time dealing with easy to achieve objectives, so that they have something successful to report at the end of the year. The aim is to get a high merit grade. In the process, the work itself ceases to be important.
> It increases variability in performance. Every employee has a different way of achieving a personal objective. If those with a low rating in one year try to adjust their actions to emulate those with high ratings, a chaotic situation could arise (tampering with the process yet again). The resulting variability effectively obscures the true value of the appraisee.
> It focuses on short-term results which are not representative of long-term performance. Some companies even have an appraisal every three months. There is a great temptation to cut corners or take short-term decisions in order to show profits at all costs.

The appraisal procedure should be replaced by proper leadership and communication and by a counseling and development procedure. Its main purpose would be to identify, sustain or develop further the employee’s contributions toward the continuous improvement of the organization as a team. Personal contact and knowledge can easily identify those who demonstrate abilities as leaders, to whom opportunities for promotion should be offered.

Statistical theory can help in the identification of those in need of special aid (not punishment). Poor contributions should be studied with the sole purpose of determining what is wrong with the whole system that caused failures to happen. One should work on causes, not on

consequences. Everything should start with the understanding that atleast 85% of the problems are system related and individuals should not be blamed for these. Rather than merely judging people, management should be concerned with the task of improving the system within which the people work.

An open communication between the employee and supervisor is supported by continuous training and counseling and by opportunities for personal skills enhancement. It can allow pride in workmanship, can maximize contribution to the company and can help in development and motivation to a degree far higher than the one hoped to be achieved by a frequently unreliable (and embarrassing) appraisal system.

13. Encourage Education and Self-Improvement for Everyone

What an organization needs are people who are improving with education. A long-term commitment to continuously train and educate people should be made by management. Deming's 14 points and the organization's mission should be the foundation of the education program. Everyone should be retrained as the organization requirements change to meet the changing environment.

Encourage continual training to keep up with new developments, changes in product design and machinery, and innovative techniques. Things change fast. Managers should be aware of this change and should themselves be appropriately trained to take advantage of it. Otherwise, the competitor will. Self-improvement for everyone should always be encouraged and ever-broadening opportunities for the workforce should always be provided.

This point might look similar to point 6 -- "institute training on the job." Deming makes a clear distinction between these two. Point 6, on one hand, refers to the foundations of training for management and new employees to assist them to perform well in their current job. While, on the other hand, point 13 refers to continual re-education and self-improvement for everyone. The simple truth, common to both points, is that without adequate training (initially and subsequently, there is no guarantee of innovation or any improvement in the company's competitive position. Retraining is a necessary investment in the most important asset of a company-- its people. It also helps in giving the employees a sense of security. People are better motivated toward self-improvement when they see that their company believes in them, because it invests in them.

With this point, Deming, perhaps indirectly, asks for a commitment to lifetime employment. Continuous re-education and retraining are based on the understanding that new skills are continuously required to keep up with developments in the new economic age. Re-education assures the employees that should the position they are currently holding become outmoded, they would be able to change into a more valuable post within the company. So the most that can happen is reassignment and not redundancy. The company itself has a lot to gain from this policy-- less brain drain from the competitors and less waste of efforts. When employees do not feel safe in their job, apart from losing their motivation to work for the benefit of their company, they waste a great deal of time and effort looking for another job with (who else?) a competitor.

Many Japanese companies provide excellent examples of commitment to the development of their people. There are a wide variety of courses available to all employees throughout their careers. The companies view this as the best way of mobilizing the full potential and intelligence of the workforce, which might otherwise be hidden and lost forever. They treat re-education as an investment and not an expense. Also, they treat their people as an asset and not a commodity.

Take Action to Ensure Top Management's Permanent Commitment to Accomplish the Transformation

Management has to accept the primary responsibility for the never-ending improvement of the process. It has to create a corporate structure to implement the philosophy. A cultural change is required from the previous "business as usual" attitude. Management should be committed, involved and accessible if the organization is to succeed in implementing the new philosophy.

Management should immediately take action to accomplish the transformation by implementing all the preceding 13 points. All employees should understand and be committed to the new philosophy. Senior managers should lead the way by fully committing themselves to continuous quality improvement and innovation, and by practicing whatever they preach.

A permanent management structure has to be created at the top to help toward the achievement of the transformation. Without full management belief, progress will be at best temporary. No real change will ever take place, even if everybody from the middle management down believes in it. The support of somebody at the "top" is imperative. The actions that affect the whole company can only be initiated by people in authority, who should be the first to admit that they also have much to learn and be prepared to learn it. There is no other way. As Deming advocates, "Quality is made in the Board Room ... [however] ... limitations on quality are also made in the Board Room." Having learned of the above 13 points and having agreed on their meaning and the direction to take, managers in authority should explain to the rest of the employees the necessity for change. Everybody should accept their new responsibilities which will differ depending on their position in the organization.

Deming's principles provide a starting point and a road map to success. Once a manager fully understands Deming's philosophy, he/she will be able to identify inhibiting management practices and will become capable enough of coordinating actions for continuous improvement.

Leadership in statistical methodology should predominate in any attempt to achieve the transformation. This is simply because quality is what counts these days and proper implementation of statistical techniques always leads to quality improvements and innovations. It is the ability of statistical theory to provide a common language which makes statistical knowledge the most important asset in all management practices. Deming believes that no general manager can actually succeed in running a company unless he/she is equipped with an ability in statistical methodology, or has assigned at least one professional statistician as a member of the board of management.

Everybody should be encouraged to contribute to the process of innovation and continual improvement of quality. Management should promote a team spirit by eliminating

communication barriers and by providing the appropriate training in statistical tools and techniques so that a common language is established. Everybody should be involved in the team which should be extended to include the suppliers, the subcontractors and even the customers. If some efforts fail to bring the desired improvement, the efforts should start again afresh, utilizing the experience gained.

There is a relentless battle for company survival in this new economic age of increased competition and expanding world markets. Who is capable of responding to the challenge? Deming has the answer-- "Actually, the problem will solve itself. The only survivors will be companies with constancy of purpose for quality, productivity and service."

MODULE 3

Customer Satisfaction-I

LESSON-15

Introduction

The most important asset of an organization is its customer. An organization's success depends on how many customers it has, how much they buy and how often they buy. Customers that are satisfied will increase in number, buy more and buy more frequently. Satisfied customers also pay their bills promptly, which greatly improves cash flow - the lifeblood of any organization. Figure 15.1 best exemplifies just how important a customer is to any organization.

Increasingly, manufacturing and service organizations are using customer satisfaction as the measure of quality. The importance of customer satisfaction is not only due to national competition but also due to worldwide competition. This fact is reflected in the Malcolm Baldrige National Quality Awards, where customer satisfaction accounts for 30 percent of the total points. Similarly, customer satisfaction standards are woven throughout ISO 9000:2000. Customer satisfaction is one of the major purposes of a quality management system.

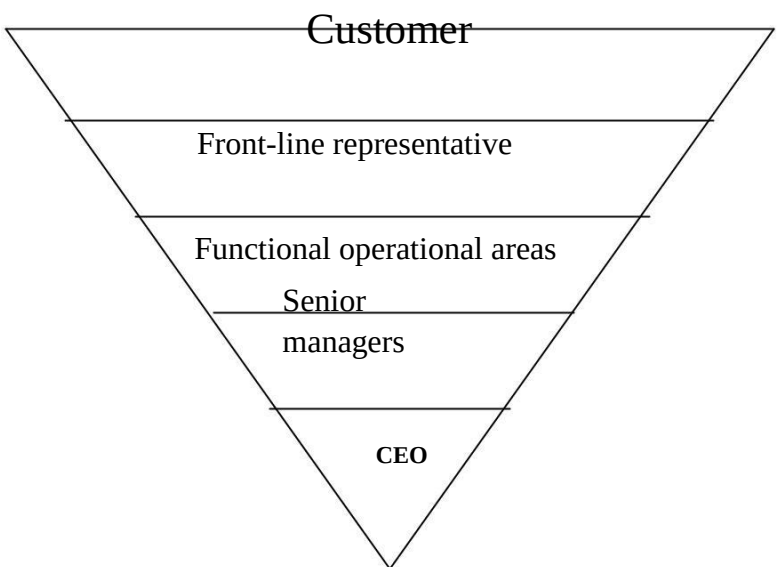


Figure 15.1-- Customer satisfaction organizational diagram

Total Quality Management (TQM) implies an organizational obsession with meeting or exceeding customer expectations, so that customers are delighted. Understanding the customer's needs and expectations is essential to winning new business and keeping existing business. An organization should give its customers a quality product or service that meets their needs at a reasonable price, which includes on-time delivery and outstanding service. To attain this level,

the organization needs to continually examine their quality system to see if it is responsive to ever-changing customer requirements and expectations.

The most successful TQM programs begin by defining quality from the customer's perspective. Quality means meeting or exceeding the customer's expectations. Dr. Deming added that quality also means anticipating the future needs of the customer. Customer satisfaction, not increasing profits, should be the primary goal of the organization. It is the most important consideration because satisfied customers will lead to increased profits.

A simplistic definition of customer satisfaction is illustrated by the Teboul model (refer to figure 15.2). The circle represents the customer's needs and the square depicts the product or service offered by the organization. Total satisfaction is achieved when the offer matches the need, or the circle is superimposed on the square. The goal is to cover the expected performance level better than the competitors.

The customer as satisfying perceives that part of the square that lies within the circle and the part of the square outside the circle is perceived as unnecessary. It is important that the organization listens to the "voice of the customer" and ensures that its marketing, design, production and distribution processes truly meet the expectations of the customer.

Customer satisfaction seems simple enough and yet it is far from simple. Customer satisfaction is not an objective statistic but more of a feeling or attitude. Although certain statistical patterns can be developed to represent customer satisfaction, it is best to remember that people's opinions and attitudes are subjective by nature. Because customer satisfaction is subjective, it is hard to measure. There are so many facets to a customer's experience with a product or service that need to be measured individually to get an accurate total picture of customer satisfaction. Whether or not a customer is satisfied cannot be classed as a yes or no answer. Errors can occur when customer satisfaction is simplified too much. The Teboul model, for instance, describes customer satisfaction as the degree to which the customer's experience of a service or product matches her expectations. Using this model, a customer's satisfaction level would be the same if the experience were mediocre in the context of low expectations, or if the experience were superior in the context or high expectations. Customer satisfaction's focus is creating superior experiences, not mediocre experiences.

Company offer

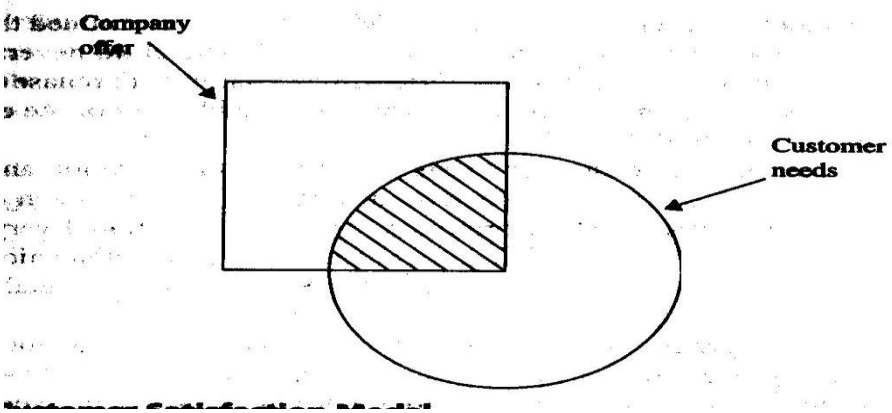


Figure 15.2-- Customer satisfaction model

Since customer satisfaction is hard to measure, the measurement of ten is not precise. As with most of the attitude, there is variability among people and often within the same person at different times often due to the difficulty of measuring feelings. Therefore, customer satisfaction strategies are developed around clearly stated, logical customer opinions and the emotional issues of a purchase are disregarded. This can be a costly mistake.

Customer satisfaction should not be viewed in a vacuum. For example, a customer may be satisfied with a product or service and therefore rate the product or service highly in a survey and yet that same customer may buy another product or service. It is of little benefit to understand a customer's views about a product or service if the customer's views about competitors' product or service are not understood. The value customers place on one product compared to another may be a better indicator of customer loyalty. Customer loyalty can be sustained only by maintaining a favorable comparison when compared with competitors. As mentioned before, customer satisfaction is not a simple concept to understand or to measure.

Who is the customer?

There are two distinct types of customers-- external and internal. An external customer can be defined in many ways, such as the one who uses the product or service, the one who purchases the product or service, or the one who influences the sale of the product or service. For instance, McDonald's determined the customer to be the child when they introduced their "happy meals." The child never paid for the meals but the child influenced the sale. Oftentimes, parents purchase lawnmowers and yet the teenage children use the lawnmowers. The identity of the external customer is not always easy to determine.

An external customer exists outside the organization and generally falls into three categories-- current, prospective and lost customers. Each category provides valuable customer satisfaction information for the organization. Every employee in an organization should know how his or her job enhances the total satisfaction of the external customer. Performance should be continually improved in order to retain existing customers and to gain new ones.

An internal customer is just as important. Every function, whether it is engineering, order processing, or production, has an internal customer-- each receives a product or service and, in exchange, provides a product or service. Every person in a process is considered a customer of the preceding operation. Each worker's goal is to make sure that the quality meets the expectations of the next person. When that happens throughout the manufacturing, sales and distribution chain, the satisfaction of the external customer should be assured.

All processes have outputs which are used by internal or external customers and inputs which are provided by internal or external suppliers. Each supplier performs work that produces some service or product that is used by another customer. As shown by figure 15.3, each forms a link in the customer/supplier chain where every chain ends with an external customer and starts with an external supplier. Every employee throughout the organization is part of the chain of internal customers and suppliers.

A basic concept of TQM is an unwavering focus on customers, both internal and external. Most of the employees know about the external customer or end user but may not think of other employees as internal customers of their output.

In an ideal organization, every employee would have direct contact with customers and be effective at meeting their needs. But the reality is that most of the employees are shielded from customers by organizational layers. For example, the first-line supervisor in a computer factory may never speak with the businessperson who buys and depends on the organization's product. However, that supervisor and countless other employees who lack direct contact should still contribute to the businessperson's satisfaction.

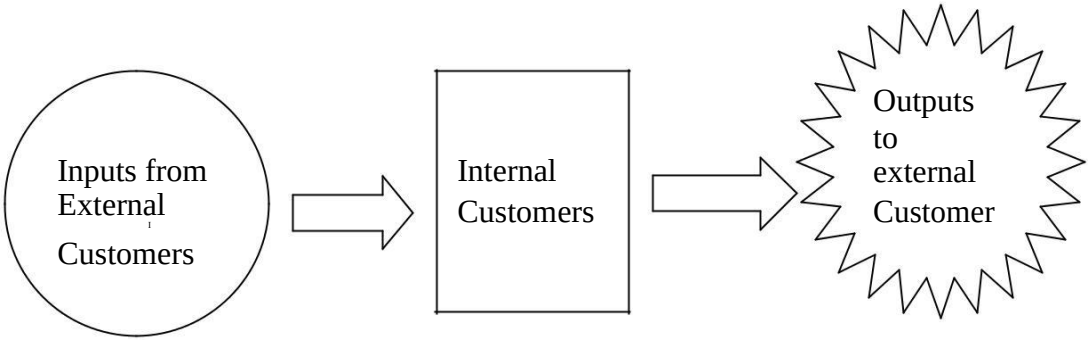


Figure15.3-- Customer/supplier chain

The formula for successful internal customer/supplier relationships varies. But it always begins with people asking their internal customers three basic questions.

What do you need form me?
What do you do with my output?
Are there any gaps between what you need and what you get?

The leader's role is to process work through the internal customer-supplier chain by helping workers guarantee that the end product or service fully satisfies the end user. Rather than strive

for personal objectives, each individual or group should identify and satisfy the internal customer(s) while fostering a team effort where all people help the organization. Each department should determine what activities are important to both external and internal customers and manage quality every step of the way. All quality management systems start with the basic need of ensuring that the external customer's requirements are adequately documented. Similarly, the organization should document explicitly what each internal customer expects. In addition, a clear criterion should be provided for measuring success in meeting the expectations of both internal and external customers.

Customer Perception of Quality

One of the basic concepts of the TQM philosophy is continuous process improvement. This concept implies that there is no acceptable quality level because the customer's needs, values and expectations are constantly changing and becoming more demanding.

Before making a major purchase, some people check consumer magazines that rate product quality. During the period 1980 to 1988, the quality of the product and its performance ranked first, price was second and service was third. During the period 1989 to 1992, product quality remained the most important factor, but service ranked above price in importance.

An American Society for Quality (ASQ) survey on end user perceptions of important factors that influenced purchases showed the following ranking:

Performance
Features
Service
Warranty
Price
Reputation

The factors of performance, features, service and warranty are the parts of a product or service quality. Therefore, it is evident that product quality and service are more important than price. Although this information is based on the retail customer, it appears, to some extent, to be true for the commercial customer also.

Performance

Performance involves "fitness for use." It is a phrase that indicates that the product and service is ready for the customers use at the time of sale. Other considerations are as follows:

Availability which is the probability that a product will operate when needed
Reliability which is freedom from failure over time
Maintainability which is the ease of keeping the product operable

Features

Identifiable features or attributes of a product or service are psychological, time-oriented, contractual, ethical and technological. Features are secondary characteristics of the product or service. For example, the primary function of an automobile is transportation, whereas a car stereo system is a feature of an automobile.

Service

An emphasis on customer service is emerging as a method for organizations to give the customer-added value. However, customer service is an intangible, i.e. it is made up of many small things, all geared to changing the customer's perception. Intangible characteristics are those traits that are though not quantifiable yet contribute greatly to customer satisfaction. Providing excellent customer service is different from and more difficult to achieve than excellent product quality. Organizations that emphasize service never stop looking for and finding ways to serve their customers better, even if their customers are not complaining. For instance, at Baptist Hospital in Pensacola, FL, janitors, after cleaning a room, ask if there is anything they can do for the patient. Often patients will have a request for a window shade to be drawn or a door closed.

Warranty

A product warranty represents the organization's public promise of a quality product backed up by a guarantee of customer satisfaction. Ideally, it also represents a public commitment to guarantee a level of service sufficient to satisfy the customer.A warranty forces the organization to focus on the customer's definition of product and service quality. An organization has to identify the characteristics of product and service quality and the importance the customer attaches to each of those characteristics. A warranty generates feedback by providing information on the product and service quality. It also forces the organization to develop a corrective action system.

Finally, a warranty builds marketing muscle. The warranty encourages customers to buy a service by reducing the risk of the purchase decision and it generates more sales from existing customers by enhancing loyalty.

Price

Today's customer is willing to pay a higher price to obtain value. Customers are constantly evaluating one organization's products and services against those of its competitors to determine who provides the greatest value. However, in our highly competitive environment, each customer's concept of value is continually changing. Ongoing efforts should be made by everyone having contact with customers to identify, verify and update each customer's perception of value in relation to each product and service.

Reputation

Most of us find ourselves rating organizations by our overall experience with them. Total customer satisfaction is based on the entire experience with the organization, not just the product. Good experiences are repeated to six people and bad experiences are repeated to 15 people. Therefore, it is more difficult to create a favorable reputation.

Customers are willing to pay a premium for a known or trusted brand name and often become customers for life. Because it costs five times as much to win a new customer as it does to keep an existing one, customer retention is an important economic strategy for any organization. Although it is difficult for an organization to quantify improved customer satisfaction yet it is very easy to quantify an increase in customer retention. Investment in customer retention can be a more effective bottom-line approach than concentrating on lowering operational costs. An effective marketing retention strategy is achieved through using feedback form information collecting tools.

Dissatisfied, Satisfied and Delighted Customers

Depending on the extent to which his requirements are met, a customer may be classified as dissatisfied, satisfied or delighted. If his requirements are not adequately met, a customer will be dissatisfied. If his requirements are just met, he will be satisfied. If, however, his requirements have been exceeded, he will be delighted. Thus, the dissatisfaction, satisfaction and delight of a customer are dependent on his expectations and the performance of the product or service. If the expectations are high and the performance of the product or service is not up to the mark, the result would be dissatisfaction. If the performance matches the expectation, the customer is satisfied. If the product or service performance exceeds the expectations of the customer, he is pleasantly surprised or delighted. This is depicted in figure 15.4.

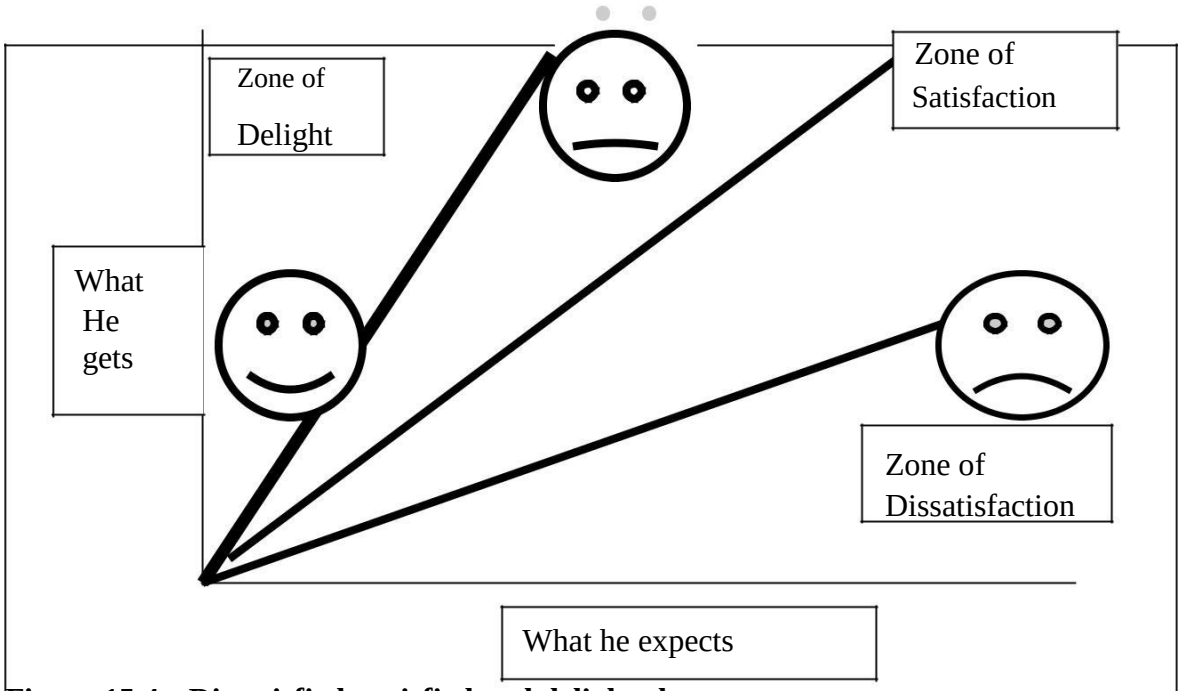


Figure 15.4-- Dissatisfied, satisfied and delighted customers

If a customer gets exactly what he is expecting, the point will be on a line exactly bisecting

the quadrant, i.e. a line that makes an angle of 45° with both X and Y axes in the diagram. If a customer gets performance deviating marginally from his expectations on either side, he will be satisfied as the point will be in the zone of satisfaction. If the performance is far below his expectations, the point will be in the zone of dissatisfaction and a customer will be dissatisfied. If, on the other hand, the performance exceeds well beyond the expectations, the point will be in the zone of delight and the customer will be delighted.

A dissatisfied customer is sure to go to the competition at the earliest opportunity. A satisfied customer will be retained as long as no alternative choice's available. He can be lured away by an aggressive competitor offering a more attractive choice. A delighted customer is a loyal customer and will be retained even if he has an alternative available to him.

A dissatisfied customer will talk about his dissatisfaction to his friends and they too may go to the competition along with the dissatisfied customer. A delighted customer will also talk about his delight to his friends and they too may become the customers of the company. It is, therefore, obvious that any organization that wants to succeed in competitive business environment should try to convert its dissatisfied customers into satisfied customers and satisfied customers into delighted customers.

Customer Satisfaction-II

Feedback

Customer feedback should be continually solicited and monitored as customers continually change. They change their minds, their expectations and their supplier. Customer feedback is not a one-time effort. In fact, it is an ongoing and active probing of the customers' mind. Feedback enables the organization to do the following:

Discover customer dissatisfaction
Discover relative priorities of quality
Compare performance with the competition
Identify customers' needs
Determine opportunities for improvement

Even in service industries, such as insurance and banking, customer feedback has become so important that it drives new product development. There are programs to identify and analyze errors, take corrective action and make ongoing enhancements. All these efforts are justified when the consumers' expectation levels are very high. Effective organizations take time out to listen to the voice of the customer and feed that information back to the idea stage. For instance, listening to the voice of the customer changed how the Internal Revenue Service (IRS) does business. Previously, the IRS thought that good customer service was mailing tax form out right after the New Year's Day. Then, the IRS asked its customers what good customer service was. The IRS found out that the customers wanted fast refunds and very little contact with the IRS. Now, about 20 million taxpayers can forget using the 1040EZ form and file on their touch-tone phone. There is no contact with the risk. It takes about six minutes and the phone system does the math. Refunds are received within 21 days.

Listening to the voice of a customer can be accomplished by numerous information collecting tools. The principal ones are the following:

Comment cards
Questionnaires
Focus groups
Toll free telephone lines
Customer visits
Report cards
The Internet
Employee feedback
Mass customization
The American Customer Satisfaction Index

Comment Card

A low-cost method of obtaining feedback from customers involves a comment card. It can be attached to the warranty card and included with the product at the time of purchase. The intent of the card is to get simple information, such as name, address, age, occupation and what influenced the customer's decision to buy the product. However, there is very little incentive for buyers to respond to this type of card and the quality of the response may not provide a true measure of customer's feeling. Generally, people respond only if something very good or very bad has happened. Comment cards are also used in the hospitality industry. Restaurants and hotels provide them at the ends of tables and in hotel rooms. They can even be found at the bottom of the restaurant sales receipts. Often, free meals or hotel stays are provided to rectify a poor experience noted on the comment card. Free meals and hotel stays can generate significant customer loyalty provided the organization also fixes the problems.

Customer Questionnaire

A customer questionnaire is a popular tool for obtaining opinions and perceptions about an organization and its products and services. However, they can be costly and time consuming. Surveys may be administered by mail or telephone. In the form of questionnaires, the customer is asked to furnish answers relating to the quality of products and services. Most of the surveys ask the customer to grade the question on one-to-five scale or a one-to-ten scale, where the highest number typically has a description like "highly satisfied." One of the reasons the one-to -five or one-to-ten scale is used is because it easily produces a metric. For example, see the spouse satisfaction survey in figure 16.1.

		Highly Satisfied		Neutral	Highly Dissatisfied	
1.	Trash removal	5	4	3	2	1
2.	Personal hygiene	5	4	3	2	1
3.	Lawn maintenance	5	4	3	2	1
4.	Romance	5	4	3	2	1
5.	Thoughtfulness	5	4	3	2	1
6.	Listening skills	5	4	3	2	1
7.	Faithfulness	5	4	3	2	1
8.	Respect for mother-in-law	5	4	3	2	1
9.	Overall, how satisfied are you with your marriage?	5	4	3	2	1

Figure 16.1-- Spouse satisfaction survey-- A typical approach

Trash removal

How often do you expect the trash to be taken out by your spouse?
_____Not at all _____Daily _____When it's full _____When reminded
_____When the stench arouses the anger of the neighbors

How often would you like the trash to be taken out by your spouse?
_____Not at all _____Daily _____When it's full _____When reminded
_____When the stench arouses the anger of the neighbors

How often is the trash taken out by your spouse?
_____Not at all _____Daily _____When it's full _____When reminded
_____When the stench arouses the anger of the neighbors

How satisfied are your with your spouse's trash removal?
_____Very Dissatisfied _____Dissatisfied_____ Neutral _____ Satisfied _____
I Fantazise about it

On a scale of 1 to 8, please rank the importance of the following to happiness of your marriage, where 1 equals most important.

_____ Trash removal
_____ Personal hygiene
_____ Lawn maintenance
_____ Romance
_____Thoughtfulness
_____ Listening skill
_____ Faithfulness
_____ Respect for mother-in-law

Figure 16.2-- Spouse satisfaction survey-- The right way

Although one- to-five scale is a typical approach to survey yet it probably is not entirely effective. It neither tells the surveyor how important trash removal is relative to other qualities nor does it tell what the spouse wants or expects. A better way to do a spouse satisfaction survey is shown in figure 16.2.

Although the most detailed and most useful information may come from a mail survey yet the results are usually not representative of normal population. This result occurs because the only people who will take the time to fill out a survey are those who feel very strongly about a subject and therefore tend to be biased. To further enhance a mail survey, the survey may be followed up with a phone call to non-responders.

To make surveys more useful, it is best to remember the following eight points.

Clients and customers are not the same.
Surveys raise customers' expectations.
How you ask a question will determine how the question is answered.
The more specific the question, the better the answer.
You have only one chance and only 15 minutes.

The more time you spend in survey development, the less time you will spend in data analysis and interpretation.
Who you ask is as important as what you ask.
Before the data is collected, you should know how you want to analyze and use the data.

Clients are the people for whom you are doing the survey and customers are the ones who use the product or service. The customers should be surveyed to provide information for the clients to take action. It is important to note that customer satisfaction surveys are different from traditional public opinion polls. For instance, public opinion polls are based on respondent anonymity whereas customers do not necessarily want to remain anonymous. Customer satisfaction surveys need to be sensitive to the management of customer relationships, which is not necessary when doing traditional public opinion polls. Customer satisfaction survey respondents are more than survey participants. In fact, they are cherished customers of an organization. Their relationship with the organization should be strengthened as a result of the survey and not taxed.

Surveys should focus on what is within the client's abilities or desires to accomplish because surveys do raise customers' expectations. For instance, an employee survey that asks employees what would be a good internal reward system creates expectations in the employee that a reward system will be instituted in some from by the company. If the company has no intention of instituting an employee internal reward system, this question should not be asked. Raising expectations and then doing nothing only serves to disappoint or anger customers. If at all possible, customer survey participants should be informed of the survey results and the changes implemented to remedy problems.

There are different categories of questions that provide different types of information. For instance, a question that begins with "Do you like Chinese food?" provides information on a customer’s feelings or attitude. On the other hand, a question that asks "How often do you dine out?" provides information on a customer’s behavior. Information on a customer's knowledge about the product can be obtained by a question that has only one correct answer (for instance, "Is there a McDonald's within five miles of your house?”). The type of question asked will determine the type of information received.

Likewise, the more specific the question, the better the answer. If the question asked is too broad, it will provide scattered answers. For example, "How would you improve food?" can produce answers ranging from "reduce the cost" to "cook everything in butter." A more tailored question gives the customer a focus for the kind of information that you are interested in. However, questions should be carefully crafted so that the marketing people do not contaminate the questions (and thereby the answers) with their own thinking.

The survey should determine what customers think is important, not what the organization thinks is important.

Customers are giving their most precious commodity when they fill out a survey-- their time. On the very most, a customer will give 15 minutes of his/her time. Customers who send back a

survey should be thanked profusely for their time. Surveyors sometimes include one dollar along with the survey as a token measure of their gratitude.

When writing a survey, it is best to remember that more multiple choice questions can be answered in 15 minutes than open -ended questions. To illustrate this point, compare the following multiple-choice question to the open-ended one.

Q. How many times do you dine out in a month?

1-2 times
3-5 times
6-10 times
More than 10 times

The open-ended question requires the customer to calculate the answer which takes more time. If an exact answer is required, the open-ended question should be asked even though it takes more time to answer. However, if a good estimate does not compromise your data needs, the multiple-choice question may be better. Whether the client wants yes or no information or more detailed information will determine the type of questions asked. In other words, how the data is going to be used will determine how the questions will be asked.

Who are asked the survey questions is just as important as what is asked. The customers in a sample should be chosen to best represent the population so that inferences can be made about the population. Customers who can be surveyed are either current customers, past customers, potential customers or competitors' customers.

Customer surveys should also measure a customer's views of the competitors' performance. It is more useful for an organization to know that it has gained points relative to the competition than to know that its customers have gone form "somewhat satisfied" to "satisfied" stage. For example, Apple's Macintosh computer although has extraordinarily satisfied customers yet the company's market share continues to decline. A company needs to survey its competitor's customers.

Surveys can be data rich but information poor. The next step is to sift through all the data to get to the useful information. The collected data should be turned into actionable information. The survey analysis should not only identify problems and opportunities but it should also suggest the magnitude of the customer base at risk and the revenue implications of inaction. The final analysis yields a specific course of action.

A second method of administering a survey involves telephoning customers. Almost everyone has a few minutes to answer questions on the telephone. Rapidly changing telecommunications are creating customer information instantly. The Gallup organization has developed an automated, voice-gathering polling service called the Gallup 800 Survey. Organizations can now effectively reach large populations, analyze the results quickly and determine what their customers are thinking on a near real-time basis. The survey consists of a series of multiple-

choice questions that provide information for a customized report that includes recommendations. Results are available within 24 hours.

Focus Groups

Customer focus groups are a popular way to obtain feedback, but they too can be very expensive. These groups are very effective for gathering information on customer expectations and requirements.

Surveying a focus group is a research method used to find out what customers are really thinking. A group of customers is assembled in a meeting room to answer a series of questions. These carefully structured questions are asked by a skilled moderator who probes into the participants' thoughts, ideas, perceptions or comments. The moderator has a clear understanding of the type of information wanted and a plan for obtaining it. Meetings are designed to focus on the current, proposed and future products and services. The people selected to participate have the same profile as the customers that the organization is trying to attract. As an incentive to participation, these people are reimbursed for their time. Focus groups are sometimes used with an organization's employees to examine internal issues.

Imprint analysis is an emerging technique used in focus groups. This is a good way to obtain the intrinsic feelings associated with a product or service. Feelings are not as easily obtained from customer questionnaires because customers often hold back information on surveys. Word association, discussions and relaxation techniques can identify a customer's emerging needs, even if the participants are unable to directly articulate those needs. Imprint analysis helps in understanding the human emotions involved in a purchase decision. For instance, a major ice cream company discovered through customer satisfaction surveys that their customers wanted to eat healthier. Before implementing a line of low fat ice cream, the company decided to do an imprint analysis. The imprint analysis discovered that these customers would consume low fat foods and deprive themselves of desserts during the week. But on the weekends, these same people wanted a super rich ice cream, containing more fat than any ice cream presently on the market. These customers wanted to reward themselves for eating healthy during the week. Needless to say, the ice cream company launched a new, full fat and extra creamy product and sold it at a premium. Their market share increased significantly, creating many loyal customers due to the extra insight that the imprint analysis provided.

Toll Free Telephone Numbers

Toll free telephone numbers are an effective technique for receiving complaint feedback. With the help of these, organizations can respond faster and more cheaply to the complaint. Such a number does not, however, reach those who decided not to buy the product or those who discovered some likable feature(s) on a competitor’s product. Toll free numbers are in use by at least 50% of all organizations with sales of at least $10 million.

Implementation of toll free telephone numbers has grown tremendously. In six years, the Cadillac division of General Motors has added 24 toll free numbers. In response to what

customers said, Cadillac eliminated deductibles on warranties and pioneered 24-hour roadside service.

Customer Visits

Visits to a customer's place of business provide another way to gather information. An organization can proactively monitor its product's performance while it is in use and thereby identify any specific or recurring problems. Senior managers should be involved in these visits and not delegate them to someone else. However, it is a good idea to take along operating personnel so that they can see firsthand how the product is performing. A site visit by L-S Electro Galvanizing Company made to its customer, General Motors, produced a surprisingly simple idea. An arrow was needed on the finished 25-ton rolls of steel to show which way the steel unrolled. Previously, GM employees had to guess and often times had to re-summon a crane to turn the roll around which wasted 30 minutes.

Another example of a productive customer visit is when US Steel sent an hourly worker, who applied anti-corrosion coating, to the Ford auto plant that used their steel. The worker found flaking zinc and knew there was too much zinc buildup on the edges. The rods that trimmed the steel were not properly aligned. US Steel also discovered that Ford was wasting steel and money by scraping the bottom sheet of each pile of steel. Ford mistook the harmless white residue on the bottom sheets for rust, when in fact the residue was caused by tremendous pressure from the heavy pile and could easily be wiped off.

The organization should also continually keep informed about new developments in the customer's industry by reading journals and attending conferences. Brain storming sessions with the customers about future products and services should be held at least annually.

Report Card

Another very effective information-gathering tool is the report card. Figure 22.3 shows a typical report card. It is usually sent to each customer on a quarterly basis. The data are analyzed to determine areas for improvement. For instance, the University of California in San Diego uses a report card to grade the quality of campus business services such as the payroll department and the bookstore.

Figure 16.3-- Sample report card

Quality Report Card

To our customers

We are continually striving to improve. To assist us in this endeavor, we need your feedback. Would you please grade our performance in each category? The grading scale is as follows:

A = Excellent
B = Very good
C = Average
D = Poor
F = Failing

1. Product Quality Grade _____
Comments: _____

2. On-Time Delivery Grade _____
Comments: _____

3. Services Grade _____
Comments: _____

4. Overall Grade _____
Comments: _____

Signed _____ Date _____
Title _____ Organization_____

The Internet and Computers

Some managers are beginning to monitor discussions that take place on the Internet to find out what customers are saying about their products. Internet users frequently seek advice regarding their everyday activities or activities related to specific interests, hobbies or sports. Newsgroups, electronic bulletin boards and mailing lists can be scanned using keyword searches if one knows that company's product is of interest to participants in certain activities, hobbies or professions. Ideally, messages that compare a company's products with those of its competitors can be uncovered. In the newsgroups, it is best to read the views and discussions of others and not intervene in the discussion with the organization's perspective on the product or service. Intervening will most likely end the discussion. Monitoring interest conversations is timely, the cost is minimal and it can be a source of creative ideas. One of the drawbacks of monitoring Internet conversations, however, is that the conversations can be unfocused.

There are even Internet sites that take consumer complaints and compliments about businesses and give organizations grades based on their ratio of complaints to compliments. For example, planetfeedback.com also sends letters to companies on behalf of consumers. The organization's Web page also provides an easy way for customers to e-mail the company with their thoughts on the organization's products and services.

Computers can be used to detect patterns in seemingly chaotic data. For instance, the sales data from a convenience store chain showed that the peak hours for selling diapers and beer were the same. The diapers were put next to the beer and sales increased for both.

Employee Feedback

Employees are often an untapped source of information. Companies are listening more to the external customer but are still not listening to employees. Employees can offer insight into conditions that inhibit service quality in the organization. Employee groups can brainstorm ideas to come up with solutions to problems that customers have identified.

Customer research reveals what is happening and employee research reveals why it is happening. Employee feedback should be proactively solicited, instead of checking the wooden suggestion box once a year. For instance, Chrysler regularly surveys employees for issues because employee surveys are timely compared to customer surveys. When staff members cannot get what they need or have low morale, they cannot provide good service. Chrysler requires that management share the survey results with employees and uses the findings to make substantial changes.

Mass Customization

The ultimate in customer satisfaction is giving customers exactly what they want. In the past, the price tag for this was prohibitive. But mass customization is a way to provide variety at an affordable cost. It is a direct result of advances made in manufacturing, such as flexible manufacturing technologies, just-in-time systems and cycle time reduction. It has been done in the car industry for years. Customers determine what type of seat coverings, color and stereo system they want. Mass customization is now being used in many other industries too. For instance, Levi Strauss customers are measured for jeans, choose the fabric and choose the pattern at a local store. The custom fit jeans are then manufactured to order at a central factory and sent to the local store. The voice of the Levi Strauss customer is heard at the fabrication stage of production. Dell assembles computers according to each customer's requirements by adding or subtracting components from one of several base systems. In this way, customers get the computer they want at a reasonable price through mass customization at the assembly stage. Modular furniture is a customized product at the delivery stage. Different customers can adapt modular furniture to meet their changing needs long after the initial purchase.

The voice of a customer can be captured in mass customized products by using the hard data of what the customer bought instead of what the customer was thinking about buying. The customer satisfaction information obtained from mass customization can be used to provide more standardized products. The voice of the purchasing customer, however, provides no information about the non- purchasing customer. Figure16.4 helps in better understanding the customer's involvement in mass customization.

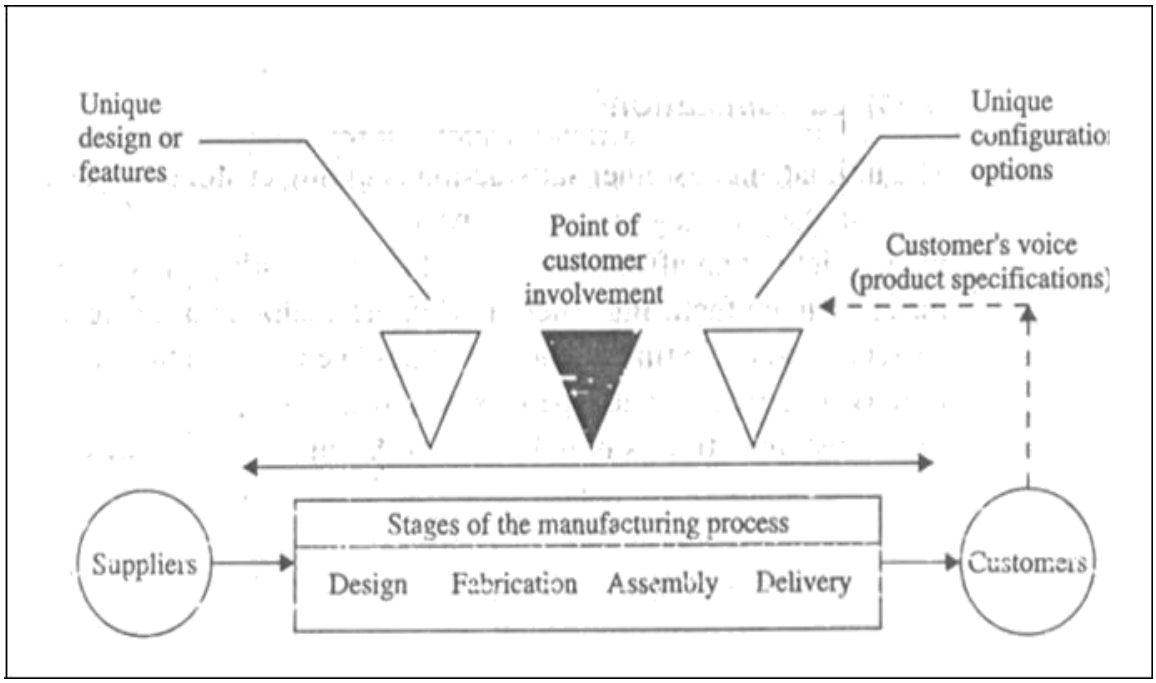


Figure 16.4-- Point of customer improvement

Customer Satisfaction-III

Service Quality

Strategies that have produced significant results in production are often harder to implement in a service environment. Thanks to the teachings of Deming, Juran and others, significant strides have been made in manufacturing. The same results have been slower in service organizations or service activities in manufacturing.

Customer service is the set of activities an organization uses to win and retain customers' satisfaction. It can be provided before, during or after the sale of the product or exist on its own. The elements of customer services are as follows:

Organization

Identify each market segment
Write down the requirements
Communicate the requirement
Organize processes
Organize physical spaces

Customer Care

Meet the customer's expectations
Get the customer's point of view
Deliver what is promised
Make the customer feel valued
Respond to all complaints
Over-respond to the customer
Provide a clean and comfortable customer reception area

Communication

Optimize the trade-off between time and personal attention
Minimize the number of contact points
Provide pleasant, knowledgeable and enthusiastic employees
Write documents in customer-friendly language

Front-Line People

Hire people who like people
Challenge them to develop better methods

Give them the authority to solve problems
Serve them as internal customers
Be sure they are adequately trained
Recognize and reward performance

Leadership

Lead by example
Listen to the front-line people
Strive for continuous process improvement

Organization

To ensure the same level of quality for all customers, the organization should record and then communicate to its employees the directions for all tasks. A service quality handbook should be created with the description of each service quality standard. Communicating the service quality standard for each task can be done by formal training, videos, personal coaching or meetings. Also, intranet sites can be developed so that employees can find answers to commonly asked questions and contact people for more information.

Sometimes, the entire process used by an organization to do business should be changed in order to better serve the customer. For instance, the Florida Estate Tax Division revamped the way they operate by eliminating 50,000 estate tax forms. Florida has many senior residents who were required to file tax forms even if the estate was less than $675,000 and no taxes were owed. The heirs had to wait approximately two weeks to get a tax clearance certificate in order to sell a home or divide up property. Since personnel resources were shifted from these returns to returns where assets were over $675,000, processing time for returns with assets over $675,000 dropped from six months to two weeks.

Other times, physical space should be reorganized to better serve the customer. Harris Methodist Hospital in Fort Worth redesigned its emergency room around the patient. It designed a "quick care" unit for emergency room patients with less serious injuries. The average "quick care" patient now spends 55 minutes in the emergency room instead of 137 minutes. Unfortunately, patients now wonder why treatment is so costly when it took so little time.

Likewise, Belmont University reorganized its physical space to better serve its customers, the students. After many years of student complaints, Belmont created a one-stop Belmont Central where students can add or drop classes, get transcripts, file financial forms, cash cheques and do a myriad of other administrative tasks. Previously, students had to visit several buildings located at opposite ends of the campus to accomplish simple administrative tasks.

Customer Care

An organization should revolve around the customer because customers are the key to any business. A customer, any customer, should be valued and treated like a friend. Responses to customer complaints should be immediate and should be more than the customer expected to receive. If they are treated with respect, customers will simply forgive errors and positively promote the organization. Employees should understand that, as Henry Ford said, “It is not the employer who pays wages-- he only handles the money. It is the customer who pays the wages.” Employees should please customers, not bosses, management committees or headquarters. Employees should not follow mind-numbing rules that provide no benefit to the customer.

Fairview-AFX requires its employees to sign a customer code of ethics. It is also given to all customers in order to hold Fairview-AFX employees accountable. Their code of ethics is to do the following:

Keep promise to customers
Return calls to customers in an expedient manner
Give customers assistance with their concerns, referring an appropriate staff member for problem-solving action when necessary
Treat customers with respect, courtesy and professionalism at all times
Remain aware and evaluate customer satisfaction regularly
Continually search for customer-related improvements
Deliver service and products quickly and efficiently
Give every customer involved a personal attention
Maintain a clean and neat appearance, including the workplace, at all times
Review and implement customer feedback and suggestions into current procedures when appropriate
Engage in any training or education that will enhance job performance and commitment to customer care
Treat every customer just as the employee would want him/herself to be treated

Communication

An organization’s communication to its customers should be consistent with its level of service quality. A customer will become dissatisfied if there is a difference between what has been advertised and what has been received. An organization communicates to its customers in many subtle ways. For instance, an organization communicates to its customers even by such means as an employee’s telephone manners, or an automated voice response system that is fast and easy for the customer to use. Customer relationships are based on communication**.** An organization should listen to its customers and establish a level of trust.

Frequently, the first impression a customer has of an organization is its Website. If the organization's Website is not customer friendly, the customer will have a bad first impression. Iomega, the manufacturer of zip drives, improved both the content and the navigation and

support tools on the organization's Website. Within one year, customer satisfaction increased by 40%, problem resolution rate was up 320% and the cost per solution fell from $10.00 to $0.69.

Front-Line People

Customers are the most valuable assets of any company. They should not be referred to employees who have not been properly trained to handle their complaints. Only the best employee is worthy of a company's customers. It is best to remember three things about front-line employees:

Hire the best
Develop the best employees into professionals
Motivate the professionals to stay and excel

To get that "best employee" on the front line, someone with a personality should be hired. For example, in real estate, the most important aspect is location. Similarly, in front- line employees, the most important aspect is personality. If employees are not happy, this will be reflected to the customers. Generally, customers are frustrated by small things. Front-line employees need to care, smile, possess a pleasant voice and thank the customer often for their business. In sum, it is having a positive attitude. Finding good employees who want to serve customers is not an easy task.

Front -line employees also need training. Managers who conduct training classes or participate in class along with employees develop a more effective working relationship and therefore convey the importance of customer satisfaction to new employees.

Of course, front-line employees should possess written and oral communication skills as well as problem-solving skills. They should also be empowered to resolve complaints. But more importantly, front-line employees should genuinely care for their customers. Customers understand and know when someone empathizes with their feelings and is genuinely trying to help. The idea is being overly fair with your customers, putting customers before costs. For instance, when a physician found a seam had split on a recently purchased business suit from an upscale department store, she returned it. Upon returning the suit, the salesperson gave her a 33% discount coupon for her next purchase because it was not fair that she had to take time from her schedule to return the suit. Of course, the physician has been a loyal customer ever since. Ritz Carlton employees may spend up to $2000 to correct a deficiency or rectify a customer complaint.

At Nordstrom, the company policy is simply stated-- “Use your good judgment in all situations, keeping in mind that there are strict orders to be obsessed with the customer rather than with Nordstrom’s costs.” Salespeople at Nordstrom are so obsessed with the customer that when a customer left her airline ticket at the counter of the Nordstrom’s women’s apparel department, the sales associate took a cab to the airport to locate the customer and deliver the ticket to her. Using good judgment is the key to customer relations.

Sometimes, a customer's needs should be balanced with other customer's needs. For instance, on a commuter flight, a passenger wanted to board with a huge elk rack that would not fit through the doorway, much less in the carry on luggage compartment. The passenger was irate when the flight attendant, pilot and baggage handler calmly explained why the elk rack would not fit, as if it needed explaining. Finally, the baggage handler firmly stated that the passenger was either to take her seat or leave the aircraft. The passenger quickly left and the remaining fifteen passengers gave a round of applause. Despite one unhappy customer, the airline was left with fifteen very happy customers.

In summary, front- line people deal with the customers every day. Front-line people are also a valuable source of information. They know better than management what the customer wants. Front-line staff also needs information and support from management to effectively deal with the public. Management can support front-line staff in various ways. For example, management can also give front-line people the authority to resolve customer problems. Rewards should be given to encourage front-line employee's efforts.

Leadership by Example

No quality improvement can succeed without management's involvement and, more importantly, commitment. Managers can best show their commitment to service quality by example. Texas Namplate Co.'s customer care personnel, including the company president, are available to customers 24 hours a day. Every CEO should be required to spend at least four hours each month behind a service desk. It is hard to understand the customer when you are looking down at him from a 43rd floor window. The American Airlines CEO should eat the food he feeds to weary travelers. The General Motors CEO should spend time in a dealer repair shop. Or better yet, the CEO should be the customer. For example, the CEO of Harley Davidson rides his bike to work. He commented that if you build motorcycles for a living, you should not ride to work in a Rolls Royce.

Additional Comments

Gaining new customers can be a lengthy process involving research, targeting, advertising, promotion and networking. Current customers provide organizations with established business relationships, knowledge and predictability in buying behaviors and short-term opportunities for expanding sales. Thus, an organization's most likely target for new business is its current customers.

Service quality is an activity. Therefore, it can be controlled and improved. Organizations with high quality service can charge up to 20% more and still retain customers. Satisfied customers not only continue to patronize the organization, they also add to profits by referring new customers. Referrals can be twice as effective as advertising.

An essential part of customer satisfaction occurs after the sale. Table 17.1 shows the various characteristics and expectations.

Many organizations emphasize traditional or reactive service after the sale. Examples include the following:

Preventive maintenance (service provided according to a prescribed timetable)
Service contract (service provided as required)
No service contract (service requires labor and material billing)
Combinations of the above

Characteristic	Expectation
Delivery	Delivered on schedule in undamaged condition
Installation	Proper instructions on setup, or technicians supplied for complicated products
Use	Clearly-written training manuals or instructions provided on proper use
Field Repair	Properly trained technicians to promptly make quality repairs, customer service, friendly service, representatives to answer questions
Warranty	Clearly stated with prompt service on claims

Table 17.1-- Characteristics and expectations

An organization striving to upgrade its service quality should move to the proactive level. Proactive organizations contact their customers and determine their service quality needs and expectations. This information is used to develop the organization's strategy. Management should continually improve the methods for obtaining input from customers to better determine their needs.

For instance, the federal government is improving service quality. Former President Bill Clinton released a report titled, "Putting Customers First '95: Standards for Serving the American People." The 232-page report lists the customer service standards that have been formulated by more than 200 federal government agencies. The standards are design to please the customers--the American people. For instance, the Occupational Safety and Health Administration (OSHA) promises that inspector will be respectful and helpful and focus on only the most serious hazards. The Bureau of Labor Statistics promises data any way you want it-- from a live person, a recorded message, fax, microfiche, diskette, tape, Internet or telecommunication device for the deaf. The Internal Revenue Service promises tax refunds due on complete and accurate paper returns in 40 days, or 21 days if the return is filed electronically. Delivering what has been promised builds the American people's confidence that their government can work effectively. After all, if a government office cannot answer the phone and give quick, courteous service, how can it handle defense, commerce and education?

Although publishing the standards was risky yet service in many government offices improved. In 1996, *Business Week* reported that an independent survey of the country's best telephone customer service ranked the Social Security Administration top in the nation.

Translating Needs into Requirements

The Kano model (refer to figure 17.1) conceptualizes customer requirements. The model represents three major areas of customer satisfaction. The first area of customer satisfaction, represented by the diagonal line, represents explicit requirements. These include written or verbal requirements. These are easily identified, are expected to be met and are typically performance related. Satisfying the customer would be relatively simple if these were the only requirements.

The second area of customer satisfaction represents innovations, as shown by the curved line in the upper left corner of the figure. A customer's written instructions are often purposefully vague to avoid stifling new ideas during conceptualization and product definition. Because they are unexpected, these creative ideas often excite and delight the customer. These ideas quickly become expected.

The third and most significant area of customer satisfaction represents unstated or unspoken requirements, as shown by the curve in the lower right corner of the figure. The customer may indeed be unaware of these requirements, or they may assume that such requirements will be automatically supplied. Basic specifications often fail to take real world manufacturing requirements into account. Many of them are merely based on industry standards or past practice. These implied requirements are the hardest to define but prove very costly if ignored. They may be rediscovered during an after-the-fact analysis of lesions learned.

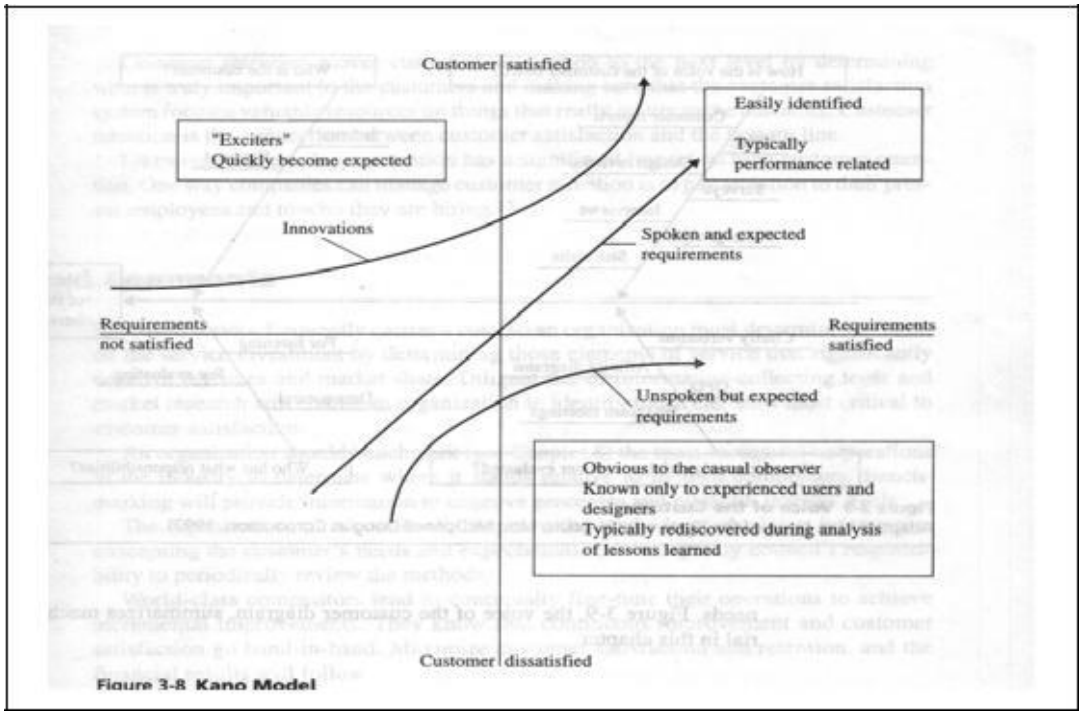


Figure 17. 1-- Kano model

Realistically, a customer does not buy a specification. Instead, he/she buys the product or service to fulfill a need. Peter Drucker once said, "Customers don't buy products, they buy results." People do not buy products, but transportation or status. Customers are loyal to whatever best helps them achieve their desired outcome. Just meeting a customer's need is not enough. The organization should exceed the customer's needs. Figure 17.2, the voice of the customer diagram, summarizes much of the content of this lesson.

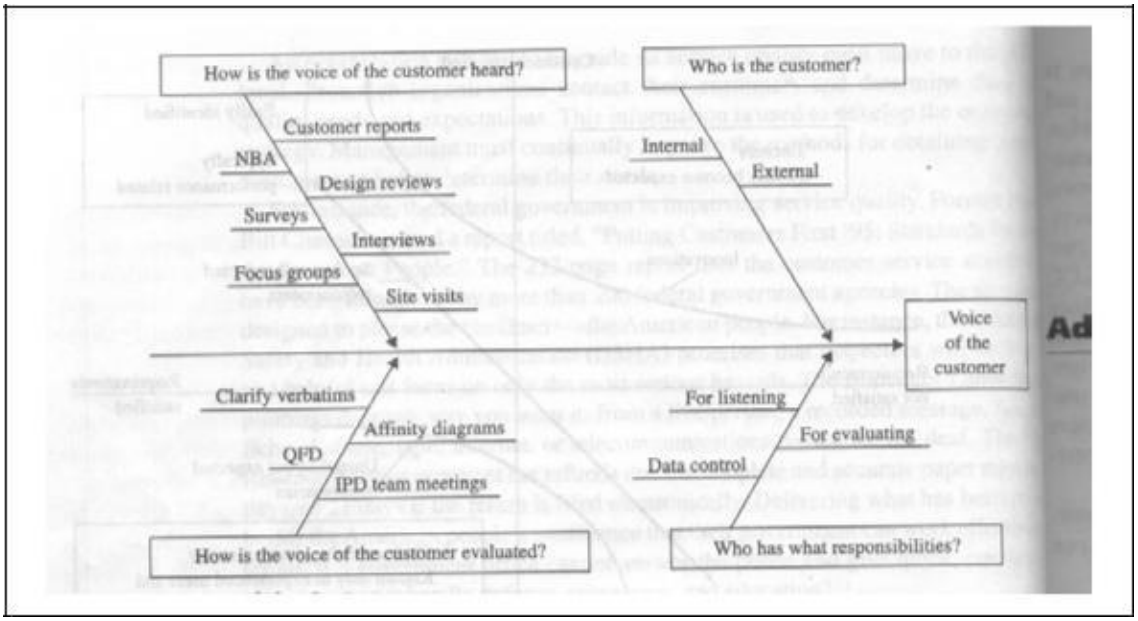


Figure 17.2-- Voice of a customer

Customer Retention

Customer retention is more powerful and effective than customer satisfaction. It represents the activities that produce the necessary customer satisfaction which creates customer loyalty and which actually improves the bottom line. Customer satisfaction surveys, focus groups, interviews and observations can help determine what customers think of a service or a product. However, what people say and think is often different from what they do. Customers may be delighted with the tropical oils and aromas in a high-priced, well-advertised hair care product but still end up buying the generic equivalent. Therefore, customer satisfaction should also be measured by using the hard measures of cash register receipt, market share, the level of customer retention and the number of referrals from customers. The better companies have established a link between customer satisfaction and the bottom line. The analysis identifies the number of customers and the revenue at risk.

Customer retention moves customer satisfaction to the next level by detonating what is truly important to the customers. It makes sure that the customer satisfaction system focuses valuable resources on things that really matter to the customer. Customer retention is the connection between customer satisfaction and the bottom line.

Likewise, high employee retention has a significant impact on high customer retention. A way by which companies can manage customer retention is by paying attention to their present employees and to whom they are hiring.

Questions

Define the terms internal customer and external customer.
Is the main concern of most consumers the price of the product or service?
List and explain the six most important factors that influence consumer purchases.
What is the best way to improve market share for a product or service?
Design a customer satisfaction questionnaire for the following service industries:

- Bank
- Telephone company
- Hospital
- Accounting firm
- Law firm
- Hotel

As a manager of a small sporting goods store, describe how you would train front-line employees to handle customer complaints.
How does employee satisfaction relate to customer satisfaction?
Define quality in two words.
Mechanical products, such as cars, break down. The car dealer often services cars. How can a car dealer use the service department to encourage future car sales?

Performance Measures-- Quality Costs

Introduction

The final concept of TQM is performance measures. One of the Malcolm Baldrige National Quality Award core values is managing by fact rather than by gut feeling. Managing an organization without performance measures is like a captain of a ship navigating without instrumentation. The ship would most likely end up traveling in circles, as would an organization. Measures play a vital part in the success or failure of an organization.

Basic Concepts

Objectives

Performance measures are used to achieve one or more of the following seven objectives.

Establish baseline measures and reveal trends
Determine which processes need to be improved
Indicate process gains and losses
Compare goals with actual performance
Provide information for individual and team evaluation
Provide information to make informed decisions
Determine the overall performance of the organization

Typical Measurement

What should be measured is frequently asked by managers and teams. The information below suggests some items that can be measured.

Human Resource

Lost time due to accidents
Absenteeism
Turnover
Employee satisfaction index
Number of suggestions for improvement
Number of suggestions implemented
Number of training hours per employee
Training cost per employee

Number of active teams
Number of grievances

Customers

Number of complaints
Number of on-time deliveries
Warranty data such as parts replacement
Customer satisfaction index
Time to resolve complaints
Telephone data such as response time
Mean time to repair
Dealer satisfaction
Report card

Production

Inventory turns
SPC charts
C_p/C_{pk}
Amount of scrap/rework
Nonconformities per million units
Software errors per 1000 lines of code
Percent of flights that arrive on time
Process yield
Machine downtime
Actual performance to goal
Number of products returned
Cost per unit

Research and Development

New product time to market
Design change orders
R&D spending to sales
Average time to process proposal
Recall data
Cost estimating errors

Suppliers

SPC charts
C_p/C_{pk}

On-time delivery
Service rating
Quality performance
Billing accuracy
Average lead time
Percent of suppliers that are error free
Just-in-time delivery target

Marketing/Sales

Sales expense to revenue
Order accuracy
Introduction cost to development cost
New product sales to total sales
New customers
Gained or lost accounts
Sales income to number of salespeople
Number of successful calls per week

Administration

Revenue per employee
Expense to revenue
Cost of poor quality
Percent of payroll distributed on time
Number of days accounts receivable past due
Number of accounts payable past due
Office equipment up-time
Purchase order errors
Vehicle fleet data
Order entry/billing accuracy

A good metric compares the measurement of interest to the total possible outcomes, such as rework hours to total hours.

Criteria

All organizations have some measurements in place that can be adapted for TQM. However, some measurements may need to be added. In order to evaluate the existing measures or add new ones, the following ten criteria are recommended:

Simple

Measures should be understandable by those who will use them.

Few Ill Number

The important measures should be distinguished from the unimportant ones so that users can concentrate on just a few. Two or three measures should be sufficient for any work group, with the number increasing for departments, functional areas, plants and corporations. Quality councils may wish to use composite measures such as a customer satisfaction index. It is composed of several weighted metrics such as on-time delivery, cost, product or service quality and complaints.

Developed by Users

In order to ensure ownership of the measures, they should be developed by the user. Measures dictated by a higher authority will usually not receive support from downstream units. However, in some cases, measures are mandated by the customer.

Relevance to Customer

Measures should be relevant to the needs of internal or external customers. Control over important changes should be vested in the people who are held responsible for the performance measure. They also decide what measures to use and set target goals.

Improvement

Although correcting nonconformance and making current decisions are important yet the focus should be on improvement, prevention and strategic long-term planning and goal setting. Measures are used to promote improvement, not to identify poor performance and penalize the low performers. They should be sensitive to the improvements made.

Cost

Of course, the bottom line is that cost and profit should reflect an improved financial picture, as shown by the cost of poor quality system and other financial data. In addition, the cost of measurement should be considered.

Visible

Facility-wide measures should be posted in a central location, such as the lunch or break room, where everyone can see them. Likewise, unit measures should be posted at the machine or work center.

Timely

Financial and accounting data are often presented too late to be actionable. This may require that measurements are taken hourly, daily or weekly rather than monthly or quarterly as in traditional accounting systems. A significant portion of measurements needs to be operational rather than financial. Data needs are to be measured, analyzed and evaluated with respect to the desired goals so that the information can be used.

Aligned

A comprehensive set of measures and indicators tied to customer and organizational performance requirements provides a way to align all activities with organizational goals.

Results

Key result measures need to be guided and balanced by the interest of all stakeholders--customers, employees, stockholders, suppliers, the public and the community.

Use of these criteria will improve the suitability of the selected measures.

Strategy

The quality council has the overall responsibility for the performance measures. It ensures that all the measures are integrated into a total system of measures. To develop the system, the quality council will obtain appropriate information from all the stakeholders. They will utilize the core values, goals, mission and vision statements as well as the objectives and criteria given above. With this information, the strategic measurement system is created.

Percent reduction in cost of poor quality
Percent reduction in nonconformities
Percent of certified suppliers
Percent reduction in supplier base
Percent reduction in corrective action cycle time

Cost

Percent increase in inventory turnover
Percent reduction in data transaction
Percent increase in materials shipped direct to work-in-process by the supplier
Percent increase in output dollars per employee
Percent reduction in floor space utilization

Flexibility

Percent reduction in cycle time
Percent reduction in setup time
Percent reduction in lot-batch size
Percent increase in number of jobs mastered per employee
Percent increase in common materials used per product

Reliability

Percent of processes capable of $C_p = 2.0$
Percent reduction in down time
Percent reduction in warranty costs
Percent reduction in design changes
Percent increase in on-time delivery

Innovation

Percent reduction in new product introduction time
Percent increase in new product sales revenue as a percent of total sales revenue
Percent increase in new patents granted
Customer perception as a leader in innovation
Percent of management time spent on or leading innovation

The above metrics are tracked monthly to show trends, identify problem areas and allocate resources.

Once the strategic measurement system is developed, the functional areas can develop their systems by involving their departments and work groups. The first step is to determine which processes or sub-processes are critical to providing input for the strategic system. Next, the critical metric(s) are determined using the information given above under basic concepts. This activity is followed by assigning responsibility for the collection, analysis and dissemination of the data. The last step is the development of improvement procedures.

Each month the quality council should meet to monitor current activities and plan future ones. To assist them, a report package is prepared consisting of the following things:

Performance measures
Narrative reports on competition, opportunities and pertinent events
System audits

Performance Measure Presentation

There are six basic techniques for presenting performance measures. The simplest and most common is the time series graph shown in figure 18.1. Time, as measured by days, weeks, months and so forth is shown on the horizontal axis and the performance measure is shown on the vertical axis. This type of graph benchmarks the process and shows favorable and unfavorable trends in the measure.

A second form of presentation is the control chart. A control chart for percent nonconforming is shown in figure18.2.

A third presentation technique is the capability index which is the ratio of the tolerance to the capability. There are two measures-- one indicates the ability of the process to meet specifications and the other indicates the centering of the process on the target.

Another way of measuring quality is Taguchi's loss function. This technique combines target, cost and specifications into one measurement. Figure 18.3 illustrates the concept.

The fifth method of presenting performance measures is the cost of poor quality. Money attracts the attention of senior management.

The last method is the Malcolm Baldrige National Quality Award. The criteria for this award quite effectively measure the performance of the TQM effort on an annual basis.

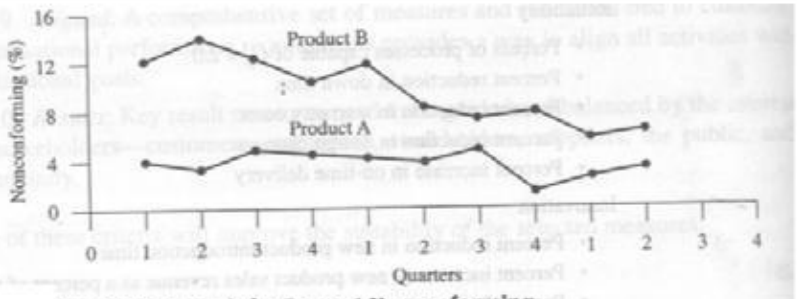


Fig. 18.1: Time Series Graph for Percent Nonconforming

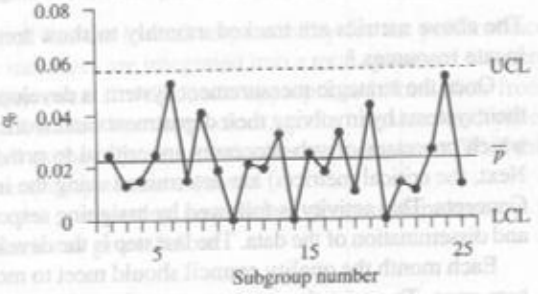


Fig.18.2: Control Chart for Percent Nonconforming

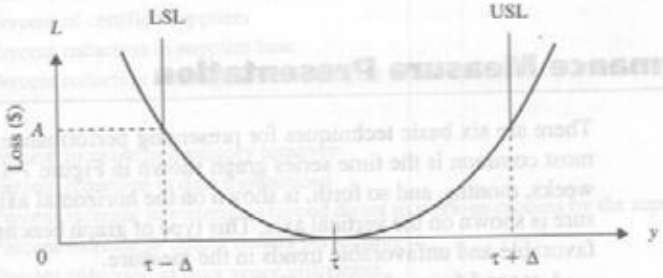


Fig. 18.3 Taguchi's Quadratic Loss Function for Nominal-the-Best

Quality Costs

The value of quality should be based on its ability to contribute to profits. The goal of most of the organizations is to make money. Therefore, decisions are made based on evaluating alternatives and the effect each alternative will have on the expense and income of the entity.
The efficiency of a business is measured in terms of dollars. The cost of poor quality can add to the other costs used in decision making, such as maintenance, production, design, inspection, sales and other activities. This cost is no different than other costs. It can be programmed, budgeted, measured and analyzed to help in attaining the objectives for better quality and customer satisfaction at less cost. A reduction in quality costs leads to increased profit.

Quality costs cross department lines by involving all activities of the organization-- marketing, purchasing, design, manufacturing and service to name a few. Some costs, such as inspector salaries and rework, are readily identifiable. Other costs, such as prevention costs associated with marketing, design and purchasing, are more difficult to identify and allocate. There are failure costs associated with lost sales and customer goodwill which may be impossible to measure and should be estimated.

Quality costs are defined as those costs associated with the no achievement of product or service quality as defined by the requirements established by the organization and its contracts with customers and society. Simply stated, quality cost is the cost of poor products or services.

Management Technique

Quality costs are used by management in its pursuit of quality improvement, customer satisfaction, market share and profit enhancement. It is the economic common denominator that forms the basic data for TQM. When quality costs are too high, it is a sign of management ineffectiveness that can affect the organization's competitive position. A quality cost program provides warnings against oncoming, dangerous financial situations.

A quality cost program quantifies the magnitude of the quality problem in the language that management knows best-- dollars. The cost of poor quality can exceed 20% of the sales (dollars) in manufacturing companies and 35% of the sales (dollars) in service organizations. In addition, the program may show quality problem areas that were previously unknown.

Quality costs identify opportunities for quality improvement and establish funding priorities by means of Pareto analysis. This analysis allows the quality improvement program to concentrate on the vital few quality problem areas. Once corrective action has been completed, the quality costs will measure the effectiveness of that action in terms of dollars.

A quality cost program lends credence to management’s commitment to quality. Arguments for quality improvement are stronger when the quality costs show a need. The program also provides cost justification for corrective action. All costs associated with the poor quality and its correction are integrated into one system to enhance the quality management function. Quality

improvement is synonymous with a reduction in the cost of poor quality. Every dollar saved on quality cost has a positive effect on profits.

One of the principal advantages of the quality cost program is the identification of hidden and buried costs in all functional areas. Quality costs in marketing, purchasing and design are brought to the forefront by the system. When senior management has all the facts on hidden and buried costs, they will demand a quality cost program.

A cost program is a comprehensive system and should not be perceived as merely a "firefighting" technique. For example, one response to a customer's problem could be to increase inspection. Although this action might eliminate the problem yet the quality costs would increase. Real quality improvement occurs when the root cause of the problem is found and corrected.

Categories and Elements

There are four primary cost categories as follows:

Prevention
Appraisal
Internal failure
External failure

The list is not meant to contain every element of quality cost applicable to every organization. It is intended to give a general idea of what types of elements are contained within each category to help in deciding individual classifications. If a significant cost exists that fits any part of the general description of the quality cost element, it should be used. Sub-elements are identified. However, detailed descriptions are not included.

Preventive Cost Category

The experience gained from the identification and elimination of specific causes of failures and their costs is utilized to prevent the recurrence of the same or similar failures in other products or services. Prevention is achieved by examining the total of such experience and developing specific activities for incorporation into the basic management system that will make it difficult or impossible for the same errors or failures to occur again. The prevention costs of poor quality have been defined to include the cost of all activities specifically designed for this purpose. Each activity may involve personnel from one or many departments. No attempt is made to define appropriate departments because each organization is structured differently.

Marketing/Customer

Costs are incurred in the accumulation and continued evaluation of customer and user quality needs and perceptions (including feedback on reliability and performance) affecting user satisfaction with the organization's product or service. Sub-elements include the following:

Marketing research
Customer and user perception surveys or focus groups
Contract and document review

Production Service/Design Development

Costs are incurred to translate customer and user needs into reliable quality standards and requirements. They are also incurred to manage the quality of new product or service developments prior to the release of authorized documentation for initial production. These costs are normally planned and budgeted and are applied to major design changes as well. Sub-elements include the following:

Design quality progress reviews
Design support activities
Product design qualification tests
Service design qualification and field trials

Purchasing

Costs are incurred to assure conformance to requirements of supplier parts, materials or processes and to minimize the impact of supplier non-conformance on the quality of delivered product or services. This area involves activities prior to and after finalization of purchase order commitments. Sub-elements include the following:

Supplier reviews
Supplier rating
Purchase order technical data reviews
Supplier quality planning

Operations (Manufacturing or Service)

Costs are incurred in assuring the capability and readiness of operations to meet quality standards and requirements, quality control planning for all production activities and the quality education of operating personnel. Sub-elements include the following:

Operations process validation
Operations quality planning
Design and development of quality measurement and control equipment
Collecting quality costs
Operations support quality planning
Operator quality education

Quality Administration

Costs are incurred in the overall administration of the quality management function. Sub-elements include the following:

Administrative salaries
Administrative expenses
Quality program planning
Quality performance reporting
Quality education
Quality improvement
Documenting and evaluating quality costs
Quality audits

Appraisal Cost Category

The first responsibility of a quality management system is the assurance of the acceptability of product or service as delivered to customers. This category has the responsibility for evaluating a product or service at sequential stages, from design to first delivery and throughout the production process, to determine its acceptability for continuation in the production or life cycle. The frequency and spacing of these evaluations are based on a trade-off between the cost benefits of early discovery of non-conformities and the cost of the evaluations (inspections and tests) themselves. Unless perfect control can be achieved, some appraisal cost will always exist. An organization would never want the customer to be the only inspector. Thus, the appraisal costs of poor quality have been defined to include all costs incurred in the planned conduct of product or service appraisals to determine compliance to requirements.

Purchasing Appraisal Costs

Purchasing appraisal costs can generally be considered the costs incurred for the inspection and/or test of purchased supplies or service to determine acceptability for use. These activities can be performed as the part of receiving inspection function or as source inspection at the supplier's facility. Sub-elements include the following:

Receiving or incoming inspections and tests
Measurement equipment
Qualification of supplier product
Source inspection and control programs

Operations (Manufacturing or Service) Appraisal Costs

Operations appraisal costs can generally be considered the costs incurred for the inspections, tests or audits required to determine and assure the acceptability of product or service to continue into each discrete step in the operations plan from start of production to delivery. In

each case, whether setup pieces or destructive testing, the cost of the losses is to be included. Sub-elements include the following:

Planned operations
Inspections
Tests
Audit
Setup inspections and tests
Special tests (manufacturing)
Process control measurements
Laboratory support
Measurement (inspection and test) equipment
Outside endorsements and certifications

External Appraisal Costs

External appraisal costs are incurred in the following cases:

Any time when there is a need for field setup or installation
Checkout prior to official acceptance by the customer
When there is need for field trials of new products or services

Sub-elements include the following:

Field performance evaluations
Special product evaluations
Evaluations of field stock and spare parts

Review of Test and Inspection Data

Costs are incurred for regular reviewing of inspection and test data prior to the release of the product for shipment. This is done to determine whether product requirements have been met or not.

Miscellaneous Quality Evaluations

This area involves the cost of all support area quality evaluations (audits) to assure continued ability to provide acceptable support to the production process. Examples of areas include mailrooms, storerooms, and packaging and shipping.

Internal Failure Cost Category

Whenever quality appraisals are performed, the possibility exists for discovery of a failure to meet requirements. When this happens, unscheduled and possibly unbudgeted expenses are

automatically incurred. For example, when a complete lot of metal parts is rejected for being oversize, the possibility for rework should be evaluated first. Then the cost of rework may be compared to the cost of scrapping the parts and completely replacing them. Finally, a disposition is made and the action is carried out. The total cost of this evaluation, disposition and subsequent action is an integral part of the internal failure costs.

In attempting to cover all possibilities for failure to meet requirements within the internal product or service life cycle, failure costs have been defined to include all costs required to evaluate, dispose of and either correct or replace non-conforming products or services prior to delivery to the customer. It also includes the costs to correct or replace incorrect or incomplete product or service description (documentation). In general, this includes all the material and labor expenses that are lost or wasted due to non-conforming or otherwise unacceptable work affecting the quality of end products or service. Corrective action that is directed toward elimination of the problem in the future may be classified as prevention.

Product or Service Design Failure Costs (Internal)

Design failure costs can generally be considered the unplanned costs that are incurred because of inherent design inadequacies in released documentation for production operations. They do not include billable costs associated with customer-directed changes (product improvements) or major redesign efforts (product upgrading) that are part of an organization-sponsored marketing plan. Sub-elements include the following:

Design corrective action
Rework due to design changes
Scrap due to design change
Production liaison costs

Purchasing Failure Costs

Costs are incurred due to purchased item rejects. Sub-elements include the following:

Purchased material reject disposition costs
Purchased material replacement costs
Supplier corrective action
Rework of supplier rejects
Uncontrolled material losses

Operations (Product or Service) Failure Costs

Operations failure costs almost always represent a significant portion of overall quality costs. These can generally be viewed as the costs associated with non-conforming product or service discovered during the operations process. These are categorized into the following three distinct areas:

Material review and corrective action
Rework or repair costs
Scrap costs

Sub-elements include the following:

Material review and corrective action costs
Operations rework and repair costs
Internal failure labor losses

External Failure Cost Category

This category includes all costs incurred due to actual or suspected non-conforming product or service after delivery to the customer. These costs consist primarily of costs associated with the product or service not meeting customer or user requirements. The responsibility for these losses may lie in marketing or sales, design development, or operations. Determination of responsibility is not part of the system. Determination of responsibility can come about only through investigation and analysis of external failure cost inputs.

Complaint Investigations of Customer or User Service

This category includes the total cost of investigating, resolving and responding to individual customer or user complaints or inquiries, including necessary field service.

Returned Goods

This category includes the total cost of evaluating and repairing or replacing goods not meeting acceptance by the customer or user due to quality problems. It does not include repairs accomplished as part of a maintenance or modification contract.

Retrofit and Recall Costs

Retrofit and recall costs are those cost required to modify or update products or field service facilities to a new design change level, based on major redesign due to design deficiencies. These include only the portion of retrofits that are due to quality problems.

Warranty Claims

Warranty costs include the total cost of claims paid to the customer or user after acceptance to cover expenses. These also include repair costs, such as removing defective hardware from a system, or cleaning costs, such as due to a food or chemical service accident. In cases where a price reduction is negotiated in lieu of a warranty, the value of this reduction should be counted.

Liability Costs

Liability costs are organization-paid costs due to liability claims, including the cost of product or service liability insurance.

Penalties

Penalty costs are the costs incurred because less than full product or service performance is achieved as required by contracts with customers or by government rules and regulations.

Customers or User Goodwill

This category involves costs incurred, over and above normal selling costs, to customers or users who are not completely satisfied with the quality of delivered product or service because the customers' quality expectations were greater than the quality they received.

Lost Sales

Lost sales comprise the value of the contribution to profit that is lost due to sales reduction because of quality problems.

Collection and Reporting

Collection System Design

The development of the collection system requires the close interaction of the quality and accounting departments. Because accounting cost data are established by departmental cost codes, a significant amount of quality cost can be obtained from this source. In fact, the system should be designed using the organization's present system and modifying it where appropriate. Some existing sources for reporting quality costs are time sheets, schedules, minutes of meetings, expense reports, credit and debt memos and so forth. But it should be remembered that not all accounting data are accurate.

Some quality cost data cross departmental lines. These types of costs are the most difficult to collect. Special forms may be required to report some quality costs. For example, scrap and rework costs may require analysis by quality control personnel to determine the cause and the departments responsible.

In some cases, estimates are used to allocate the proportion of an activity that should be charged to a particular element. For example, when the marketing department engages in research, it is necessary for the department supervisor to estimate the proportion of the activity that pertains to customer quality needs and should be charged as a quality cost. Work sampling techniques can be a valuable tool for assisting the supervisor in making the estimate.

Insignificant costs of poor quality, such as a secretary retyping a letter, may be difficult to determine and may be overlooked. However, significant ones are frequently hidden or buried because the accounting system is not designed to handle them. Quality cost is the tool that can determine opportunities for quality improvement justify the corrective action and measure its effectiveness. Including insignificant activities is not essential to use the tool effectively. However, all significant activities or major elements should be captured, even if they are only estimated.

The comptroller's office should be directly involved in the design of the quality cost system. This office has the ability to create a new system that will integrate quality costs into the existing accounting system. An ideal system would be one where the quality cost is the difference between actual cost and the cost if everyone did a perfect job. Or it may be the difference between actual revenue and revenue if there were no unhappy customers. This ideal is most likely impossible to obtain.

Incoming inspection would be appraisal whereas supplier certification would be prevention.
An 800 number would be prorated between the cost of doing business and customer complaints.
Cost of a team meeting might be due to failure, but cost of the solution might be appraisal or prevention.

Quality costs should be collected by product line, projects, departments, operators, non-conformity classification and work centers. This manner of collection is sufficient for subsequent quality cost analysis. Procedures are developed to ensure that the system functions correctly. Micro reports are prepared for functional area and departments, and macro reports are done for the TQM function.

Quality Cost Bases

Quality costs by themselves present insufficient information for analysis. A baseline is required which will relate quality costs to some aspect of the business that is sensitive to change. Typical bases are labor, production, sales and unit. When these baselines are compared with quality costs, an index is obtained.

Labor

Quality cost per hour of direct labor is a common index. Direct labor information is readily available because it is used for other indexes too. Automation affects the base over an extended period of time. Therefore, the value of a labor base is limited to comparisons within a short period of time. Sometimes, direct labor dollars are used rather than direct labor hours. This technique eliminates the inflation factor because dollars are divided by dollars.

Production

A quality cost per dollar of production cost is another common index. Production cost is composed of direct labor, direct material and overhead. Production cost information is readily available because it is used for other indexes too. Because there are three costs involved, this index is not significantly affected by material price fluctuations or by automation. Design cost, marketing cost or purchasing cost might be appropriate in some situations as a substitute for production cost.

Sales

Quality cost per dollar of net sales is the most common type of index. This information is a valuable tool for higher management decision-making. Because sales lag behind production and is frequently subject to seasonal variations, this index is sometimes a poor one for short-term analysis. It is also affected by changes in selling price and shifts in available markets. However, in the eyes of senior management, there may be no better common denominator than net sales for year-to-year planning and measurement.

Unit

Quality cost per unit, such as the number of boxes, kilograms of aluminum or meters of cloth, is an excellent index where product lines are similar. However, where product lines are dissimilar, comparisons are difficult to make and interpret.

Because each of the various indexes has disadvantages, it is the normal practice to use three indexes. From experience, the most useful indexes are used to compare trends in quality costs.

For current, ongoing applications, various ratios can be used. These ratios will reflect management emphasis on areas that are undergoing quality improvement. Typical ratios that may be considered are as follows:

Operations failure costs as a percent of production costs
Purchasing quality costs as a percent of materials costs
Design quality costs as a percent of design costs

There is no limit to the number of ratios that can be used. Since there is no single perfect ratio, use of more than one ratio is recommended.

Quality Cost Report

The basic quality cost control instrument is the quality cost report which is usually issued by the accounting department. An example of this type of report is shown in figure 18.4. Provision is made to report the quality costs for the current month for each cost elements as well as the current and prior year-to-date values. Applicable indexes and ratios are shown at the bottom of the report.

	Current Month	Year-to-Date	
Prevention Costs $(000)		**Current**	**Prior Yr.**
Marketing / Customer			
Product / Service Development			
Purchasing			
Operations			
Quality Administration			
Total			

	Current Month	Year-to-Date	
Appraisal Costs $ (000)		**Curre nt**	**Prior Yr.**
Product / Service Development			
Purchasing			
Operations			
External Appraisal Cost			
Total			

	Current Month	Year-to- Date	
Internal Failure Costs $(000)		**Current**	**Prior Yr.**
Product / Service Design			
Purchasing			
Operations (Subtotal)			
Material Review			
Rework			
Repair			
Reappraisal			
Extra Operations			
Scrap			
Total			

	Current Month	Year-to-Date	
External Failure Costs $(000)		**Curre nt**	**Prior Yr.**
Customer Complaints			
Returned Goods			
Retrofit Costs			
Warranty Claims			
Liability Costs			
Penalties			
Customer Goodwill			
Total			

	Current Month	Year-to- Date	
Baseline Data $(000)		**Current**	**Prior Yr.**
Net Sales			
Direct Labor			
Production			
Design			

	Current Month	Year-to-Date	
Quality Cost Ratios $(000)		**Curre nt**	**Prior Yr.**
External Failure Cost / Net Sales			
Operations Failure Costs / Production			

By comparing current costs with historical ones, a certain amount of control can be exercised. It is also possible to establish a budget for each cost element. By comparing actual quality costs with budgeted costs, favorable and unfavorable variances can be determined.

Analysis

Analysis techniques for quality costs are quite varied. The most common techniques are trend and Pareto analysis. The objective of these techniques is to determine opportunities for quality improvement.

Trend Analysis

Trend analysis involves simply comparing present cost levels to past levels. It is suggested that at least one year should elapse before drawing any conclusions from the data. Trend analysis provides information for long-range planning. It also provides information for the instigation and assessment of quality improvement programs. Data for trend analysis come from the monthly report and the detailed transactions that make up the elements. Trend analysis can be accomplished by cost category, by sub-category, by product, by measurement base, by plants within a corporation, by department, by work center and by combinations thereof. The graphs of some of these trend types are shown in figure18.5. Times scales for these time series graphs may be by month, quarter or year, depending on the purpose of the analysis.

Figure 18.5(a) shows a graph of the four cost categories by quarter. It is the cumulative type. Here the second line from the bottom includes the prevention and the appraisal costs. The third line from the bottom includes the internal failure, appraisal and prevention costs. The top line includes all four cost categories. The figure shows that prevention and internal failure costs are increasing, but appraisal costs remain unchanged and external failure cost are decreasing.

Figure 18.5(b) shows the trend analysis for three different measurement bases. The differences in the trends of the three bases point to the need for more than one base. A decrease in the percent of net sales during the fourth quarter is due to a seasonal variation, whereas the variation in production costs for the third quarter is due to excessive overtime costs.

Figure 18.5(c) shows the trend analysis for two different products. The figure shows that the costs for product B are better than those for product A. In fact, product B is showing a nice improvement whereas product A's costs are increasing. As increase in the prevention and appraisal costs will, it is hoped, improve the external and internal failure costs of product A, it is important to note that comparisons between products and plants should be made with extreme caution.

A trend graph for the external failure category is shown in figure 24.5(d). Returned costs and lost sales costs have increased whereas costs for the other sub-categories have remained unchanged. In this figure, the index is by production costs and the time period is by quarters.

Figure 18.6 shows a short-run trend analysis chart for the assembly area. The ratio of rework costs to total assembly costs in percent is plotted by months. This ratio is compared to the quality measure percent non-conforming. Both curves show a decrease which supports the basic concept that quality improvement is synonymous with reduced costs.

Trend analysis is an effective tool, provided it is recognized that some period-to-period fluctuations are chance variations. These variations are similar to those that occur on control charts. The important factor to observe is the trend. It is also important to note that there may be a time lag between the occurrence of cost and the actual reporting of that cost.

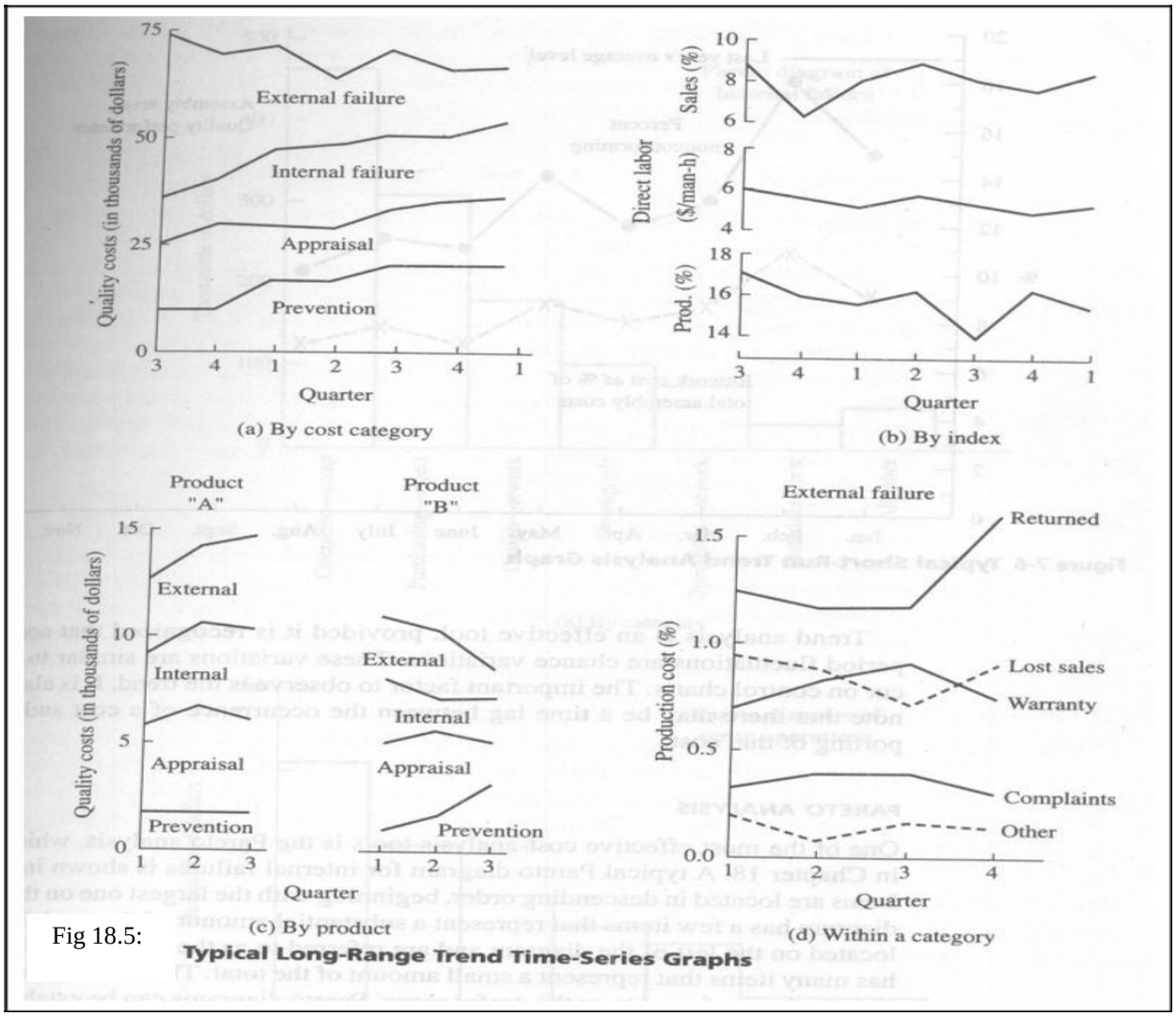


Fig 18.5: **Typical Long-Range Trend Time-Series Graphs**

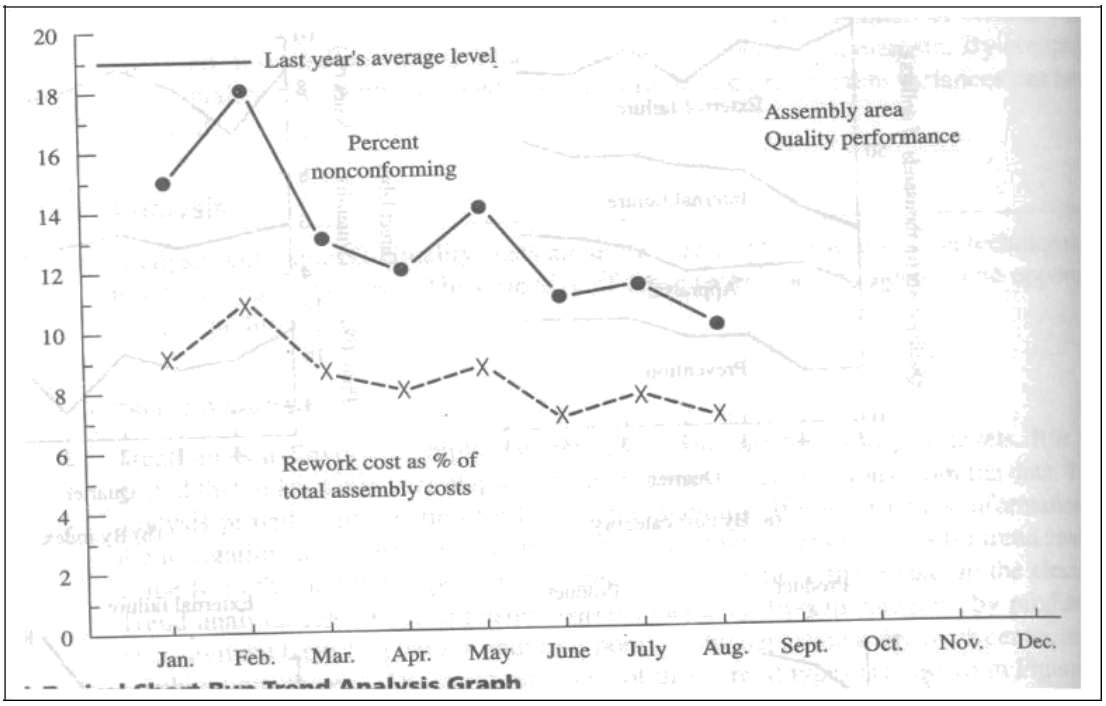


Figure 18.6-- Typical short run trend analysis graph

Pareto Analysis

One of the most effective cost analysis tools is the Pareto analysis. A typical Pareto diagram for internal failures is shown in figure 18.7(a). Items are located in descending order, beginning with the largest one on the left. A Pareto diagram has a few items that represent a substantial amount of the total. These items are located on the left of the diagram and are referred to as the vital few. The diagram has many items that represent a small amount of the total. These items are located on the right and are referred to as the useful many. Pareto diagrams can be established for quality costs by operator, by machine, by department, by product line, by non-conformity, by category, by element and so forth.

Once the vital few are known, projects can be developed to reduce their quality costs. In other words, money is spent to reduce the vital few quality costs. Little or no money is spent on the useful many.

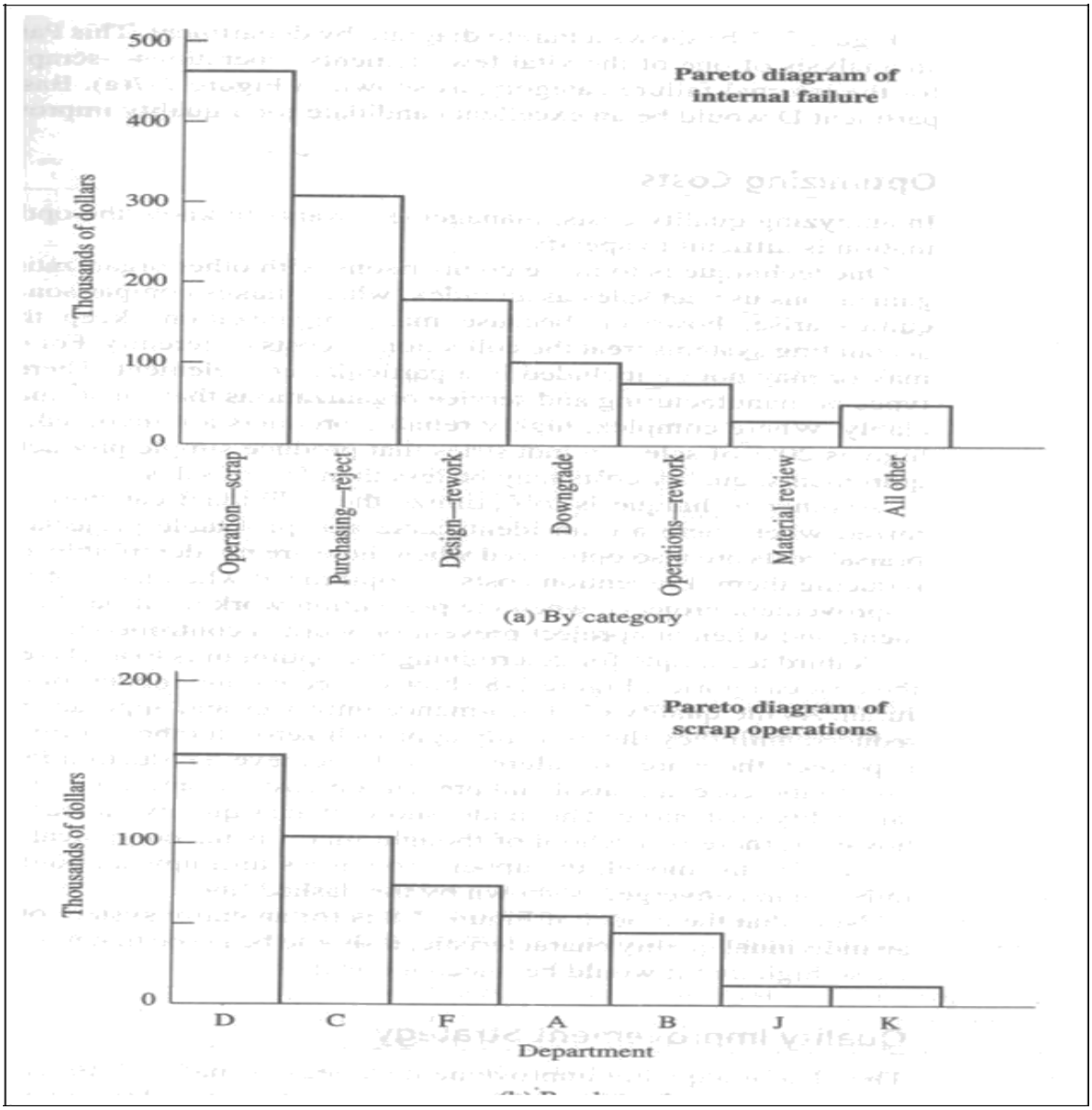


Figure 18.7-- Pareto analysis

Figure 18.7(b) shows a Pareto diagram by department. This diagram is actually an analysis of one of the vital few elements (operations-- scrap) in the Pareto diagram for the internal failure category, as shown in the figure. Based on the diagram, department D would be an excellent candidate for a quality improvement program.

Quality Improvement Strategy

The idea of a quality improvement strategy is that each failure has a root cause, causes are preventable and prevention is cheaper. Based on this concept, the following strategy is used:

Reduce failure costs by problem solving.
Invest in the "right" prevention activities.
Reduce appraisal costs where appropriate and in a statistically sound manner.
Continuously evaluate and redirect the prevention effort to gain further quality improvement.

Prevention of Quality Costs

Rather than solving problems that are costing money, it would be better if problems could be prevented. Prevention activities are related to employee attitudes and to formal techniques to eliminate problems in the product cycle before the problems become costly.

Employee attitudes toward quality are determined by top management's commitment to quality and the involvement of both in the quality improvement program. Suggestions for achieving this commitment and involvement are as follows:

Include both groups as members of project teams.
Establish a quality council with the CEO as the chair and functional area managers as members.
Involve employees in the annual quality improvement program.
Provide a system where by employees can present quality improvement ideas.
Communicate quality expectations to employees.
Publish an organization newsletter.
Hold a quarterly meeting of all employees.

Reducing Appraisal Costs

As failure costs are reduced, most likely the need for appraisal activities will also be reduced. Programs for cost improvement can have a significant impact on the total costs. Periodically, a project team should review the entire appraisal activity to determine its effectiveness. Typical questions that the project team might investigate are the following:

Is 100% inspection necessary or would statistical process control work more efficiently and effectively?
Can inspection stations be combined, relocated or eliminated?
Are inspection methods the most efficient?
Could the inspection and test activity be automated?
Could data be more efficiently collected, reported and analyzed using the computer?
Should operating personnel be responsible for inspection, thus decreasing costs?
Is appraisal being used as substitute for prevention?

Performance Measures-- Deming Prize

How was the Deming prize established?

The Union of Japanese Scientists and Engineers (JUSE) invited the late Dr. W. E. Deming (1900-1993), one of the foremost experts of quality control in the United States, to Japan in July 1950.

Upon his visit, Dr. Deming lectured day after day his “Eight-Day Course on Quality Control” at the Auditorium of the Japan Medical Association in Kanda-Surugadai, Tokyo. This was followed by Dr. Deming’s “One-Day Course on Quality Control for Top Management,” held in Hakone. Through these seminars, Dr. Deming taught the basics of statistical quality control plainly and thoroughly to executives, managers, engineers and researchers of Japanese industry. His teachings made a deep impression on the participants mind and provided great impetus to quality control in Japan which was in its infancy.

The transcript of the eight-day course, “Dr. Deming’s Lectures on Statistical Control of Quality,” was compiled from stenographic records and distributed for a charge. Dr. Deming donated his royalties to JUSE. In appreciation of Dr. Deming’s generosity, the late Mr. Kenichi Koyanagi, managing director of JUSE, proposed using it to fund a prize to commemorate Dr. Deming’s contribution and friendship in a lasting way and to promote the continued development of quality control in Japan. Upon receiving the proposal, the JUSE's board of directors unanimously made a resolution to establish the Deming Prize.

Later, the Japanese translation of Dr. Deming’s book Some Theory of Sampling was published. Dr. Deming further contributed to the fund using the royalties from his book. Since then, the Deming Prize has grown considerably and today JUSE carries the overall administrative costs for the prize.

Categories of the Deming Prize

As shown in the table 19.1, the categories of the Deming Prize are the Deming Prize for Individuals, the Deming Application Prize and the Quality Control Award for Operations Business Units.

The Deming Prize	**For individuals or groups**
for Individuals	Given to those who have made outstanding contributions to the study of TQM or statistical methods used for TQM, or those who have made outstanding contributions in the dissemination of TQM
The Deming	For organizations or divisions of organizations that manage their business autonomously
Application Prize	Given to organizations or divisions of organizations that have achieved distinctive performance improvement through the application of TQM in a designated year
The Quality Control Award	For operations business units of an organization
for Operations Business Units	Given to operations business units of an organization that have achieved distinctive performance improvement through the application of quality control/management in the pursuit of TQM in a designated year

Table 19.1-- Categories of Deming prize

Definition of TQM (Total Quality Management) (revised in June 1998)

The Deming Prize Committee defines TQM as follows:

TQM is a set of systematic activities carried out by the entire organization to effectively and efficiently achieve company objectives so as to provide products and services with a level of quality that satisfies customers, at the appropriate time and price.

Systematic activities mean organized activities to achieve the company's mission (objectives) that are lead by strong management leadership and guided by established clear mid- and long-term vision and strategies as well as appropriate quality strategies and policies.

Carried out by the entire organization to effectively and efficiently achieve means to involve everyone at all levels and all parts of the company so as to achieve the business objectives speedily and efficiently with the least management resources. This is accomplished through an appropriate management system that has a quality assurance system at its core and it integrates other cross-functional management systems such as cost, delivery, environment and safety. The respect for humanity value encourages the company to develop human resources which uphold its core technology, speediness and vitality. The company maintains and improves its processes and operations, and uses appropriate statistical techniques and other tools. Based on facts, the company manages its business by rotating the management cycle of PDCA (plan, do, check and act). The

company also rebuilds its management system by utilizing appropriate scientific methods and information technology.

Company objectives refer to securing appropriate profit for the long term through satisfying customers consistently and continuously. Also, they encompass improving the benefit to all stakeholders including employees, society, suppliers and stockholders.

Provide refers to activities from producing "products and services" to handing them off to customers, including surveys, research, planning, development, design, product preparation, purchasing, manufacturing, installation, inspection, order-taking, sales and marketing, maintenance, after-sales services and after-usage disposal and recycling.

Products and services include manufactured products (finished products and parts and materials), systems, software, energy, information and all other benefits that are provided to customers.

Quality refers to usefulness (both functional and psychological), reliability and safety. Also in defining quality, influence on the third parties, society, the environment and future generations should be considered.

Customers include buyers but also users, consumers and beneficiaries.

For any company, the shortest way to win the Deming Application Prize is to manage its business in the most appropriate manner to the company. It is undesirable to conduct unnecessary activities for its fundamental business just for the sake of the examination. Such activities will not help the company with its examination rather they may negatively affect the examination.

The emphasis of the examination is on whether or not the company has developed a unique brand of TQM suitable for its business and scale. It does not require all applicant companies to uniformly follow the same brand of TQM.

If the company just copies the format of TQM from others or if it prepares rules and standards more than necessary under the name of TQM, such activities will not support receiving the Prize.

Some people think that advanced statistical methods should be used to pass the examination. It is a misunderstanding.

New activities suitable for the applicant company's business and scale are highly respected.

Non-profit organizations should read "companies" as "institutions" or "organizations."

The Deming Prize and Development of Quality Control/Management in Japan

The Deming prize, especially the Deming Application Prize that is given to companies, has exerted an immeasurable influence directly or indirectly on the development of quality control/management in Japan.

Applicant companies and divisions of companies sought after new approaches to quality management that met the needs of their business environment and challenged for the Deming

prize. Those organizations developed effective quality management methods, established the structures for implementation and put the methods into practice.

Commonly, those who have challenged for the Prize share the feeling that they have had a valuable experience and that the management principle of achieving a business success through quality improvement has really worked. Through witnessing the success of these organizations, many other companies have been inspired to begin their own quest for quality management. Learning from those who went before them, the new practitioners are convinced that quality management is an important key to their business success and that the challenge to attain the Prize can provide an excellent opportunity to learn useful quality methodologies. Thus, quality management has spread to many organizations, its methods have evolved over the years and the methods contributed to the advancement of these organizations' improvement activities.

This mechanism that encourages each organization's self-development comes from the examination process of the Deming Prize, though the very process has invited some criticism that the marking criteria for the Deming Application Prize is unclear. To make the examination process more transparent and to communicate the intentions of the Deming prize more clearly, the evaluation criteria and the judgment criteria for passing are now presented.

However, the Committee's basic stance on the examination criteria remains unchanged. Namely, the criteria should reflect each applicant organization's circumstance.

The Deming Prize examination does not require applicants to conform to a model provided by the Deming Prize Committee. Rather, the applicants are expected to understand their current situation, establish their own themes and objectives and improve and transform themselves company-wide. Not only the results achieved and the processes used but also the effectiveness expected in the future are subjects for the examination. To the best of their abilities, the examiners evaluate whether or not the themes established by the applicants were commensurate to their situation. Whether or not their activities were suitable to their circumstance and whether or not their activities are likely to achieve their higher objectives in the future.

The Deming Prize Committee views the examination process as an opportunity for "mutual-development" rather than "examination." While in realty the applicants still receive the examination by a third party, the examiners' approach to evaluation and judgment is comprehensive. Every factor such as the applicants' attitude toward executing Total Quality Management (TQM), their implementation status and the resulting effects are taken into overall consideration. In other words, the Deming Prize Committee does not specify what issues the applicants should address, rather the applicants themselves are responsible for identifying and addressing such issues, thus, this process allows quality methodologies to be further developed.

Total Quality Control (TQC) that had been developed in Japan as discussed above was re-imported to the United States in the 1980s and contributed to the revitalization of its industries.

While the term TQC had been used in Japan, it was translated as TQM in western nations. To follow an internationally accepted practice, Japan changed the name from TQC to TQM.

There is no easy success at this time of constant change. No organization can expect to build excellent quality and management systems just by solving problems given by others. They need to think on their own, set lofty goals and drive themselves to challenge for achieving those goals. For these companies that introduce and implement TQM in this manner, the Deming Application Prize aims to be used as a tool for improving and transforming their business management.

Structure and Roles of the Deming Prize Committee:

The Deming Prize Committee conducts the examination and awards the Deming Prize. It is customary that the chairman of the Foundation of Economic Organizations assumes office as the chairman of the committee. The committee members are consisted of TQM experts from industries and academia. The Deming Prize Committee utilizes five subcommittees to carry out the Deming Prize examination and discuss related matters.

The Total Adjustment Subcommittee	Coordinates Deming Prize-related activities, widely listens to input on how to improve the examination and award process and reports its recommendations to the Committee.
The System Amendment Subcommittee	Reviews the systems and regulations regarding the Deming Prize and proposes necessary revisions to the Committee.
The Deming Prize for Individuals Subcommittee	Examines and selects the candidates for the Deming Prize for Individuals.
The Deming Application Prize Subcommittee	Examines and selects the candidates for the Japan Quality Medal, the Deming Application Prize and the Quality Control Award for Operations Business Units. Also, conducts the TQM Diagnosis by Deming Prize Committee Members.
The Nikkei QC Literature Prize Subcommittee	Examines and selects the candidates for the Nikkei QC Literature Prize.

Deming Prize for Individuals

What is the Deming Prize for Individuals?

The Deming Prize for Individuals is an annual award given to one of the following:

Individuals who have made outstanding contributions to the study of TQM or statistical methods used for TQM

Individuals who have made outstanding contributions in the dissemination of TQM.

To apply for the Deming Prize for Individuals, recommendation from the members of the Deming Prize Committee will be necessary.

An individual who fulfils the above (1) or (2) may apply for the prize regardless of nationality. However, those whose activities are limited to outside Japan are not eligible for application.

Deming Application Prize

What is the Deming Application Prize?

The Deming Application Prize is an annual award presented to a company that has achieved distinctive performance improvements through the application of TQM. Regardless of the types of industries, any organization can apply for the Prize, be it public or private, large or small, or domestic or overseas. Provided that a division of a company manages its business autonomously, the division may apply for the Prize separately from the company.

There is no limit to the number of potential recipients of the Prize each year. All organizations that score the passing points or higher upon examination will be awarded the Deming Application Prize.

Companies Qualified for Receiving the Prize

The Deming Application Prize is given to applicant companies or divisions of companies (applicant companies hereafter) that effectively practice TQM suitable to their management principles, industry, business and scope. More specifically, the following evaluation criteria are used for the examination to determine whether or not the applicant companies should be awarded the prize:

Reflecting their management principles, industry, business, scope and business environment, the applicants have established challenging and customer-oriented business objectives and strategies under their clear management leadership.

TQM has been implemented properly to achieve business objectives and strategies as mentioned item 1) above.

As an outcome of item 2), outstanding results have been obtained for business objectives and strategies as stated in item 1).

Quality Stabilization and Improvement

By disseminating the concept of quality and the concept of controlling/managing business activities throughout the organization, companies have improved their day-to-day operations. At the same time, statistical quality control methods have been utilized and a quality assurance system has been established. These activities together with an enhanced quality consciousness have allowed companies to provide customers with quality products and services that are matched with customer requirements and company policies and that have been properly planned, developed, designed, produced and installed.

As a result, there have been reductions in development and design troubles, parts defects, production defects, installation defects, service defects and market claims and complaints. Expected product and service quality has been achieved and it has become possible to provide products and services with attractive quality that positively satisfy customers. Results also include improved reliability, safety and quality that meet society's needs. Due in part to these improvements, many companies has acquired a world-class reputation.

These quality improvements not only please customers but also bring about positive economic results, as listed in items (2), (3) and (4) and improve the company's organizational constitution, as described in items (4) through (10).

(2) Productivity Improvement/Cost Reduction

Significant effects have been achieved as a result of the following improvements:

Reduced development and design troubles during the new product development stage
Decreased parts defects or reduced process troubles due to the spread of TQM promotion with vendors
Lower manufacturing defects and reduction of rework and adjustment work at the manufacturing stage
Reduced installation defects at construction companies
Increased customer satisfaction in service industry companies

Furthermore, through a systematic approach to cost reduction during new product development, competitive cost targets have been achieved. Activities to improve production control systems and reduce man-hour have also enhanced productivity.

(3) Expanded Sales

Through a systematic approach to satisfying customers' requirements, or to developing competitive new products in anticipation of customers' potential requirements, Deming Prize-winning companies have achieved improved customer satisfaction and as a result have been able to expand their sales. Furthermore, they have strengthened their management system for the initial distribution of new products and have deployed TQM into their sales activities.

These efforts have contributed to capturing new customers or markets and to preventing out-of-stock problem situations, both of which have resulted in increased sales.

(4) Increased Profits

Item (3)-- expanded sales and item (2)-- improved productivity/reduced cost work together to increase profits. To promote TQM, of course, some expenses are inevitable, such as education and training, payroll for TQM promotion staff and other activities and events. However, based on the improved business performance companies have achieved by implementing TQM, it is clear that TQM is highly cost-effective.

(5) Thorough Implementation of Management Plans/Business Plans

To secure profits, it is important to implement management plans/business plans that center on profit plans. Naturally, quality control/management should be carried out in concordance with these plans. To logically establish policies and objectives, it is necessary first to understand and analyze historical business performance. Then, to efficiently achieve these policies and objectives, it is necessary to deploy them, implement them and evaluate the results achieved. As a concrete means to do this, Policy Management, one of the TQM management methods, has been widely introduced and promoted. Through systematic approaches like Policy Management, many companies have been efficiently achieving their management plans/business plans.

(6) Realization of Top Management's Dreams

To a greater or a lesser extent, a company has its traditions, organizational cultures, customary business practices, the way of thinking, complex human relations etc. These factors, quite often, make it difficult for top management to communicate and carry out what it intends to implement in the organization. However, by establishing the high goal of winning the Deming Prize and by promoting TQM with an examination date in mind, many companies are able to improve their organizational constitution. Top management at these companies often pleasantly states, "We were able to achieve at once many things we had wanted to accomplish for years."

As quality control/management is disseminated throughout the entire company and as top management's policies are promptly communicated to all levels of the company and achieved, plant managers, department heads, section chiefs as well as supervisors improve their understanding of business management. Moreover, their solidarity is strengthened and thus it becomes possible to develop the next generation of executives and managers. Some top managers have commented, “I have been president for a long time and achieving my policies has never gone this well.”

TQM by Total Participation and Improvement of the Organizational Constitution

During the process leading up to the Deming Prize examination, the company as a whole focused on improving product and service quality, and the organizational constitution was strengthened. These efforts have contributed to breaking down sectionalism, improving interdepartmental communications, removing barriers between departments and instilling a sense of unity. Every employee has learned to see things from the viewpoint of the entire company and has become more confident in his/her job.

Some presidents say, "Through challenging for the Deming Prize, we became convinced that it is possible for our company to accomplish anything when all our employees cooperate. We have become much better at interdepartmental communications and cross-functional management."

Heightened Motivation to Manage and Improve as well as to Promote Standardization

Some companies commented, "Each employee has improved his/her understanding of scientific management and ability to objectively understand the work situation. Employees have enhanced their ability to think on their own and, thus, they have become more capable of coming up with improvement ideas. For example, the number of suggestions per employee has dramatically increased." Others are happy to say, "We can promote standardization that produces good results, not just standardization for its own sake, an effort that has greatly contributed to the establishment of standards that are alive and in use throughout the company."

Uniting Total Organizational Power and Enhancing Morale

In recent years, QC Circle activities have captured worldwide attention. QC Circles are not just for a morale-boosting movement. In companies that have active QC Circles, first-line supervisors and employees have acquired simple managerial and analytical skills, have become more interested in their own work and have acquired the ability to autonomously manage and improve their day-to-day tasks in a logical manner. Obviously, when the efforts of each and every employee are combined, a company can expect to generate enormous powers. Employees enjoy coming to work and therefore attendance rates improve. The company's further development is accelerated, a foundation for better labor-management relationships is laid, morale is improved and a contribution is made to optimizing the competence of every employee. When this occurs, staff group roles become much clearer and thus staff is able to concentrate its energy on bigger and more meaningful improvement projects.

Establishment of various Management Systems and the Total Management System

As discussed in the preceding sections, when scientific management activities through TQM penetrate the entire company, the company's organizational constitution is genuinely

improved. Quality assurance and other management systems for new product development, profit, cost and vendor relations are established along with many other cross-functional management systems. All these different systems then become connected through the total management system. Moreover, standards for every individual's action in the company become clarified, as are the lines of authority and responsibility. Thus, the organization improves its overall efficiency and effectiveness.

These great results, achieved by the Deming Prize-winning companies, would have been difficult to achieve without challenging for the prize. Therefore, we would like to extend our invitation to your company to apply for the Deming Application Prize with courage, enthusiasm and a conviction plan as part of your pursuit for organizational constitution improvement.

Some of tangible and intangible benefits we achieved through TQM are as follows:

Improved customer satisfaction

Improved new product development process

Improved customer quality

Supplier satisfaction

Employee/family fulfillment

Excellent industrial relations

Change in organizational culture - high ownership among employees for improving organizational performance

Breakthrough achievements in business results

Satisfied local society

We decided to challenge the Deming Prize to encourage our employees to achieve higher standards and also to motivate them.

After successfully winning the Deming Prize in 1998, we continue to improve our performance viz. 100% employee participation in Quality Control Circles consecutively for the last two years and 100% participation in Suggestion (Teian) scheme during the last year. We have been certified for QS9000 quality systems in August 2000 and ISO14001 environmental management systems in August 2001.

Deming Prize is not our destination and we believe that it is only a ticket for TQM journey toward organizational excellence. We have embarked further improvement in our performance as follows:

Improvement in product quality
Improving productivity

Reducing cost through achieving 100 ppm quality
Implementing lean manufacturing systems and Total Productive Maintenance (TPM)

TQM Diagnosis by the Deming Prize Committee

It is recommended for preparing for the Deming prize challenge or grasping the level of TQM.

What is the TQM diagnosis?

It is useful to have a third party objectively diagnose the implementation status of TQM and provide recommendations so that the company can better understand where it stands and what it has to do to promote TQM more effectively.

The TQM diagnosis was established in 1971. It is provided by the Deming Application Prize Subcommittee upon request of a company. Its aim is to contribute to the further development of that company's TQM.

The TQM diagnosis is not a preliminary Deming Application Prize examination. A company that receives the TQM Diagnosis cannot apply for the Deming Application Prize examination that same year. Furthermore, whether or not a company has received the QC diagnosis has no influence or bearing whatsoever on the results of the Deming Prize examination.

TQM Diagnosis Procedures

The purpose of the TQM diagnosis is to further advance the promotion and practice of effective TQM in companies under diagnosis. The TQM diagnosis and resulting guidance is provided from an objective viewpoint to companies at varying stages of TQM advancement as indicated below. The companies that wish to receive the TQM diagnosis should complete and submit the application form with necessary documents at least three months prior to the desired diagnosis dates. (The application form is provided at the end of this booklet.) However, no diagnosis will be conducted during the Deming Prize examination period (early July to mid-October).

For companies at the introductory and promotional stages-- Diagnose the status of TQM and provide recommendations.

For companies that wish to effectively use the Deming Application Prize criteria to promote TQM-- Diagnose the status of TQM and provide recommendations in view of the criteria.

For companies that wish to receive the Diagnosis in lieu of the on-site review three years after receiving the Japan Quality Medal or the Deming Application Prize-- Diagnose the status of TQM and provide recommendations.

The Deming Application Prize Subcommittee conducts the TQM diagnosis. While the details of the diagnosis program will be determined in consultation with the company, the methods and

documents used for the diagnosis follow those for the Deming Application Prize. As a rule, the diagnosis will be based on the company's presentations, the on-site examination, the document review and questions and answers. The results of the diagnosis will be communicated through a report on the diagnosis findings after the findings of all the examiners who conducted the diagnosis have been compiled. Those companies that wish to receive the TQM diagnosis should contact the JUSE Secretariat for the Deming Prize Committee.

Conclusion

There is no examination fee for the Deming Application Prize and the QC Award for Operations Business Units. However, the applicant company is expected to carry the expenses associated with the on-site examination, such as travel and hotel accommodations for the examiners as well as production cost of the report on examination findings and the summary report of the prizewinners' TQM practices for the report meeting.

As for the TQM diagnosis, fees for the diagnosis as well as expenses for travel and hotel accommodations, production cost for the diagnosis report and administration costs will be charged to the company.

Companies that wish to apply for the Deming Application Prize are encouraged to read the Guide for the Deming Prize Application or the JUSE Home Page.

For clarification, please contact the Deming Prize Committee.

Performance Measures-- MBNQA

Introduction



The Malcolm Baldrige National Quality Award (MBNQA) is an annual award to recognize U.S. organizations for performance excellence. Public Law 100-107 created it on August 20, 1987. The award promotes understanding of the requirements for performance excellence and competitiveness improvement, sharing of information on successful performance strategies and the benefits derived from using these strategies.

There are five categories which are as follows:

Manufacturing
Service
Small business
Health care
Education

Three awards may be given each year in each category. Competition for the awards is intense. Interestingly, many organizations that are not interested in the award are nevertheless using the categories as a technique to measure their TQM effort on an annual assessment basis.

Criteria for Performance Excellence

The criteria for performance excellence are the basis for making awards and for giving feedback to applicants. In addition, they perform the following functions:

Help improve performance practices and capabilities
Facilitate communication and sharing of best practices information among US organizations of all types
Serve as a working tool for understanding and managing performance, planning, training and assessment

The results-oriented goals are designed to deliver ever-improving value to customers, resulting in marketplace success and to improve overall organization performance and capability.

The core values and concepts are embodied in seven categories. (Refer to figure 20.1) The seven categories shown in the figure are subdivided into 20 examination items. Each examination item

consists of sets of areas to address. Applicants submit information in response to specific requirements of these areas.

Key Characteristics of the Criteria

The Criteria are directed toward Results

They focus principally on seven key areas of business performance. Results are a composite of the following:

Customer satisfaction/retention
Market share, new market development
Product and service quality
Productivity, operational effectiveness and responsiveness
Human resource performance/development
Supplier performance/development
Public responsibility/corporate citizenship

Baldrige Criteria for Performance Excellence Framework
A Systems Perspective

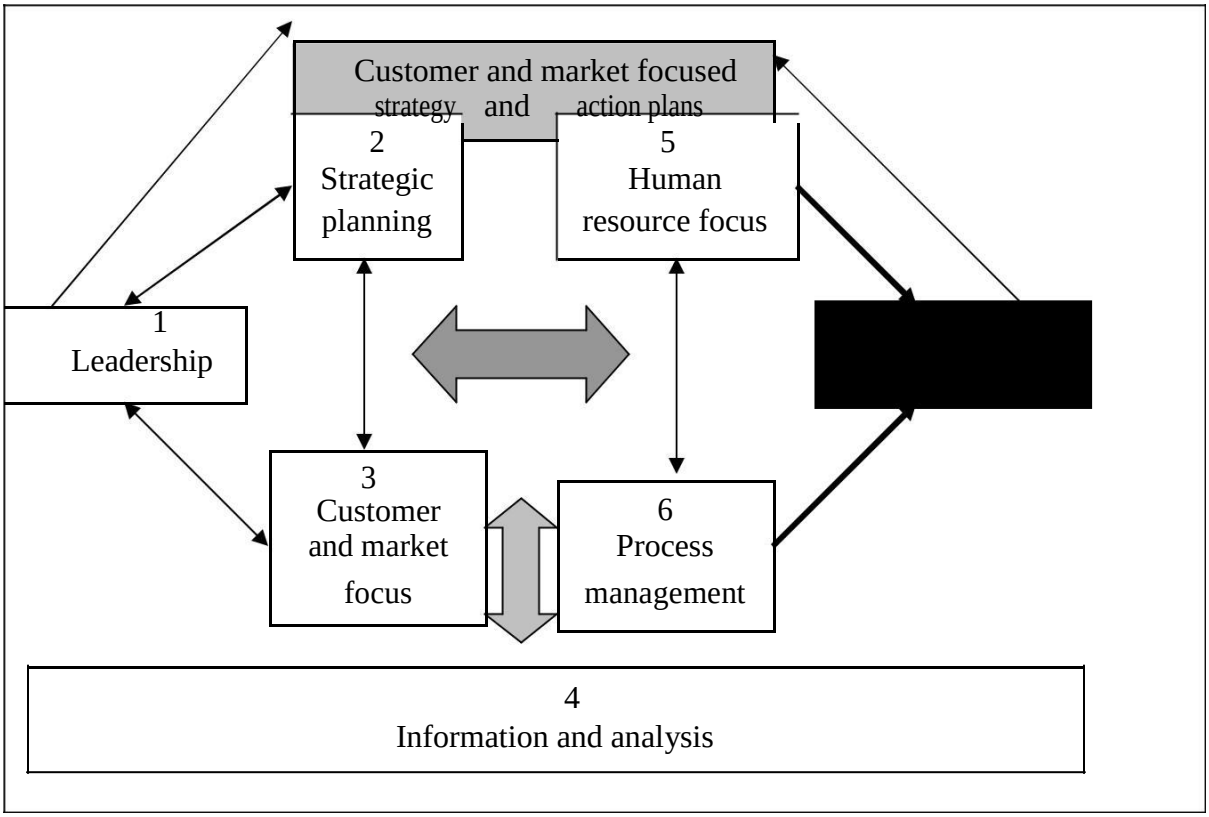


Fig 20.1-- Award criteria framework

Improvements in these seven areas contribute significantly to organization performance including financial performance. The results also recognize the importance of suppliers, the needs of communities and the needs of the nation.

The Criteria are Non-Prescriptive and Adaptable

The focus is on results, not on procedures or tools. Organizations are encouraged to develop and demonstrate creative, adaptive and flexible approaches meeting basic requirements. Non-prescriptive requirements are intended to foster incremental and major "breakthrough" improvement.

Selection of tools, techniques and systems usually depends upon factors as business type and size, the organization's stage of development and employee capabilities and responsibilities.

The focus is on common requirements within an organization rather than on specific procedures that foster better understanding, communication and alignment while supporting diversity and creativity in approaches.

The Criteria Support in a Systems Approach is to maintain the Organizations Goal Alignment

A systems approach to goal alignment, particularly when strategy and goal change over time, requires dynamic linkages among criteria items. In the criteria, action oriented learning takes place using feedback between processes and results through cycles of learning.

The Criteria Support Goal-Based Diagnosis

The criteria and the scoring guidelines make up a two-part diagnostic (assessment) system. The criteria are a set of 20 performance-oriented requirements. The scoring guidelines indicate the assessment dimensions- approach, deployment and results and the key factors used to assess against each dimension. An assessment thus provides a profile of strengths and opportunities for improvement relative to the 20 basic requirements. In this way, assessment leads to actions, which contribute to the results composite previously described. This diagnostic assessment is thus a useful management tool that goes beyond most performance reviews and is applicable to a wide range of strategies and management systems.

Criteria for Performance Excellence

Table 20.1 shows the seven award categories and the 20 items with their point values. It is important to note that almost half of the total score is based on results.

The Leadership Category

The Leadership category examines the company's leadership system and senior leaders' personal leadership. It examines how senior leaders and the leadership system address values, company directions, performance expectations, a focus on customers and other stakeholders, learning and innovation. Also examined is how the company addresses its societal responsibilities and provides support to key communities.

The Strategic Planning

The strategic planning category examines how the company sets strategic directions and how it develops the critical strategies and action plans to support the directions. Also examined are how plans are deployed and how performance is tracked.

The Customer and Market Focus

The customer and market focus category examines how the company determines requirements, expectations and preferences of customers and markets. Also examined is how the company builds relationships with customers and determines their satisfaction.

The Information and Analysis

The information and analysis category examines the selection, management and effectiveness of use of information and data to support key company processes and action plans and the company's performance management system.

The Human Resource Focus

The human resource focus category examines how the company enables employees to develop and utilize their full potential, aligned with the company's objectives. Also examined are the company's efforts to build and maintain a work environment and work climate conducive to performance excellence, full participation and personal and organizational growth.

The Process Management

The process management category examines the key aspects of process management, including customer-focused design, product and service delivery, support, and supplier and partnering processes involving all work units. The category examines how key processes are designed, implemented, managed and improved to achieve better performance.

The Business Results

The business results category examines the company's performance and improvement in the following key business areas:

Customer satisfaction
Financial and marketplace performance
Human resource results
Supplier and partner performance
Operational performance
Performance levels relative to competitors

Scoring System

The system for scoring applicant responses is based on three evaluation dimensions

Approach
Deployment
Results

Approach

Approach refers to how the applicant addresses the item requirements. The factors used to evaluate approaches include:

Appropriateness of the methods to the requirements
Effective use of the methods
Degree to which the approach is systematic, integrated and consistently applied
Embodies effective evaluation/improvement /learning cycles
Based on reliable information and data
Evidence of innovative and/or significant and effective adaptations of approaches used in other applications of types of businesses

Deployment

Deployment refers to the extent to which the applicant's approach is applied to all requirements of the item. The factors used to evaluate deployment include:

Use of the approach in addressing business and item requirements
Use of the approach by all appropriate work units

Results

Results refer to outcomes in achieving the purposes given in the item. The factors used to evaluate results include:

Current performance

Performance relative to appropriate comparisons and/or benchmarks
Rate, breadth and importance of performance improvements
Demonstration of sustained improvement and/or sustained high-level performance
Linkage of results measures to key performance measures identified in the business overview and in approach/deployment items

Use of the scoring system requires considerable training. Examiners receive more than three days of training, with most of the time devoted to the scoring system. A simpler system is given by the

sample self -evaluation, which is shown in the next section. This approach would be more appropriate for small and medium-sized organizations.

Comments

The MBNQA provides a plan to keep improving all operations continuously and a system to measure these improvements accurately. Benchmarks are used to compare the organization's performance with the world's best and to establish stretch goals. A close partnership with suppliers and customers that feeds improvements back into the operation is required. There is a long-lasting relationship with customers, so that their wants are translated into products and services that go beyond delivery. Management from top to bottom is committed to improving quality. Preventing mistakes and looking for improvement opportunities is built into the culture. There is a major investment in human resources by means of training, motivation and empowerment.

According to Dr. J. M. Juran, who studied the winners of the award, the gains have been stunning. The gains can be accomplished by large and small US organizations and by US workers. The gains include quality, productivity and cycle time.

Questions

Who was Malcolm Baldrige?
What is the Malcolm Baldrige National Quality Award?
Why was the award established?
How is the Baldrige Award achieving its goals?
What are the Baldrige criteria?
Which organizations have received the award?
When were the education and health care categories established?
Why are categories in education and health care needed?
How are recipients selected?
Is it tougher for small organizations to receive the award?
Can only U.S. organizations receive the award?
Do the award criteria take into account an organization’s financial performance?
Does the award amount to a product or service endorsement for the award recipients?
Why are the Baldrige Award recipients asked to share their successful strategies?
Are organizations simply chasing after the award and ignoring the lessons of performance improvement?

MODULE 4

Juran-I

Introduction

Dr. Joseph M. Juran's Vision

A national centre for research in quality should:

Provide an academic home for the field of quality
Deepen and clarify the basic disciplines of quality
Extend quality principles into non-business segments in America (e.g. education, government, the environment, healthcare)
Develop the world's leading quality scholars

This will be a place where leaders engage with scholars to shape critical questions, where new knowledge is developed, translated and disseminated and above all where quality scholars are trained. It is my hope that, generations from now, historians will note that we helped create the "century of quality."

Quality Field

While the research domain associated with "quality" is continually evolving, an emerging consensus includes universal concepts such as:

Continuous Improvement and Learning

Continuous improvement and learning refers to both incremental and "breakthrough" improvement. It applies to both the individual and organizational levels. Improvement and learning can be directed toward better products and services, better processes and to being more responsive, adaptive and efficient.

Involvement of People

Whether in healthcare, business, education, research, or any other endeavor, quality improvement relies on individuals and teams to carry it out. Organizations depend increasingly on the knowledge, skills, innovation and motivation of their employees. Their contributions should be integrated and aligned with the organization's strategy.

Decisions Based on Facts

Improvement within organizations relies upon using data and information to support evaluation and decision-making. Trends, projections, cause-and-effect etc. may not be evident without analysis.

Systems Approach

The most important problems of a business, an enterprise and society have systemic, deeply rooted and multiple causes. Coherence of understanding requires a systems view. All elements of that system should be aligned in a same direction to achieve true breakthroughs in quality.

Long-Range View of the Future

Ideas, products, services, processes and relationships suffer when long-term consistency of purpose is sacrificed to expediency. New opportunities, changing expectations and evolving stakeholder requirements should be considered by an organization. Short-term plans, strategies and resource allocations need to reflect these long-term influences.

Prevention Orientation

In medicine, law, government and business, the search for quality relies upon the idea that problems can be prevented. It is often less costly to prevent a problem than to correct it "downstream." Accordingly, organizations need to emphasize opportunities for interventions "upstream" at early stages in a process.

Fast Response

A focus on timeliness tends to reduce steps of a process and costs within an organization. Quality products and services introduce convenience to and remove delay from our lives. Time improvements often drive improvements in overall organization, cost, quality and productivity.

External Focus

Students, customers, readers, patients, clients and citizens are some of the groups out of which one becomes the primary recipient of a product or service. It is that group upon whom one should focus. As Peter Drucker said, "The purpose of an organization lies outside itself." A focus on external stakeholders can influence an organization's success because it often increases this group's satisfaction and loyalty.

Results Orientation

Balanced and integrated results affecting all stakeholders are the hallmark of a quality enterprise. This will help ensure that an organization's actions meet different stakeholders' needs and avoid

adverse impact on any group. Results also offer a way to communicate short and long-term priorities, monitor performance and marshal support for improvement.

10. Ethics and Responsibility

Quality organizations and individuals see themselves as part of a larger whole which should be respected. Leadership includes influencing other organizations, private and public, to support the causes which it believes, such as improved education, resource conservation, community service, or crime reduction.

11. Waste Reduction

Time and materials are wasted extravagantly in many fields. Reducing waste can improve quality and increase general abundance of time and materials in an organization.

Key Contributions

Following are the key contribution of Juran:

Top management involvement
Pareto principle
Training in quality management
Definition of quality as fitness for use
Project-by-project approach
Authored a standard reference-- *Quality Control Handbook*
Influenced Japanese managers

The Juran Trilogy Diagram

Juran developed the quality trilogy-- quality planning, quality control and quality improvement. These three processes of the Juran trilogy are interrelated. The Juran trilogy diagram is a graph with time on the horizontal axis and cost of poor quality on the vertical axis (refer to figure 4.1).

The initial activity is quality planning. The planners identify the customers and their needs. The, they develop product and process designs to respond to those needs. Finally, the planners turn the plans over to the operating forces, “You run the process, produce the product features and meet the customers’ needs.”

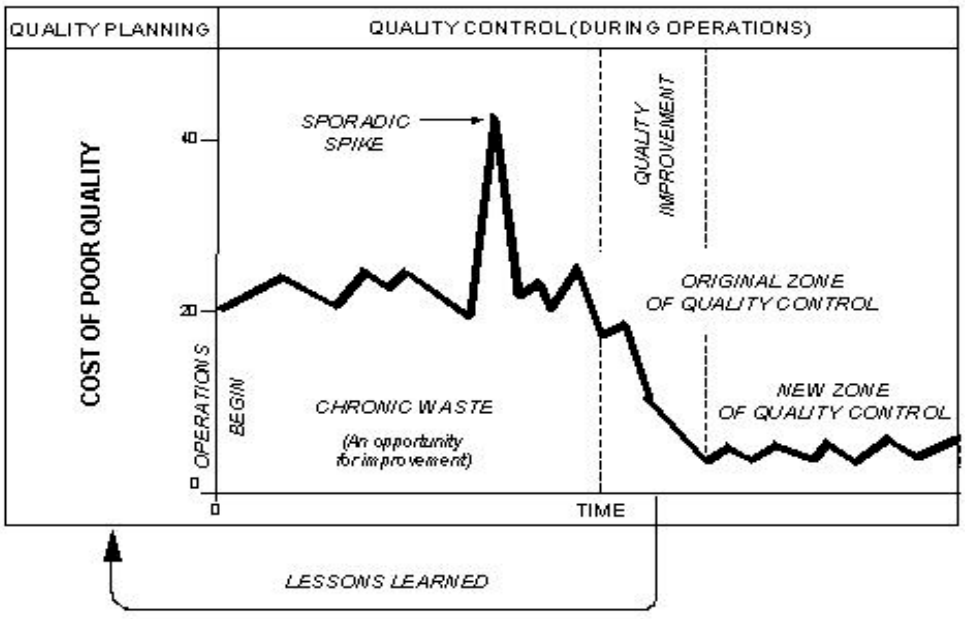


Figure 4.1-- The Juran trilogy diagram

Chronic and Sporadic

As operations proceed, it soon emerges that the process is unable to produce 100 percent good work. Figure 4.1 shows that over 20 percent of the work usually has to be redone due to quality deficiencies. This waste is chronic as it goes on and on.

The reason of this chronic waste is the wrong planning of operating process. Under conventional responsibility patterns, the operating forces are unable to get rid of this planned chronic waste. What they can do is to carry out quality control, i.e. to prevent things from getting worse. Figure 4.1 also shows a sudden sporadic spike that has raised the defect level to over 40 percent. This spike might be resulted from some unplanned event such as a power failure, process breakdown, or human error. As a part of their job of quality control, the operating forces converge on the scene and take action to restore the status quo. This is often called "corrective action," "troubleshooting," "putting out the fire" and so on. The end result is to restore the error level back to the planned chronic level of about 20 percent.

The figure also shows that, in due course, the chronic waste was driven down to a level far below the original level. This gain came from the third process in the trilogy--quality improvement. In effect, it was seen that the chronic waste was an opportunity for improvement and steps were taken to make that improvement.

The Trilogy Diagram and Product Deficiencies

The trilogy diagram relates to product deficiencies. The vertical scale exhibits units of measure such as cost of poor quality, error rate, percent defective, service rate and so on. On this same scale, perfection is at zero and what goes up is bad. The results of reducing deficiencies are reduction of the cost of poor quality, meeting more delivery promises, reduction of customer dissatisfaction and so on.

The Trilogy Diagram and Product Features

When the trilogy diagram is applied to product features, the vertical scale changes. Now, the scale may exhibit units of measure, such as millions of instructions per second, mean time between failures, percent on-time deliveries and so on. For such diagrams, what goes up is good and a logical, generic vertical scale is "product salability."

An Honored Theorist

The Union of Japanese Scientists and Engineers invited Dr. Juran to Japan to teach them the principles of quality management as they rebuilt their economy. Along with W. Edwards Deming, his more colorful and perhaps better-known American colleague, Juran received Second Order of the Sacred Treasure award from Emperor Hirohito of Japan. Dr. Juran published his lectures from Japan in his book *Managerial Breakthrough* in 1964.

In 1979, Juran founded "The Juran Institute" to better facilitate broader exposure of his ideas. The Juran Institute is today one of the leading quality management consultancies in the world and it produces books, workbooks, videos and other materials to support the wide use of Dr. Juran's methods. The institute and the consulting practice continue to thrive today. Dr. Juran worked to promote quality management into his 90's and only recently retired from his semi-public life. One can get the papers, lectures and tapes of Dr. Juran from The Juran Institute or other quality management educational providers. The Juran Foundation continues his work by exploring the social and industrial implications of quality improvement while making his and others' valuable contributions more accessible.

Juran-II

Learning Objective

To learn how to apply quality trilogy, i.e. quality planning, quality improvement, quality control for total quality management

Juran's Message

"Intrinsic is the belief that quality does not happen by accident, it must be Planned!" Quality should have a structured approach toward company-wide quality management.

Quality Management

The need to improve business results by improving quality of products, services and processes is driven by macro-economic events and customers' demands for better products and services at the lowest possible costs. The tools and techniques to achieve a greater level of quality in the past may not be enough for today. The changing needs of society, customers, shareholders and regulators are some of the reasons an organization should continually improve and breakthrough to new levels.

If you cannot answer "yes" to all of the following questions, you may need to review your improvement initiatives:

Do you have 100% loyal customers and no dissatisfaction?
Do your processes provide consistent service delivery and little rework?
Does you organization lead the competition in quality (high sigma) in marketplace?
Are you able to create new and successful products meeting customers' needs and shareholders' expectations?

Juran Institute's methodologies, related training and consulting services are based on the proven and globally accepted Juran Trilogy®. The trilogy provides a model of how an organization can improve its bottom line by better understanding the relationship between processes that plan, control and improve quality and hence business results. Dr. Juran created this model in the 1950s. It defines managing for quality as three basic quality-oriented, interrelated processes.

Quality Planning

It is the process for designing products, services and processes to meet new breakthrough goals.

Quality Control

It is the process for meeting goals during operations.

Quality Improvement

It is the process for creating breakthroughs to unprecedented levels of performance.

These three aspects of company-wide strategic quality planning are further broken down in Juran's "quality planning road map" into following key elements:

Quality Planning	• Identify who are the customers • Determine the needs of those customers • Translate those needs into your language • Develop a product that can respond to those needs • Optimize the product features so as to meet yours as well as customers' needs
Quality Improvement	• Develop a process which is able to produce the product • Optimize the process
Quality Control	• Prove that the process can produce the product under operating conditions with minimal inspection • Transfer the process to "operations"

The key elements in implementing company-wide strategic quality planning are as follows:

Identifying customers and their needs
Establishing optimal quality goals
Creating measurements of quality
Planning processes capable of meeting quality goals under operating conditions
Producing continuing results in improved market share, premium prices and a reduction in error rates in the office

Quality planning comprises the following basic activities:

Identify the customers and their needs
Develop a product that responds to those needs
Develop a process able to produce that product

On a closure look, one can generalize a "road map for quality planning," i.e. an invariable sequence of steps. These steps are as follows:

Identify the customers

Determine the needs of those customers
Translate those needs into your language
Develop a product that can respond to those needs
Optimize the process
Prove that the process can produce the product under operating conditions
Transfer the process to operations

To carry out the road map, an organization should include the following elements:

The availability of internal experts such as "Six Sigma Belts" who become change agents and drivers and propel their organization to best in class
Just-in-time, project-by-project training in tools and techniques for all employees that enables learning to take place and makes optimal use of the tools required
Improved, customer-focused products, services and processes that produce a significant increase in customer satisfaction
Systematic application and deployment through proven methodologies like Six Sigma DMAIC and DFSS to meet more ambitious performance goals continually and provide a common language for an organization

Juran mission includes the following:

Creating an awareness of the role of quality planning due to the quality crisis in the 1980's and the need to revise the approach to quality planning

Establishing a new approach to quality planning and providing training regarding how to plan for quality with the help of this new approach

Assisting companies to replace existing processes throughout the company containing unacceptable quality deficiencies

Establishing mastery within companies over the quality planning process and utilizing this to plan for quality in ways to avoid the creation of chronic problems

Juran identifies the lesson as putting the emphasis on the results to be achieved, not on the campaign:

"The recipe for action should consist of 90% substance and 10% exhortation, not the reverse."

His formula for results is as follows:

Establish specific goals to be reached
Establish plan for reaching the goals
Assign clear responsibility for meeting the goals
Base the rewards on results achieved

Dr. Juran warns that there are no shortcuts to quality. He is skeptical of companies that rush into applying "quality circles" and believes that majority of the quality problems are the fault of poor management rather than poor workmanship.

In general, he believes that the management controllable defects account for over 80% of the quality problems. Further, he emphasize on the fact that the long-term training to improve quality should start from the top. These three universal processes are interrelated in ways one can depict in the Juran Triology.

Juran's 10 Points for Quality Improvement

Build Awareness of Need and Opportunity for Improvement

Realize that all processes are improvable

Taking an example of mistakes published in a newspaper the previous day, Juran say that they should:

Survey the staff, asking them why the mistakes were made
After a week, select the top ten reasons
Decide how to make sure those mistake-causing steps will not be repeated
Keep track of the number of mistakes being made to ensure they are decreasing

This is a beginning of a quality improvement program.

Set Goals for Improvement

Juran's formula for results is as follows:

Establish specific goals to be reached
Establish plans for reaching the goals
Assign clear responsibility for meeting the goals
Base the rewards on results achieved

Organize to Reach your Goals

Establish quality council
Identify problems
Select projects
Appoint teams
Designate facilitators

Provide Training

Any company that has been actively engaged in moving toward TQM in the past few years knows how important education and training are. The concepts, methods and tools for

modern quality management are new for most of the members of a company -- managers, professionals and workforce. The investment in education and training is high but the rewards are great.

5. Carry Out Projects to Solve Problems

Large improvements are usually the result of interdepartmental or even cross-functional quality improvement teams. These teams tackle the chronic problems that have been coming in the way of company progress for a long time. These are the vital few problems that create the breakthroughs in quality by reducing waste and improving customer satisfaction dramatically.

Report Progress

The important thing here is the progress expected and the actual progress achieved. Necessary actions to improve the status can be initiated to reduce the variance. Information on progress also provides management the confidence on the improvement activity and further support, if required.

Give Recognition

Recognition is a means of providing morale to both those involved in the improvement activity and all others in an organization. This is an important activity to be done by management as improvements provide a change for betterment resulting in savings to a company. At times, the improvements are made possible against lot of criticisms. Recognition rejuvenates the spirits and makes it possible for improvement in areas in other spheres.

Communicate Results

Lesson learnt during an improvement process requires to be shared to create an awareness of the approach taken and the possibility to learn and improve further. It also provides an outlook to people in other areas toward the basis for triggering similar improvements in their areas.

Keep Score

A company's goals are achieved step-by-step. Each step taken takes it nearer to the targeted goals. Further steps to be taken involve an action based on the result in the previous steps. Tracking a progress and measuring it provides management the leverage to control the process.

Maintain Momentum by Making Annual Improvement a Part of the Regular Process of a Company

Actions taken in the above steps involve people. Sustaining their involvement in an improvement activity is required to achieve long-term organizational goals and to remain competitive.

Juran's approach is very people-oriented and it places a strong emphasis upon teamwork and a project-based approach. By expanding the "quality planning roadmap," it can be seen that Juran's concepts are applied to design "quality systems" in Software Industry.

Further, Juran is credited with coining the phrase "fitness for purpose" and is, therefore, particularly influential when one comes to consider the use of quality management ideas in software development.

Big 'Q' Concept

In the recent past, Juran spoke about "Big Q" to emphasize that quality is not just the concern of production or even of total quality within an organization but extends further to the linkage between organizations and includes all service organizations and operations. Under Big Q, the concept of "customer" extends beyond those immediately involved with producing a product or service. It also includes stakeholders who have a legitimate concern, such as legislators and consumer groups. Juran states, "In many companies there is only a dim awareness that the scope of the customer has widened, so there is no longer a consensus on who is the customer."

Questions

Who were called as the "quality gurus?" How is Juran different from others?
Explain Juran's "quality trilogy?"
When should one review one's improvement initiatives?
Explain Juran's 10 points for quality improvement.

Crosby

P B Crosby

Philip B. Crosby is one of the American quality gurus who rose to international fame thanks to his teachings on quality management. Crosby has taught thousands of company executives and is best known in relation to the concepts of Zero Defects (ZD) and "Do it right first time." Crosby has written a number of books. Of these, *Quality is Free* is the most popular one, having sold over a million copies. His two other books are *Quality without Tears* and *The Art of Getting Your Own Sweet Way.*

He has spent the last thirty-eight years working in the quality arena. Fourteen of those years were in ITT where in one year, ITT saved $720 million using Crosby's own TQM program. He got his business education in quality as he came up through the ranks from inspector to tester to assistant foreman to junior engineer to section chief to manager to director and finally to corporate vice president. Today, he is the chairman of his own quality college and consultancy firm called Philip Crosby Associates (PCA) Inc. which he started in 1979 and is situated in Winter Park, Florida, USA.

He rightly ranks himself with Deming and Juran and writes:

We all believe that the problem of quality belongs to management. We all believe that prevention is the way to get it. And we are all impatient that everyone is not leaping into what we see as a sensible mature philosophy of doing things.

Dr. Deming has emphasized statistics over the years and has brought that approach to thousands of people. Dr. Juran is known for his engineering methods. If you do what they teach, you will do very well. They are dedicated people and worthy of respect.

Like Juran, Phil Crosby has been a prolific writer on quality. Unlike Juran, some of whose works contain much quantitative and statistical technique, Crosby concentrates on quality philosophy, particularly relating to management. Crosby's dynamic speaking style and stimulating writing style have gained him a large following.

Crosby is perhaps best known for his "four absolutes" of quality, his phrase "quality is free," his 14-point plan (different from Deming's 14 points) and his down to earth commonsense on a wide range of quality topics.

Crosby's Absolutes for Quality Management

First Absolute-- The Definition of Quality is Conformance to Requirements, not Goodness

This very specific definition of quality leaves very little open, which is probably what Crosby intends. According to him, once the requirements are specified, then quality is judged solely on the criteria of whether it is met or not. Aesthetics or feelings do not come into it. It is then the duty of management to specify those requirements very clearly to say what they want and this Crosby believes is one of the major failings of management. Of course, if management does not decide what is needed then by default, operators are going to have to make that decision for the company.

The definition of quality can never make any sense unless it is based on exactly what the customer wants. A product is a quality product only when it conforms to the customer's requirements. Of course, these requirements should be made known to the workforce, which should be provided with adequate tools to achieve them. Consequently, the management has the following three tasks to perform:

Establish the requirements to be met and communicate them to the employees
Provide the appropriate tools and techniques and the necessary training in them
Provide continuous support and encouragement

Second Absolute-- The System of Quality is Prevention

In other words, prevention is better than detection or appraisal. This is very much in line with the philosophy behind SPC-- understand the process, look at what can go wrong and take preventive actions before the process begins to deal with customers. The secret of success is to study the process and perform some sort of risk analysis, i.e. identify opportunities for error. Something can then be done so that the error is avoided. Contingency plans can also be drawn up so that if a problem materializes, the damage is controlled and restricted to the minimum possible.

A company which relies on mass inspection of the final output to improve quality is doomed to stagnation. The only prerequisite of prevention is an understanding of the process. Implementation of SPC can provide the understanding needed. One can then immediately know what to do to prevent rather than inspect, appraise or test.

Third Absolute-- The Performance Standard is Zero Defects

Here Crosby is stating that nothing less than perfect quality has to be the aim. Setting targets below 100 per cent is the start of a downward spiral. And error-free products are possible which has been proven by Japanese industry. It is not, therefore, unreasonable to expect a level of zero defects and the quality tools for achieving it do exist. For example, the technique advocated by Taguchi regards the mere satisfaction of specification limits as not good enough. This is because any deviation from the target, however small, causes a loss to society and will keep causing it until Zero Deviation (ZD) is accomplished.

It is important that a feeling of determination exists throughout the company to do things right first time, on time, every time. Determination coupled with a system of management that provides the communication needed and the tools for prevention can succeed in making zero defects a reality. However, it is important that the concept of ZD is not seen as a motivation program but only as a management performance standard, simply indicating that there is no room for imperfection, complacency or the attitude that "that's close enough!" Crosby admits that many managers misunderstood the concept of ZD and used it as a slogan, imposing an arbitrary target on the workforce. As Deming emphasizes, unless the right conditions are created and the techniques are provided to reach this target, such a treatment of this concept can only create anxiety, frustration and mistrust toward management.

Ofcourse, traditional quality management has taken zero defects to be non-economic and there should be a trade-off between prevention costs and failure costs. The Crosby view is now supported by a developing view that prevention costs, particularly where "total quality" is in place, do not necessarily rise massively as one approaches zero defects. But, in fact, these rise by no more than failure costs fall. In other words, zero defects may well be optimal from a cost point of view. But again, it comes back to getting the requirements right in the first place.

Fourth Absolute-- The Measurement of Quality is the Price of Non-Conformance

In order to attract the attention of senior management, quality has to be measured in financial terms. This is how quality can become a management function and not just a technical term that is measured for the cost consequences involved in doing things wrong (due to rejects, reworking, warranty costs etc.). These can very well represent 20-40% of the total operating costs. This is the Price of Non-Conformance (PONC) which is mainly the result of not doing things right first time.

Like Juran, Crosby believes in costing quality as a prime motivator for management. Crosby classifies costs into "PONC," the price of non-conformance (all the costs involved in not getting the product or service right) and "POC," the Price of Conformance (what it costs to do things right, prevention, detection etc.). Here, Crosby's famous phrase "quality is free" is appropriate. (It is also the title of one of his books.) As he says, "it's not a gift, but it's free." Or, in other words, if you put effort into improving quality, it will more than pay for itself through improved productivity, reduced rework and claims, and improved customer satisfaction.

When a rough calculation of the PONC is done initially, it can be so alarmingly high that it will surely prompt top management to do something about quality. What will become apparent is the need for professional quality functions, prevention efforts and quality education. The cost of these efforts is the price of conformance (POC)-- money well spent.

Crosby's Fourteen Steps for Quality Improvement

The quality improvement process is never-ending. To keep the momentum going, the appropriate culture and attitude about quality have to be embedded throughout the organization. Crosby has laid down fourteen steps to assist in the establishment of a quality ethic. The order is not too important, as most of the steps can run in parallel. However, it is evident that steps 1-6 have to be

made by management and should naturally come first.

Step 1-- Management Commitment

This step starts with a policy statement on quality and Crosby's suggested form of words for the policy is-- “Perform exactly like the requirement ... or cause the requirement to be officially changed to what we and our customers really need.” Such a short statement captures Crosby's definition of quality based on conformance. It avoids the elephant traps senior managers fall into in trying to frame a quality policy. These include the following:

Writing a treatise instead of a short statement
Allowing for non-conformance with an Accepted Quality Level (AQL) built into the policy
Indicative statements on how to deviate from the policy
A delegation of the responsibility for evaluating the policy away from the chief executive

Senior management has to demonstrate a commitment to quality. This is the only way to convince the workforce that management is not only serious about quality, but also prepared to be involved in the process. A corporate policy on quality should be issued. This needs to be clear and unambiguous. It should ideally be based on the important premise of defect -free delivery of products and services, on time. Quality should be the first item on the agenda of all management meetings and in all the activities that top managers are involved with. Management commitment should continuously be demonstrated and tested until it can be assumed.

Step 2-- The Quality Improvement Team

The next step is to set up quality improvement teams with representatives from each department. Before this can happen, the main messages of TQM have to reach everyone in the organization. Crosby has developed a ten question “true or false” test to measure employee/manager thinking on total quality. (Refer to table 7.1 below and the end of the lesson for Crosby's answers). Crosby considers these improvement teams to be part-time involvement for the members, but a full-time job for the chairperson. He/she has to be a manager who has the confidence of his or her staff and is a true believer in the need to improve quality and achieve zero defects and defect prevention.

As Crosby sees it, the responsibilities of the team members are the following:

To layout the entire quality improvement program
To represent their departments in the team
To represent the team to their departments
To carry out the decisions of the team within their own department
To make creative contributions to quality improvement

A team needs to be set up to guide the process of quality improvement. This team will require a definite direction and leadership and should have clear access to top management. The idea is not to use this team for corrective actions or firefighting. Its main initial tasks will include the following:

Change the attitudes and practices of those who run the company
Set up the educational activities required
Coordinate and support the whole effort

In short, the quality improvement team will be the group of people (ideally from management ranks) which will assist in the changing of the system to enable quality to flourish.

1. Quality is a measure of goodness of the product that can be defined in ranges such as fair, good and excellent. (True/False)
2. The economics of quality requires that management establish acceptable quality levels as performance standards. (True/False)
3. The cost of quality is the expense of doing things wrong. (True/False)
4. Inspection and test operations should report to manufacturing so that they can have the tools to do the jobs. (True/False)
5. Quality is the responsibility of the quality department. (True/False)
6. Worker attitudes are the primary cause of defects. (True/False)
7. I have trend charts that show me the rejection levels at every key operation. (True/False)
8. I have a list of my ten biggest quality problems. (True/False)
9. Zero defects is a worker motivation program. (True/False)
10. The biggest problem today is that the customer doesn't understand our problems. (True/False)

Table 7.1-- Crosby's "true or false" questionnaire to measure employee/manager thinking on total quality

Step 3-- Measurement

Set in place quality measurement to provide a display of current and potential nonconformance problems. The measurement should facilitate objective evaluation and corrective action. Most companies have already established a quality control department which measures reject rates. The task is to communicate the information in a way that is understandable and useful to employees using terms such as "defects per unit" or "percentage defective" and by displaying trend charts. Frequent defects should be classified as seriousness, cause and responsibility to prepare for corrective action.

To avoid frustration and hassle, one needs a clear method of measurement. Every part of any activity, its input, process work and output, lends itself to measurement. The type of measurement can be easily decided upon by the people associated with the particular activity. Once this decision is taken, a level of reference is created, reasonable targets can be set, progress can be monitored and comparisons can be made. There is no other way to communicate in definite terms.

Step 4-- The Cost of Quality

The next step is to determine the "cost of quality" and explain how to use it as a management tool. Calculating how much poor quality is costing the company can be beneficial in getting management's attention, in providing an incentive for improvement, in setting up priorities and in showing up trends. But Crosby himself admits that the whole concept of the cost of quality, if not handled properly, can be counterproductive and can actually cause more trouble rather than save money. This opinion is also shared by Deming who actually believes that the most important cost figures are incalculable anyway. Nevertheless, Crosby believes that quality costs need to be identified objectively, pulled together and fed into the regular management process formally and treated as a positive rather than a threatening item. Only then can the concept serve as a good stimulus for the quality improvement process itself.

Crosby's components of the overall cost of quality are as follows:

Scrap
Rework
Warranty
Service apart from regular maintenance
Inspection labor
Engineering changes
Purchase order changes
Software correction
Consumer affairs
Audit
Quality control labor
Test labor
Acceptable equipment costs
Other costs of doing things wrong

Crosby argues that the cost of quality should be no more than 2.5 percent of sales. The best way to reduce the cost of quality is through prevention.

Step 5-- Quality Awareness

An adequate system of communication is vital for a company. Through this, awareness about quality should spread throughout the organization and be adapted to the company's culture. People should be continuously reminded about the management commitment to quality, the associated policies and the training facilities on offer. Crosby is not against slogans or posters

about “Zero Defects” or “Do it right first time” as a reminder to the workforce of the importance of quality, something that Deming strongly disagrees with.

The quality awareness program is run by the improvement team with the help of professionals in public relations, personnel, quality etc. to raise the level of quality awareness and the personal concern for the company's quality reputation for all employees. The program should have a low-key start and be ongoing. The idea is to have a two-pronged approach using both the regular meetings between management and employees to discuss non-conformance problems and company-wide communications with posters, newsletters and special events.

Step 6-- Corrective Action

The main purpose of corrective action should be to prevent errors or to identify and eliminate causes of problems forever. Unfortunately, many companies regard corrective action as an activity composed of reworking, firefighting or replacement of the non-conforming item with a conforming one. But such an activity is always non-value-added. Corrective activities need to be based on the analyses of past data so that the causes of problems are determined and taken care of permanently.

Crosby recommends four levels of activities to attack the problems and to obliterate them. These are daily, weekly and monthly meetings between rising levels of managers focused on eliminating the critical main problems first. Corrective action is also initiated through task forces.

Step 7-- Zero Defects Planning

Proper planning is required for the concept of ZD to become properly embedded in the company culture. It will have to start with a ZD commitment on the part of top management. This is the only way that the concept will be taken seriously and recognized as a dignified ideal. Crosby offers the following seven suggestions to plan a zero defects program:

Get the message out through all supervisory people that there is going to be a zero defects approach.
Determine what materials are needed and secure them.
Choose a launch that has a good fit with your company culture.
Spell out the functions that will be accomplished.
Design some system of recognition for improved performance.
Set up a detailed time schedule for the program and rehearse people who will take part.
Identify the error-cause removal process and make plans to set it in motion.

The theme of zero defects is to do it right the first time. It is a performance standard. Crosby's enthusiasm for zero defects has led him to recommend that employees actually sign a zero defects pledge which is as follows:

“Most human error is caused by lack of attention rather than lack of knowledge. Lack of attention is created when we assume that error is inevitable. If we consider this condition

carefully and pledge ourselves to make a constant conscious effort to do our jobs right the first time, we will take a giant step toward eliminating the waste of rework, scrap and repair that increases costs and reduces individual opportunity. Success is a journey not a destination."

Step 8-- Employee Education

An investment in quality education can result in quantum leaps in improvement. A proper education system requires time and money, class work and assignments, explanatory videos and workshops, homework and team discussions in order to personalize the subject to the company concerned. Crosby summarizes the entire education process in what he calls "the six Cs:"

> Comprehension (understanding of what is necessary, abandonment of the old way of thinking and of outdated practices)
> Commitment (management-led dedication to cultural change)
> Competence (methodical and scientific implementation of the improvement process)
> Communication (complete cooperation throughout the production process, including suppliers and customers)
> Correction (elimination of all causes of problems and prevention of new ones arising)
> Continuance (never-ending effort for improvement)

It is necessary to train supervisors actively to carry out their part in the total quality improvement process. By supervisor, Crosby means all managers from the chairman on down the line. The training he offers starts with a six-hour blitz on quality awareness. It is followed by a specialized training session on zero defects scheduled about four weeks before zero defects day. The aim is to make the supervisors confident in the messages and able to explain the new systems such as the error -cause removal system. He recommends that a handbook be prepared by the company with the key messages in it. To show that he believes in the old axiom "repetition is the mother of learning," he recommends the entire training program be repeated.

Step 9-- Zero Defects Day

Another point of difference with Deming's teachings is the matter of zero defects day. Crosby recommends that a ZD day is planned to reward serious efforts. Also, it is celebrated at least annually with speakers representing senior management, the customers, the unions and even the city or region. This will then act as a reminder of the importance of quality and as a demonstration of the commitment toward the ZD principle. Deming opposes unsubstantiated ZD campaigns and exhortations as counterproductive. If a ZD day is part of a quality effort which lasts only for a single day, without being supported by any quality action in the rest of the year, it will only make the workforce question management's sincerity. It will also create a negative atmosphere of indifference.

This step is to create an event which will let all employees know through a personal experience that there has been a change. The idea here is to commit the company and its employees in public to the new deal and to show some style and celebration in doing so. He recommends a large open gathering and a bit of "show biz" to have fun as well as to demonstrate commitment to the total quality ideas from the top down.

Step 10-- Goal Setting

This involves goal setting and encouraging individuals and groups to set improvement goals. Goal setting is the immediate consequence of measurement. There is no point in measuring something unless there is a target to be met. When it comes to quality, the ultimate goal is that of zero defects and all intermediate goals should move in that direction. Of course, Deming would argue that arbitrary targets do not serve any purpose whatsoever.

Supervisors should lead the groups to set about two firm goals for each work area that are specific and measurable. These goals should not duplicate the scheduled improvement goals that flowed from the zero defects day. For example, to reduce defects per unit by 20 percent in one month, or to win the good housekeeping award next month.

Step 11-- Error-Cause Removal

This is to encourage employees to communicate to management the difficulties they have in achieving their improvement goals in the error-cause removal campaign. The permanent removal of the causes of error requires a team effort. Adequate means of communication will ensure the sharing of necessary information. This can help not only in the identification of the common sources of error and their permanent elimination but also in the prevention of the same problems arising in the future.

One of Crosby's suggestions here is to set up a suggestion box into which workers can pop a one-page error -cause removal form. He claims that 90 percent of these forms are acted on. In the forms, the employee need not know the answer, as in traditional suggestion boxes. The following are his suggested rules for such a scheme:

> Everyone who submits an error-cause removal form receives an immediate personal thank you note. The form is forwarded to the department that has the responsibility for the problem. A further acknowledgement is sent to whoever submitted the form once a decision is made about it.
> Every error-cause removal form is taken seriously.
> If someone decides to do nothing about an error-cause removal form, he or she should clear this decision with at least one but preferably two levels of supervision.

Step 12-- Recognition

This step is to recognize and appreciate all those who participate in the program. Crosby considers recognition as a necessary reference point and as a guideline to help the improvement efforts in the right direction. The recognition process needs to be planned carefully and developed gradually. It should not be rushed. When a “Beacon of Quality” is awarded to somebody who deserves it, it does not have to be in monetary terms. It can act as an incentive to others and an example to emulate.

Step 13-- Quality Council

All quality professionals can be brought together in one group under the name of the quality council. These will be the people who will define the mission, vision, values and policies necessary for managing the improvement process. They can learn from each other and their coordinated expertise can be more effective in supporting the quality improvement teams in their efforts toward the elimination of hassle and the achievement of zero defects.

Step 14-- Do it All Over Again

This step indicates to do it all over again to emphasize that quality programs never end and that they are indeed a journey not a destination. The process of learning, participating, experimenting with new methods and improving should never end. Quality improvement has to become the culture of a company and this can only happen if the effort is a continuous one. The process can then gain speed and permanence. The momentum should never be allowed to slow down. Continuous re-education and involvement, actively supported by top management, are the keys in making quality attainment an enduring way of life.

The similarities of Crosby's principles to those of Deming and indeed to those of a TQM culture, give rise to another quality triangle, this time with reference to Crosby's quality ingredients. Crosby's triangle is shown in figure 6.1.

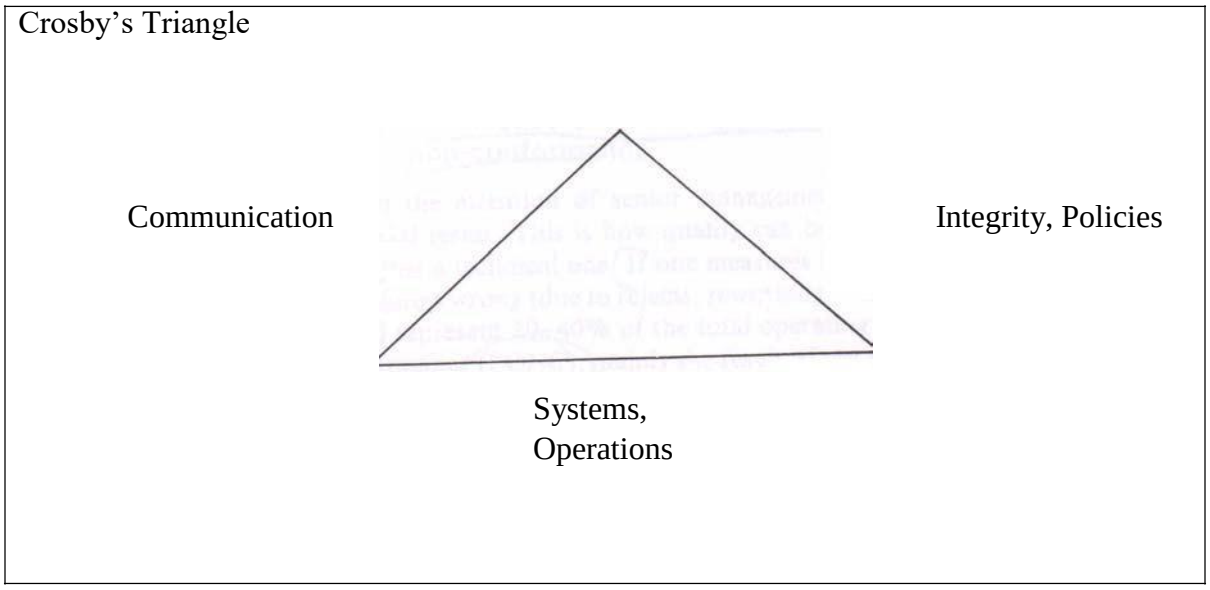


Figure 6.1-- Crosby's triangle

Crosby's Diagnosis of a Troubled Company

Crosby sees a troubled company as a patient in need of a quality vaccine. Trouble with quality inside always results in trouble with the customers outside. Customer dissatisfaction with the end product or service may be the final and most obvious symptom of a diseased company. But there are other symptoms also, the appearance of which always indicates trouble with quality. One

symptom is usually the consequence of another, something that perhaps facilitates their simultaneous cure. Some of the main symptoms and their interrelationship are listed below:

The company has an extensive field service for reworking and corrective actions. But service under guarantee and readjustment or reworking of the product the customer has already bought may be the main cause of losing the customer forever. Investing heavily in such a service is an admission that faulty output is inevitable and should always be expected as a way of life. It is an admission that no process can ever be defect-free. Another version of this symptom is the presence of an extensive program of mass inspection. Of course, the reason for the extensive inspection or field reworking service is usually the presence of the next symptom.

The outgoing product normally deviates from the customer's requirements. In many situations, non-conformance is so heavily embodied in the company culture that it has become the norm. Defects are seen as a necessary evil, tackled only by mass inspection or the reworking service. But this is something that normally costs much more than the effort required to prevent defects arising in the first place. Deviation from the desired target is usually the result of ignorance about quality standards, which brings us to the third symptom.

Management does not provide a clear performance standard, so the employees develop their own. It is the management's responsibility to provide the conditions in which quality can flourish and to establish a culture where continuous improvement is the standard. If this is not done, the workforce defines its own standards based justifiably on the current capability of the processes. But in the absence of a quality ethos and of a management commitment, these processes will always function below their potential. This is something that will drive employees, through no fault of their own, to commit themselves to a specific level of incompetence. The absence of management commitment and involvement is always apparent from the next symptom.

Management denies that it is the cause of the problem. Managers tend to blame the workers in order to hide their inability to improve the system. As Deming and Juran state, more than 80% of the problems are traceable to the system. It is the management's responsibility to take care of these. Denial of this responsibility invariably means that management causes and will continue to cause the majority of the problems. Costly firefighting then becomes their only line of action, something that gives rise to the fifth symptom.

Management does not know the price of nonconformance. A determination of the cost of quality at this stage could alleviate this symptom. It might reveal how much it costs to the company to do things wrong, to firefight, to mass inspect, to rework and re-inspect. It might reveal the usefulness of prevention and of proper training-- training on the appropriate tools for achieving quality, first time, every time. As long as management prefers to remain ignorant about the costs of nonconformance, extensive field service will always be necessary, which brings us back to symptom one.

The above symptoms are indicative of a company that always has problems with quality. Crosby also recognizes interrelated symptoms which characterize a company with a poor track record in the quality improvement effort, the most obvious of which are as follows:

The improvement effort is aimed at the lower level of the organization. It is as though senior management should not be responsible for and are not serious about quality.

The effort is called a program rather than a process. This gives the impression of something temporary, soon to be replaced by something else, rather than the impression of the never-ending which requires constant attention.
There are many temporary activities, uncoordinated from above. These always result in cynicism and self-defeating admission of the fact that defects are inevitable and that the economics of quality require errors.

There is an apparent management's non-involvement in the quality effort. This results in ignorance of what tools are required and of how long one needs to allow for the process of quality improvement to have an effect. This, in turn, causes management to become impatient for results and to proceed with spontaneous actions for short-term solutions which do more harm than good.

Crosby also has a "Quality Management Maturity Grid" passing through the stages of uncertainty, awakening, enlightenment, and wisdom and certainty. During this transition, the reported typical cost of quality as a percentage of sales, starts unknown, rises to 8 percent and then declines to 2.5 percent. But the actual costs of quality declines from 20 percent to 2.5 percent.

In recent years, Crosby has been critical of ISO 9000 and of quality awards such as the Baldridge. He says that they are old fashioned, rarely providing a living for consultants and a recipe for managers "who don't want to think about what quality really is!"

A Final Word from Crosby

Every ingredient involved in setting up a permanent system to eliminate hassle and to cause quality improvement requires special attention. When management respects the rights of the customer exactly the way it respects the rights of the banks and stockholders, then quality will happen all the time. When honoring the right of the employees to be free of hassle is considered as important as increasing sales, then hassle will be eliminated.

What needs to be done first is to educate people and at the same time to formalize the management commitment, the measurement and the awareness. Quality is to be first among equals and it should be first on the agenda.

Quality will never cease to be a major problem until management believes that there is absolutely no reason that we should ever deliver a nonconforming product or service to our customers. The producing of defect-free products and services on time is mostly caused by the minds of those who hold the strings. If something you want to happen is not happening, follow

the string back to its origin. It might terminate in the office of someone you know. Perhaps even yourself.

Zero Defects Program

The philosophy behind "Zero Defects" is to negate the commonly held view that "to err is human." Instead, ZD philosophy believes in total perfection or "to do the job right the first time." This idea first originated in 1961 in the Orlando Division of the Martin Company in USA which manufactured Missiles Systems. It was noticed in this company that failures in the Missiles System were caused, many a time, by small items costing as low as $1.50. The ZD program reportedly paid rich dividends to this company.

Errors or defects are caused by two factors-- lack of knowledge and lack of attention. While the former factor can be taken care of by imparting more knowledge, the latter is an attitudinal problem.

Modern Worker vs. Traditional Worker

The main theme behind zero defects is that the worker should be positively motivated to achieve as much perfection in his job as possible. The modem worker, as opposed to the traditional worker, is alienated with the product, i.e. he has little pride in his work. The mass production of goods may be one of the causes responsible for this. Also, achievement, enjoyment and responsibility is lacking significantly in modem workers. Thus, the modem worker resorts to complaints regarding his working environment, wages and other things. Motivating the worker to take pride in his job and to do his job as perfectly as possible the first time itself is the heart of the zero defects program.

Means for Motivation

Motivation is achieved through various means-- posters, publicity, voluntary pledges by workers, visits of customers to the plant etc. The thrust is on each worker fixing his/her own defectives-reduction goal by himself (not by the supervisor, although the supervisor may help him in the process). Before such pledges and other motivational techniques, it is necessary to generate a good awareness about the product amongst workers, such as what is the product, where is it used etc. It is also necessary to generate an awareness of the performance of the product-quality in the past. Such an awareness campaign should precede the actual implementation of the zero defects program.

Organization of the ZD Program

The zero defects program should be a separate activity coordinated probably by an administrator with the help of a number of zero defects representatives working in various functional areas and manufacturing departments of the company. The zero defects administrator may report to the quality manager of the organization. Top management support is absolutely essential for implementing a radical program such as zero defects.

Removal of Errors

For the actual implementation of the zero defects program, in addition to the positive motivation of the worker to do a better job, it is essential to probe, by various means, the causes of the defects or errors. One such vital component of the zero defects program is the error-cause removal campaign. Suggestions are invited from all, in writing, as to how the errors are caused in his/her own work as well as in other areas of work in the company. Of course, not all the causes could be genuine. But the idea here is to encourage all suggestions because some small things may be causing large errors. The zero defect administrator with the help of others might sift through these suggestions and implement only a few. But it is necessary that he/she give positive recognition to all the workers who have shown interest in the zero defects program. It could be a certificate, it may be some sort of publicity in the company's magazine, or it may simply be a pat on the back. But such feedback to the workers is important to keep up the tempo of ZD.

Criticism of the ZD Program

The program is, therefore, basically a motivational program where the workers are made more responsible, more achievement-oriented and more proud of their work. It cannot be a short-term program. It has to be a long-term one. Because of this, some think that interest in ZD may be lost in the long-term. Such apprehensions are not warranted, provided:

the management (including the top management) is itself not demotivated toward ZD
all the important precautions regarding implementing the zero defects program are properly taken care of

To explain the latter, if a company has a large component of bought out parts in its final product, it goes without saying that the zero defects program should be applicable and operating in the vendor organizations also. Although many feel that it is conceptually impossible to have zero defects yet benefits from ZD in terms of improved quality are substantial in the light of the cost associated with the zero defects program. In many organizations abroad, the benefits-to-cost ratio has been said to be as high as 70 to 1. In addition to the benefits in terms of better quality of product, there are many indirect benefits such as improved industrial relations, better plant utilization etc. On the whole, the zero defects program, if properly applied, can produce results on a long-term basis.

Three Paths, One Journey-- Deming, Juran and Crosby Compared

Deming, Juran and Crosby are the main pioneers of the area of Total Quality Management (TQM). Their contributions to TQM are regarded as three paths, one journey and are compared as follows:

W. Edwards Deming

Quality is continuous improvement through reduced variation.

The Seven Deadly Diseases

(1) Lack of constancy of purpose
(2) Emphasizing short-term profits and immediate dividends
(3) Evaluation of performance, rating or annual review
(4) Mobility of top management

Running a company only on visible figures

Excessive costs of warranty fueled by lawyers on contingency fees

Joseph M. Juran

Quality is fitness for use.

The Quality Trilogy

(1) Quality planning
(2) Quality improvement
(3) Quality control

Philip B. Crosby

Quality is conformance to requirements.

The Four Absolutes of Quality Management

(1) The definition of quality is conformance to requirements
(2) The system of quality is prevention
(3) The performance standard is zero defects
(4) The measurement of quality is the price of non-conformance

The Fourteen Points	The 10-Step Quality Improvement Process	The 14-Step Quality Improvement Plan
(1) Create constancy of purpose for improvement of product and service (2) Adopt the new philosophy (3) Cease dependence on mass inspection (4) End the practice of awarding business on price tag alone (5) Improve constantly and forever the system of production and service (6) Institute training on the job (7) Institute leadership (8) Drive out fear (9) Breakdown barriers between staff areas (10) Eliminate slogans, exhortations and targets for the workforce (11) a. Eliminate numerical quotas for the workforce c. Eliminate numerical d. for people in management (12) Remove barriers to pride of workmanship (13) Encourage education and self-improvement for everyone (14) Take action to accomplish the transformation	(1) Build awareness of the need and opportunity for improvement (2) Set goals for improvement. (3) Organize to reach the goals (4) Provide training through out the organization (5) Carryout projects to solve problems. (6) Report progress (7) Give recognition (8) Communicate results (9) Keep score (10) Maintain momentum by making annual improvement part of the regular systems and processes of the company	(1) Management commitment is defined, created and exhibited (2) Quality improvement team is formed (3) Measurement to determine areas for improvement (4) Cost of quality measures are developed (5) Quality awareness is created in everyone (6) Corrective action is taken on problems previously identified (7) Zero defects planning (8) Employee education of all employees in the company (9) Zero defects day is held to let all employees know there has been a change (10) Goal setting for individuals and groups (11) Error-cause removal by employees, sharing with management the obstacles they face in attaining goals (12) Recognition for those who participated (13) Quality councils to communicate regularly (14) Do it all over again to emphasize that quality improvement never ends

Answers

Answer to Crosby's “true or false” questionnaire to measure employee/manager thinking on total quality-- Q. No. 3 is true, Q. No. 8 should be true and the rest are false.

Questions

Explain Crosby’s absolute for quality management.
Which are Crosby’s 14 steps for quality improvement? Explain them.
Which are the main ingredients of Crosby’s quality vaccine?
What are the views of Crosby of a troubled company? What solution does he suggest for the same?

MODULE 4

Approaches to Quality-Kaizen

Introduction to Kaizen



The Chinese character on the left, or KAIZEN as pronounced in Japanese, means improvements. It further means improvements without spending much money by involving everyone including both managers and workers, and using common sense.

One of the key aspects of Kaizen is that it is an on-going, never-ending improvement process. As the reader may already know, it is not too difficult to introduce something new into an organization. The difficult part is, how to keep it going and maintain the momentum once it has been introduced. Many companies have tried to introduce such projects as quality circles, reengineering and lean production. While some of them have been successful, most of them have failed to make such a project a going concern. For instance, many Western companies introduced quality circles by involving employees but most of the companies have simply given up the idea of quality circle activities by now. This happened because management failed to build internal infrastructures, systems and procedures that would assure the continuing of quality circle activities. This has happened because most Western companies lacked the concept of Kaizen. In this lesson, various aspects of Kaizen will be explained.

Kaizen and People

The true nature of Kaizen is in the human content it carries. Improvement through Kaizen practice means deep, systematic and continuous involvement of people (everybody) by using certain techniques, but mainly their brain, causing a process of improvement to start, develop and never end. The Kaizen motto is "...today better than yesterday, tomorrow better than today...."
The concept of continuous improvement is applied in all directions. Industrial processes and working methods can be improved. Quality defects can be eliminated and waste can be reduced. Customer service can be made better. The work environment can be improved and the boss/subordinates relationship can be improved.... the sky is the limit.

Now, improvements in industry can be obtained in many ways. New technology can bring improvement to a process or to product quality. Technology can bring improvements in productivity and in efficiency. It can also bring improvements to customer service. External consultants can bring improvements to working methods, processes and interpersonal relations. But these types of improvements do not fall under the Kaizen umbrella. Kaizen is improvement through the “poor man approach.” According to this approach, a poor man does not spend money on improvements because he has no money to throw at it. He rather uses his wisdom, brain, creativity, talent and patience.

Kaizen and Innovation

A Chinese saying is as follows:

"When a man has not seen his friend for three days, he should have a good look at his friend with widely opened eyes to see what kind of changes have happened."

Probably, this saying represents a Chinese way of describing their belief in continuous improvements. In the West, on the other hand, managers worship at the altar of innovation. Innovation means to make improvements by investing a large sum of money in equipment, or introducing a latest technology to make a big change. While Kaizen subscribes to a gradual improvement, innovation subscribes to a big revolutionary change. Some may wish to call it a "big bang" philosophy.

Kaizen	**Innovation**	
Japan	Strong	Weak
West	Weak	Strong

	Kaizen	**Innovation**
1. Effect	Long-term and long-lasting but un-dramatic	Short-term but dramatic
2. Pace	Small steps	Big steps
3. Timeframe	Continuous and incremental	Intermittent and non-incremental
4. Change	Gradual and constant	Abrupt and volatile
5. Involvement	Everybody	Select few "champions"
6. Approach	Collectivism, group efforts, systems approach	Rugged individualism, individual ideas and efforts
7. Mode	Maintenance and improvement	Scrap and rebuild
8. Spark	Conventional know-how and state of the art	Technological breakthroughs, new inventions, new theories
9. Practical requirements	Requires little investment but great effort to maintain it	Requires large investment but little effort to maintain it
10. Effort orientation	People	Technology
11. Evaluation criteria	Process and efforts for better results	Results for profits
12. Advantage	Works well in slow-growth economy	Better suited to fast-growth economy

Innovation	Kaizen
Creativity	Adaptability
Individualism	Teamwork (systems approach)
Specialist-oriented	Generalist-oriented
Attention to great leaps	Attention to details
Technology-oriented	People-oriented
Information: closed, proprietary	Information: open, shared
Functional (specialist) orientation	Cross-functional orientation
Seek new technology	Build on existing technology
Line + staff	Cross-functional organization
Limited feedback	Comprehensive feedback

Table 7.1-- Difference between Kaizen and innovation

While Kaizen comes in small steps, innovation comes in big steps. Kaizen subscribes to conventional know-how and common sense while innovation pursues technological breakthroughs. Kaizen is effort-based, while innovation is investment-based. In Kaizen, we constantly review the process to see if the desired result is obtained while innovation looks for the result only.

The following story is a good illustration of the two different approaches between Kaizen and innovation.

Recently, our Kaizen consultant in Germany reported that the plant manger at one of his clients was about to buy additional machines to handle an increase in business. At the consultant's advice, he collected data on the usage of the machines and found that they were actually used only 38% of the time. Therefore, the consultant advised the manager to introduce various Kaizen projects, such as better maintenance, setup time reduction and quality improvements. As a result, company saved 15 million Deutsche marks and yet was able to meet the increased orders.

Innovation-minded managers tend to resort to buying new machines, hiring more people, or introducing new technologies when business prospects are bright. However, whenever management wishes to buy more machines, to hire more people and request more budget, that is the best time to do Kaizen.

In today's stagnant business environment, Kaizen may be a more desirable alternative than innovation.

A popular phrase often heard in Japan is as follows:

If you have no money, use your brain. If you have no brain, sweat it out!

Kaizen Tools

The following tools are used for Kaizen:

PDCA or storyboards	Sequence of activities that show/discover what is going on.
5S	Set the scene for Continuous improvements, de-clutter the work place and raise morale
7 wastes	Distinct classifications of waste found on the shop floor or office.
7 old and new quality tools	Numerical and text based descriptions of quality control issues
5 Whys	Root cause problem solving
Value stream mapping	Determine value-adding activities from non-value adding ones
Workstation improvement	Educate staff to allow them to improve their own areas
Success stories	Celebrate the success of your teams

Table 7.2-- (Some) tools of Kaizen

What is 5s and why do we want to do it?

5S represents five disciplines for maintaining a visual workplace. These are foundational to Kaizen and a manufacturing strategy based "Lean Manufacturing" concepts. 5S is the starting point for improvement activities that ensure our company’s survival. The five disciplines are:

Sort

Remove all items from the workplace that are not needed for current operations. Leave only the bare essentials.

- Target excess inventory, obsolete items, quality defects, unneeded tools/equipment
- Will use red tags, local and central red tag holding areas
- Account for discarded items
- Take before and after pictures

Set in Order

Arrange needed items so that they are easy to find, use and put away.

- Consider motion economy
- Use painting, outlining and signboard strategies, Visual 5S

Shine

Sweeping, wiping-off equipment, painting and assuring everything stays clean.

- Create 5S schedules for painting
- Should create cleaning inspection checklists
- Create current and future shine targets

Standardize

Method to maintain the first three disciplines (sort, set-in-order, shine)

- Prevention steps for clutter-suspension, incorporation, elimination
- Integrate 3S duties into regular work with 5S job cycle charts, five minute 5S, visual 5S activities

Sustain

A top-down support of the ongoing 5S process should:

- Create the conditions to support 5S
- Allocate time
- Create awareness
- Provide a structure
- Show support
- Offer rewards and recognition

Encourage training/participation

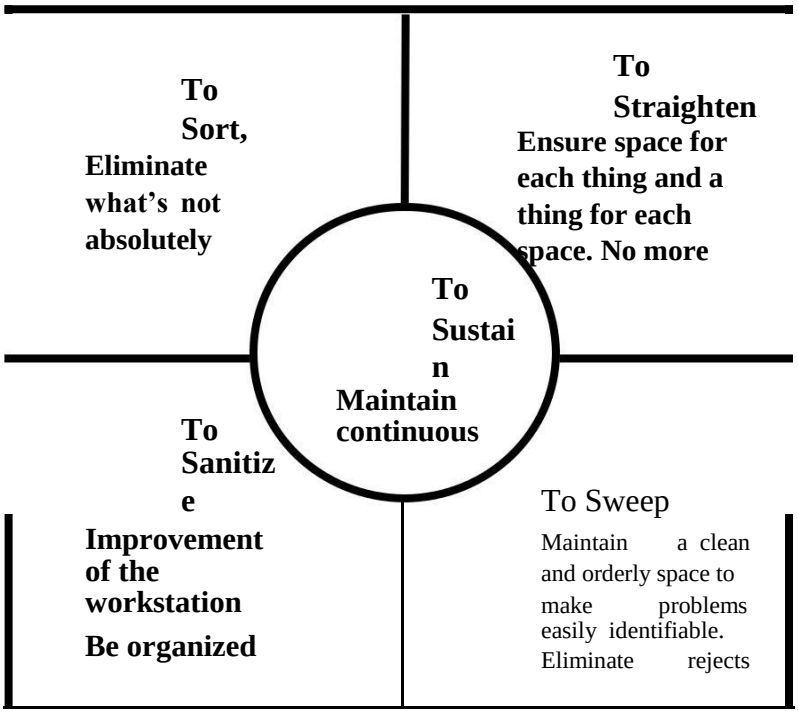


Figure 7.1-- The 5 S

What are the 7 wastes?

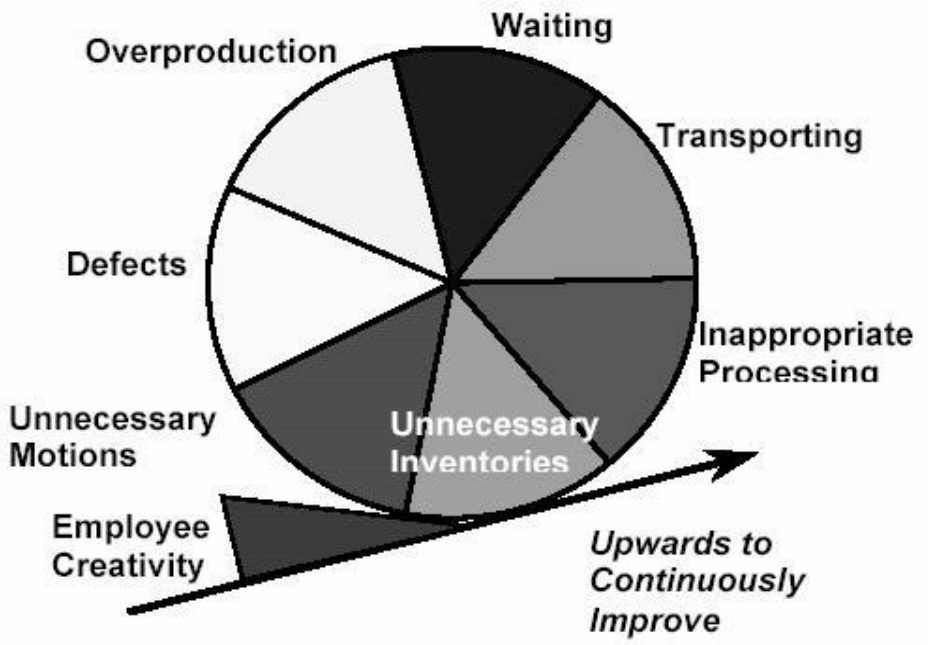


Figure 7.2-- The seven wastes

These wastes are as follows:

Defects

Quality defects originate rework, scrap and lost raw materials. If these defects go all the way to the customer, the loss will be even greater. To avoid this, we move from the traditional and obsolete "Quality Control" still in use in some facilities, to the innovative "Quality at the Source" (Jidoka) concept. Here, each member of the organization is empowered and will make sure that no faulty products leave or arrive at their workstations. This is supported with ingenious "mistake proofing" (Poka-Yoke) devices.

Waiting

Waiting is caused mainly by low reliability or availability of an equipment, lack of stock or poor scheduling. Here we have several tools, strategies and disciplines that will prevent this type of loss. Analyzing your process, we will be able to propose cost-effective improvements, from simple relocations or re-mapping to TPM and other implementations.

Processing

Over-processing takes place everywhere. Think of those steps that do not add any real value and processes that can be inaccurate or incorrect. An individual can team up the manufacturing force and find the appropriate actions that will start saving time, material, space and money.

Production

Over-production is just as bad as under-production. Production may also be too early or too late. Make sure production is performed at the right time in the right quantity. Lean Manufacturing establishes a one-piece flow environment where production obeys the market. We help drastically reduce this disagreement between supply and demand.

Motion

There are many cases of people required to perform unnecessary motion, or awkward movements, or where motion is not efficient (not adding value to the product). One of our customers saw in just a few hours, the reduction from 42 miles of motion of 24 people in three shifts to less than two miles of motion with 16 people in two shifts. Our mission is to use the same resources to produce more.

Inventory

Having too much raw material, WIP (Work in Process), finished goods because of large lots is sometimes overlooked and is a financial loss. SMED (Quick-Setup Strategy) implementations assist manufacturers to reduce lot sizes. Cellular organization or re-organization cuts WIP drastically. JIT deliveries provide instant solutions to the "conventional warehouse" problems.

Transportation

A defective or poor layout of the plant, an ineffective material handling system, an inconvenient location, all cause too much transportation which adds cost and risk to the operation. A value stream mapping will give you a cutting edge to reduce some of that overlooked unnecessary transportation. We are prepared to introduce these improvements and help many companies achieve their goals.

7 Old Quality tools

- Measles chart
- Scatter (Correlation) diagram
- Check sheet
- Run graphs
- Control charts
- Pareto 80:20
- Fishbone diagram

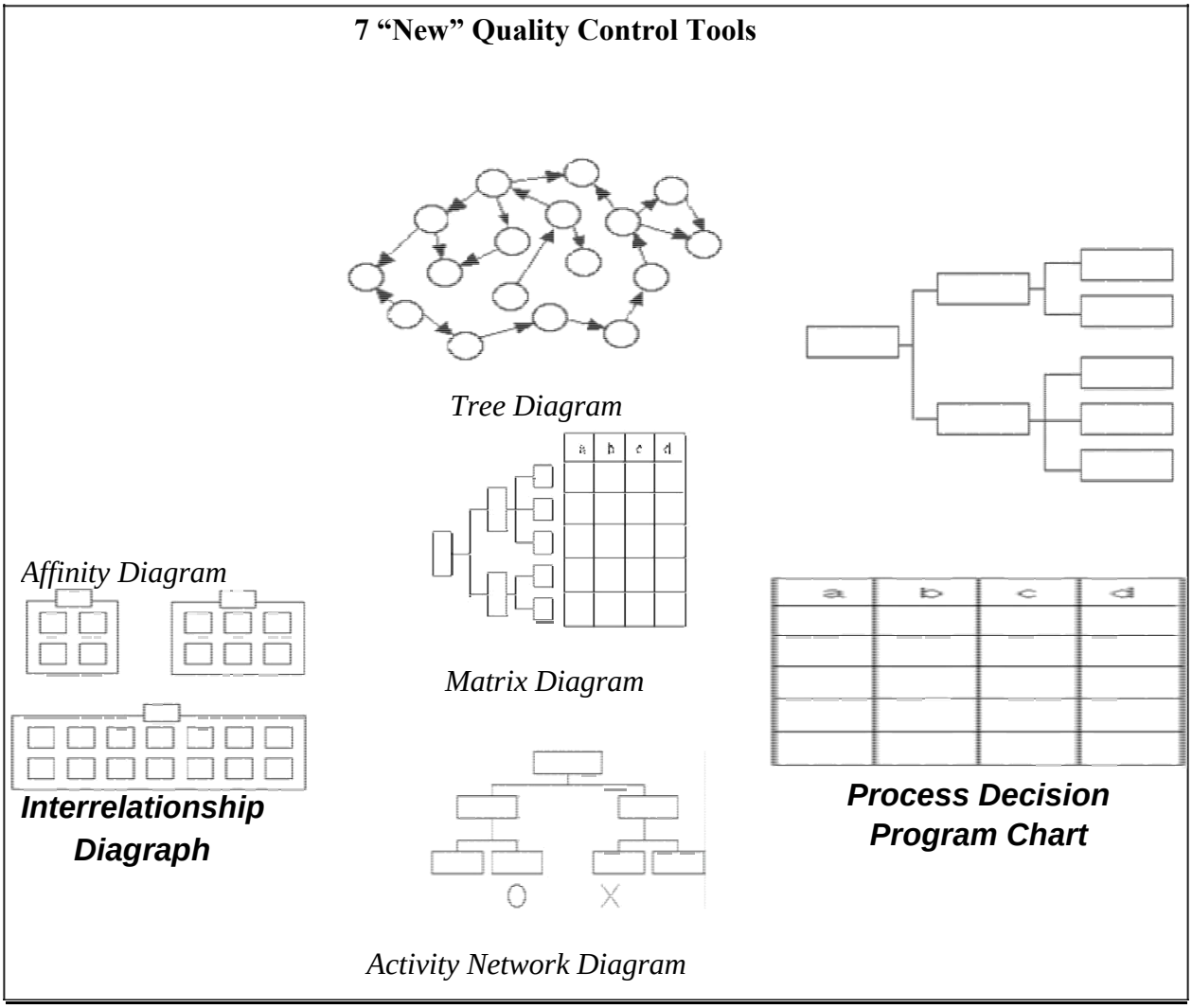


Figure 7.3-- Seven "new" quality control tools

Five Whys

Ask "why" five times so that the underlying cause can be identified
Do not accept excuses for why things cannot be done
Do not blame, find problem and implement solutions

Value Stream Mapping

Identify and eliminate as much non-value adding activity as possible

Value adding	Value adding activities are the activities that from the perspective of a final customer make a product or service more valuable.
Non-value adding	Non-value adding activities are the activities that from the perspective of a final customer add no value even under present circumstances.
Necessary non-value adding	Necessary non-value adding activities are the activities that from the perspective of a final customer add no value but are necessary under present circumstances.



Ergonomics

•Adapt the workstation to the employee

more security

more comfort

•Reduce waste

excessive fatigue

useless efforts and movement

less physical constraints



Figure 7.4-- Visual control and workstation

Shigeo Shingo

Introduction

Shigeo Shingo

Shingo was born in Saga City, Japan in 1909. He graduated in Mechanical Engineering from Yamanashi Technical College in 1930. The Taipei Railway Factory in Taiwan employed him after his studies. His first major accomplishment came about in 1930 when he introduced scientific management to Taipei Railway Company in order to reduce cost of operations. Subsequently he became a professional management consultant in 1945 with the Japan Management Association. He later became manager of the Education Department of the Computing Department, at the Fukioko Office. It was in his role as Head of the Education Department that in 1951 he first heard of and applied statistical quality control. By 1954 he had investigated 300 companies. In 1955 he took charge of industrial engineering and factory improvement training at the Toyota Motor Co. for both its employees and parts suppliers (100 companies).

During the period 1956-58 at Mitsubishi Heavy Industries in Nagasaki, Shigeo Shingo was responsible for reducing the time for hull assembly of 65,000 tons super-tanker from 4 months to 2 months. This established a new world record in shipbuilding and the system spread to every shipyard in Japan.

In 1959 he left the Japan Management Association and established the Institute of Management Improvement, with himself as President. In 1962 he started industrial engineering and plant-improvement training at Matsushita Electric Industrial Company. As previously, training was done on a large scale, with some 7,000 persons trained.

It was in the period 1961-1964 that Shigeo Shingo extended the ideas of quality control to develop the Poka-Yoke, “mistake proofing” or “zero defects” concept. Subsequently the approach was successfully applied at various plants with records of over two years totally defect-free operation being established.

In 1968 at the Sata Ironworks he originated the Pre-Automation system which later spread throughout Japan. He was awarded a Yellow Ribbon Decoration for his distinguished services in improving production in 1970. Also in that year he originated the SMED System at Toyota (Single Minute Exchange of Die) which is a part of the Just in Time system. This concept was integrated into the JIT/ Toyota Production System with a significant reduction in operating costs.

Shigeo Shingo's first overseas study tour was in 1971. He visited Europe in 1973 at the invitation of Diecasting Associations in West Germany and Switzerland. He conducted practical training at Daimler Benz and Thurner in West Germany, and H-Weidman Ltd., Bucher-Guyer AG and Gebr Buhler Ltd in Switzerland. He visited Livernos Automation in the USA in 1974 and from 1975

to 1979 he conducted training for the American Company Federal Mogul on SMED and Non-stock Production. His first consultancy for an overseas firm was for Citroen in France in 1981.

Other companies where he advised include many parts of Daihatsu, Yamaha, Mazda, Sharp, Fuji, Nippon, Hitachi, Sony and Olympus in Japan and Peugeot in France. The use of his methods within the US company Omark Industries led to such increased productivity, defect and stock reductions that the company instigated the annual Shingo award to the facility which out of the seventeen Worldwide demonstrated the best overall improvement. Up to the time leading to Dr. Shigeo's demise in 1990, many industries worldwide adopted his principles to successfully improve productivity and reduce both part defects and work in process inventory.

Shingo wrote more than 14 major books. Several have been translated into English and other European languages, especially his book on the Toyota Production System.

The late Shigeo Shingo is strongly associated with Just-in-Time manufacturing and may not be classified as a quality guru by all. Nevertheless his work on “pokayoke” or fail-safe devices is very significant and is widely implemented. For this reason he is bound to be considered as one of the “greats” sooner or later.

Shingo emphasized the practical achievement of zero defects by good engineering and process investigation, rather than an exhortation/slogan emphasis that has been associated with the quality campaigns of many American and Western companies. Shingo himself, like Deming and Juran, showed concern at such American approaches, arguing that posting defect statistics is misguided and that instead the defectives should be hunted down.

The greatest impact of Dr. Shingo Shigeo's teachings can be classified into the three concepts listed as follows:

Zero quality control

Just In Time (JIT)

Single Minute Exchange of Dies (SMED)

Poka-yoke

In terms of quality, Shingo’s paramount contribution was his development in the 1960s of poka-yoke and source inspection systems. These developed gradually as he realized that statistical quality control methods would not, in themselves, reduce defects to zero.

The basic idea is to stop the process whenever a defect occurs, define the cause and prevent the recurring source of the defect. No statistical sampling is, therefore, necessary. A key part of this procedure is that source inspection is employed as an active part of production to identify errors before they become defects. Error detection either stops production until the error is corrected, or it carries adjustment to prevent the error from becoming a defect. This occurs at every stage of the process by monitoring potential error sources. Thus, defects are detected and corrected at source, rather than at a later stage. Typically, this process is made possible by instrumenting

machines with immediate feedback and reliance on the fallible judgment of personnel is minimized. They are essential, however, to establish the potential error sources.

Following a visit to Yamada Electric in 1961, he started to introduce simple, mechanical or physical devices into assembly operations, which prevented parts being assembled incorrectly and immediately signaled when a worker had forgotten one of the parts. These mistake-proofing or "poka-yoke" devices had the effects of reducing defects to zero.

In 1967 Shingo further refined his work by introducing source inspections and improved poka-yoke systems that actually prevented the worker from making errors so that defects could not occur. Associated advantages were that statistical sampling was no longer necessary and workers were more free to concentrate on more valuable activities such as identifying potential error sources.

Shigeo Shingo did not invent failsafing ("pokayoke" in Japanese, literally means mistake proofing) but developed and classified the concept, particularly in manufacturing. More recently failsafing in services has developed. Shingo's book *Zero Quality Control: Source Inspection and the Pokayoke System* is the classic work.

Failsafing device is a simple, often inexpensive, device which literally prevents defects from being made. The characteristics of a failsafing device are that it undertakes 100 percent automatic inspection (a true pokayoke would not rely on human memory or action) and either stops or gives warning when a defect is discovered. Note that a pokayoke is not a control device like a thermostat or toilet control valve that takes action everytime but rather a device that senses abnormalities and takes action only when an abnormality is identified.

Shingo distinguishes between "mistakes" (which are inevitable) and "defects" (which result when a mistake reaches a customer.). The aim of pokayoke is to design devices which prevent mistakes becoming defects. Shingo also saw quality control as a hierarchy of effectiveness from "judgment inspection" (where inspectors inspect), to "informative inspection" where information is used to, control the process as in SPC and finally to "source inspection" which aims at checking operating conditions "before the fact." Good pokayokes fall into this last category.

According to Shingo, there are three types of failsafing devices. These are as follows:

Contact
Fixed value
Motion step

This means that there are six categories, as shown in table 11.1 with service examples.

	Control	Warning
Contact	Parking height bars	Staff mirrors
	Armrests on seats	Shop entrance bell
2) Fixed Value	French fry scoop	Trays with Indentations
	Pre-closed medication	
3) Motion Step	Airline lavatory	Spellcheckers
	Doors	Beepers on ATMs

Table 8.1-- Pokayoke in service failsafe services

The contact type makes contact with every product or has a physical shape which inhibits mistakes. An example is a fixed diameter hole through which all products must fall; an oversize product does not fall through and a defect is registered. The fixed value method is a design which makes it clear when a part is missing or not used. An example is an “egg tray” used for the supply of parts. Sometimes this type can be combined with the contact type, where parts not only have to be present in the egg tray but also are automatically correctly aligned. The motion step type automatically ensures that the correct numbers of steps have been taken. For example, an operator is required to step on a pressure -sensitive pad during every assembly cycle, or a medicine bottle has a "press down-and-turn" feature for safety. Other examples are a checklist, or a correct sequence for switches which do not work unless the order is correct.

Shingo further developed failsafe classification by saying that there are five areas that have potential for failsafe. These are as follows:

Operator (Me)
Material
Machine
Method
Information (4 M)

An alternative is the process control model comprising input, process, output, feedback and result. All are candidates for failsafing. According to Grout, following are the areas where poka-yoke should be considered:

Where worker vigilance is required
Where mispositioning is likely
Where SPC is difficult
Where external failure costs dramatically exceed internal failure costs
In mixed model
In JIT production

Shingo says that pokayoke should be thought of as having both a short action cycle (where immediate shut down or warning is given) and also a long action cycle where the reasons for the defect occurring in the first place are investigated. John Grout makes the useful point that one drawback of pokayoke devices is that potentially valuable information about process variance may be lost, thereby inhibiting improvement.

In an extension, Richard Chase of University of Southern California has extended Shingo's work to services. He discusses stages of failsafing by both the provider and the customer. The service provider's work should attempt to be failsafed at the task stage (doing the actual work), at the treatment stage (the interaction with the customer-for instance, customer greeting) and with the tangibles (the physical appearance, cleanliness, etc.). On the customer side, failsafing could be attempted at three stages, equivalent to Vandermerwe's pre, during and post stages of customer service. A systematic way to consider failsafing is to construct a cycle of service diagram and then for each moment of truth consider how it may be failsafed.

A common mistake poka-yoke has been successful in eliminating is the omission of a component in an assembly or a container. Shingo shows how a simple change in job tasks can eliminate this mistake. Yamada Electric made a switch that required workers to insert two springs. The workers would withdraw one spring from a large box, insert it into the switch, perform some other assembly tasks, withdraw a second spring from the box and insert it, and then finish the assembly. The springs were small and once inserted they were not visible. Sometimes the workers forgot whether they had put both springs in the switch. The result was that sometimes they opened a switch to check whether both springs were installed and at other times they did not notice that a spring was missing and the switch went out defective.

After observing the process, Shingo suggested that an extra task be added to the job. The worker would first withdraw two springs from the box, put them on a small plate and then insert them into the switch when needed. If a spring remained on the plate at the end of assembly, the worker would know he had forgotten to insert it. Notice that this added a task to the job and increased assembly time slightly, but even more time was saved because workers no longer had to disassemble switches when they thought a spring might be missing. Moreover, the defect rate dropped to zero.

More extensive discussions of poka-yoke can be found in Shingo's books. Other pakayoke techniques that have been applied successfully are as follows:

Weighing boxes to make sure all the pieces that are supposed to be in them are enclosed
Placing sensors on components so that an alarm sounds if the sensor is not in the correct position when assembled
Using sensors that will stop production line if a worker's hand does not withdraw a component from each box of parts

Zero Quality Control

Poka-Yoke Techniques to Correct Defects + Source Inspection to Prevent Defects = Zero Quality Control

This famous equation is the essence of *Zero Quality Control Concepts* formulated by Dr. Shigeo Shingo.

Having learned about and made considerable use of statistical quality control, it was some 20 years later that Shingo was “finally released from the spell of statistical quality control methods” when he saw how the Shizuoko plant of Matsushita's Washing Machine division had succeeded continuously for one month with zero defects on a drain pipe assembly line involving 23 workers. This was achieved principally through the installation of poka-yoke devices to correct defects and source inspection to prevent defects occurring. Together these techniques constitute Zero Quality Control, which, Shingo argues, can achieve what may have been impossible using statistical quality control methods.

Dr. Shigeo Shingo's Zero Quality Control (ZQC) techniques make use of the following engineering principles:

100 percent inspections done at the source instead of sampling inspections

Immediate feedback from successive quality checks and self checks

Poka-yoke designed manufacturing devices

The zero quality control concepts are based on a theoretically ideal scenario. However, by using these principles and concepts, quality improvements can be made. Dr. Shigeo's basic idea was to implement mistake-proofing devices in the assembly line to eliminate the possibility of defective operations. In addition, his emphasis on targeting the root cause of defect (source defect) whenever a defect occurs virtually eliminates the need for statistical process control.

In 1977, Matsushita’s washing machine manufacturing facility went for a one-month period with zero part defects. This example reinforced Dr. Shigeo’s theories by illustrating the potential improvements that are made possible by implementing zero quality control principles. Although Dr. Shigeo realized that statistical quality control could aid in elimination of defects yet he argued that by using sound manufacturing and process engineering practices, defects could be removed from processes without the use of many statistical tools used in most quality control techniques.

JIT

The Just in Time (JIT) manufacturing concept was founded in part due to the contribution of Dr. Shingo Shigeo and Mr. Taichii Ohno of Toyota Motor Co. from 1949 to 1975. During this period, Dr. Shigeo took charge of industrial engineering and factory improvement training at Toyota Motor Corporation. This is commonly referred to as JIT or the Toyota Production

System. The essential element in developing JIT was the use of the Ford System along with the realization that factory workers had more to contribute than just muscle power.

According to the American Production and Inventory Control Society (APICS), JIT can be defined as:

A philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all stages of conversion from raw material onward. The primary elements include having only the required inventory when needed; to improve quality to zero defects; to reduce lead time by reducing setup times, queue lengths and lot sizes; to incrementally revise the operations themselves; and to accomplish these things at minimum cost.

The basic essence of JIT has been implemented to the new "continuous improvement" or "lean manufacturing" wave in the industry today. The primary objective in implementing JIT to a production facility is to obtain a competitive advantage and increased productivity by eliminating the following seven types of wastes:

Waste from overproduction
Excess transportation
Excess inventory
Waiting time
Processing waste
Wasted motion
Waste from production defects

In applying these simple concepts, a company can realize monetary savings. The use of statistical process control helps assure that the outcome of production is consistently met with desired results.

In JIT, as soon as the notion of using small production lot sizes was developed, it became obvious that setup times would have to be reduced.

SMED

The SMED system was born out of necessity, in order to achieve Just-In-Time production, one of Toyota's manufacturing corner stones. This system was developed to cut set- up times, enabling smaller batch sizes to be produced. The set-up procedures were simplified by using common or similar set-up elements whenever possible. This approach was in complete contrast with traditional manufacturing procedures, as Shingo pointed out, "It is generally and erroneously believed that the most effective policies for dealing with set-ups address the problem in terms of skill. Although many companies have set up policies designed to raise the skill level of the workers, few have implemented strategies that lower the skill level required by the set-up itself."

The success of this system was illustrated in 1982 at Toyota, when the die punch set up time in cold- forging process was reduced over a three-month period from one hour and forty minutes to three minutes.

In 1950, while working for Toyo Kogyo's Mazda plant, Shigeo Shingo began his systematic study of production setups. Shingo was asked to study a stamping operation which was a major production bottleneck to determine whether additional stamping presses were needed.

As he studied and collected data on the operation, Shingo noticed that the presses were actually operating only a small part of the time. The rest of the time they were either idle while being set up or operating at low efficiency while being adjusted after setup. The key event occurred while Shingo was observing a die change for one of the presses. During the setup, he noticed everyone running around frantically. One of the workers he questioned told him that a bolt needed for the setup was missing. After an hour, the worker finally returned to the machine with a bolt. On seeing him Shingo said, "Ah, you've found it." The worker responded, "No, I didn't actually find it. I borrowed a long die bolt from the next machine over there. I cut it to make it shorter and then threaded it. That's what took so long. It wasn't easy, I can tell you."

Shingo found that similar problems occurred frequently during setups. At that point he made the key discovery that would lead to faster setups. Setup operations actually consisted of two different activities. Shingo calls them internal and external.

Internal setup activities, such as mounting a die or changing the ink cartridge on a photocopier, are those that can be performed only while the equipment is stopped. External setup activities, such as collecting all bolts needed to mount a die or unpacking an ink cartridge from its carton, are those that can be done while the equipment is operating.

Shingo put this dichotomy of setup activities into action by preparing a structured plan for the external setup activities of the die change. For example, before the stamping press was stopped for setup, all bolts were collected and put into a box, all tools were arranged for easy access, the new die was transported to the machine and all preparatory activities were performed. Simply by doing external activities while the press was still operating and doing only internal setup activities while it was stopped, the setup time was cut in half.

A second major discovery occurred while Shingo was observing the setup of a large side planer used to machine diesel engine beds. Much time was spent "centering and dimensioning the engine bed... on the planer table itself." This was done while the planar was shut down, so it was treated as an internal setup activity. Shingo recognized that this work could be done on a second table while the planar was operating. Then when the planar stopped, the table in the planar could be switched with the second table, on which the engine was already aligned. This approach converted an internal to an external setup activity and resulted in a 40% increase in productivity.

Shingo's two observations formed the foundation of a procedure for reducing setup times that he called single-minute exchange of dies (SMED) named for consulting projects in which he reduced the time for die changes on large presses from several hours down to less than 10 minutes.

Despite its name, SMED is applicable to almost any type of machine setup or changeover. Shingo's most striking successes with the method involved reducing the setup time for a bolt-making machine at Toyota from 8 hours to one minute and reducing the setup time for a boring machine at Mitsubishi Heavy Industries from 24 hours to less than three minutes.

SMED uses the following four-step procedure:

Observe and Analyze how the Setup is Currently performed

Setups should be observed carefully and activity charts and worker-machine charts should be constructed. Whenever possible, one should videotape the setups. This is not only helpful in constructing the necessary data and charts; it is invaluable in showing workers what they are currently doing and how the setup can be improved. For example, when 3M Corporation videotaped its changeover process, it was noticed that workers often did not have the correct tools when needed. Putting toolboxes near the changeover sites eliminated wasted time getting tools and reduced the changeover time.

Separate Internal from External Setup Activities

One of the most effective ways to reduce setup times is to separate internal from external activities and then to make a written setup plan that ensures that external setup activities are performed while the process is operating. Some of the most common external setup activities are preparing and testing parts and tools, transporting these to the machine, bringing materials to be processed to the machine and transporting materials away from the machine such as finished products to storage or waste to disposal bins. The following suggestions can help workers perform these as external setup activities.

Make a checklist of the items needed for each setup/changeover. Then create a "part-holder" box (kit) that will hold the parts, with the list attached, so that the worker can check off parts while gathering them before the setup. As part of the gathering process, the worker may also test the items collected, such as making sure that bolt threads are not damaged. One of the biggest wastes of setup time results from not discovering until internal setup is being performed that a required part is defective; checking and testing parts during the external phase eliminates these delays.

Provide machine operators with their own material-handling equipment such as hand trucks so that they can perform most or all of the material transports themselves. This makes it easier for them to transport materials as an external activity rather than waiting for separate transport workers to be available (it may also reduce the need for transport workers).

Simply performing external activities while production continues will normally reduce setup times by 30-50%.

3. Convert Internal to External Setup Activities

As Shingo found with setting up the engine-bed side planer, activities that appear to be internal setup activities can sometimes be converted to external activities. Changing work methods, adding work aids, or buying duplicate sets of tools or equipment can assist in this conversion. The following general examples show how this can be done.

Many operations require the heating of molds or materials to be processed. Rather than doing all the heating as part of the internal setup, workers can often preheat outside of the setup so that final heating during internal setup requires less time. This may require the purchase of a second mold or holding vessel. For example, rather than heating a fluid in the main production vessel which requires the production process to be stopped, one can preheat in a second vessel during production of the previous batch and then the second vessel can be switched with the main vessel when the process is stopped. The time the process is stopped is considerably reduced. The same idea applies to cooling or mixing of materials.

Cleaning activities can often be transferred from internal to external setup. For example by having two sets of tools or two processing vessels, one can replace the dirty or contaminated one with a clean one quickly during internal setup and then the dirty one can be cleaned after production has restarted. For fluid vessel cleaning rather than having two separate vessels a lower-cost solution is often to use plastic vessel liners that can be exchanged quickly.

4. Simplify and Streamline Activities

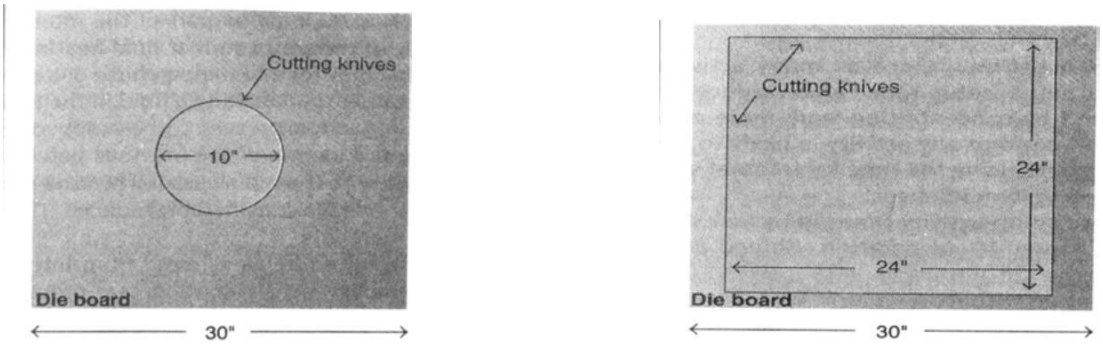
Once as many activities as possible have been assigned to external setup, setup time can be reduced further by simplifying and streamlining work and by concentrating work more effectively. Although reducing the time needed to perform any activity is likely to have some benefit yet the primary focus should be on reducing the time for internal setup activities because this will reduce production system idleness.

The best way to reduce setup activity times is by task simplification. In addition, Shingo advocates the following techniques and principles:

Provide each workstation with its own tools and store the tools conveniently. For example, several technicians at a medical laboratory were required to recalibrate their scales before each batch of tests they performed. Weighing three standard weights did this. When each technician was given her own set of standard weights, she did not have to wait between batches to use a set of standard weights shared with others.

Standardize the size and shape of dies and other parts that must be changed during setups. Even though the working area of the dies is different-- for example, one job may require stamping 10-inch-diameter circles and another requires stamping 24-inch squares-the external dimensions of the dies can be the same as shown in

Figure 11.1. This way the dies or tools can be inserted and removed like cassettes in a cassette player without having to calibrate and align the die or tool.
Use the same fasteners, such as bolts for each setup. The fasteners can stay with the machine; they simply have to be loosened and retightened for each setup, rather than removed, replaced, transported and stored.
Use fasteners that can be loosened and tightened with a single turn rather than those that require turning the fastener several revolutions.
Reduce or eliminate adjustments by using fixed settings and markings on dies, tables and guide bars. Every setup can be pre-marked so that tools and dies do not have to be measured each time. For example, the printer in our department at the university is used to print on paper and envelopes of different sizes. Originally, a trial-and-error approach was used to adjust the width of guide bars and the printer settings to print each item correctly. Now set tings are marked on the print feeder for the most common items printed, reducing changeover time from several minutes to just a few seconds.



Die for cutting 10" circles Die for cutting 24" squares

Figure 8.1-- Standardized die size: same external dimensions.

The use of SMED procedures has become widespread in manufacturing, with hundreds of success stories reported. For example, Ford Motor Company reduced the time for a die change on one of its presses from 5 hours to 5 minutes and Packaging Corporation of America cut its changeover time for its carton-making machines from 21 hours to fewer than 8 hours.

The principles of SMED have been applied to many situations other than setups for different products. They can be used to minimize downtime while replacing parts or tools, such as drill bits in a drill, or while performing maintenance and repair jobs. For example, steel, aluminum and paper manufacturers regularly change the rolls on their rolling mills or paper machines as part of their preventive maintenance. Many roll-changing activities, such as pre-positioning new rollers and gathering tools and replacement parts, can be done as external setup, thereby minimizing the time the mills are shut down. Although originally developed in heavy manufacturing industries for die changes and other large machine setups yet the principles of SMED apply readily to many activities in service production. For example, they have been used

to change over medical operating rooms between surgeries and to turn around airplanes between flights. They can even be used in our everyday lives, such as in changing a cartridge in a printer or preparing meals (unpackaging one food to be micro-waved while another is cooking).

Questions

Explain Poka?
What is zero quality control?
What is JIT?
Explain SMED system.
Zero Quality Control (ZQC) techniques make use of which engineering principles?
What is the best way to reduce setup activity? Which are the techniques that Shingo suggest?

MODULE 4

Ishikawa

Introduction

“In management, the first concern of the company is the happiness of the people connected with it. If the people do not feel happy and cannot be made happy, that company does not deserve to exist.”-- Kaoru Ishikawa

This is one of the most important statements ever given and is said by one of the quality gurus named Professor Ishikawa. He was born in 1915. He graduated in 1939 from the Engineering Department of Tokyo University having majored in applied chemistry. In 1947, he was made an assistant professor at the University. He obtained his Doctorate of Engineering and was promoted as professor in 1960. He has been awarded the following prizes:

The Deming Prize
The Nihon Keizai Press Prize
The Industrial Standardization Prize for his writings on quality control
The Grant Award in 1971 from the American Society for Quality Control for his education program on quality control

He died in April 1989. Widely regarded as the father and pioneer of the “quality circles” in Japan in the 1960s, Ishikawa was the leading Japanese contributor to quality management.

As one of Japan's quality control pioneers, he developed the cause and effect diagram (Ishikawa diagram) in 1943 and published many books on quality control. In addition to his work at Kawasaki, Ishikawa was a long-standing member of the Union of Japanese Scientists and Engineers and an assistant professor at the University of Tokyo.
Kaoru Ishikawa wanted to change the way people think about work. He urged managers to resist becoming content with merely improving a product's quality, insisting that quality improvement can always go one step further. His notion of company-wide quality control called for continued customer service. This meant that a customer would continue receiving service even after receiving the product. This service would extend across the company itself in all levels of management and even beyond the company to the everyday lives of those involved. According to Ishikawa, quality improvement is a continuous process and it can always be taken one step further.

With his cause and effect diagram (also called the "Ishikawa" or "fishbone" diagram), this management leader made significant and specific advancements in quality improvement. With the use of this new diagram, a user can see all possible causes of a result and hopefully find the root of process imperfections. By pinpointing root problems, this diagram provides quality improvement from the "bottom up." Dr. W. Edwards Deming-- one of Ishikawa’s colleagues-- adopted this diagram and used it to teach total quality control in Japan as early as World War II.

Both Ishikawa and Deming used this diagram as one of the first tools in the quality management process.

Ishikawa also showed the importance of the following seven quality tools:

Control chart
Run chart
Histogram
Scatter diagram
Pareto chart
Run chart
Flowchart

Additionally, Ishikawa explored the concept of quality circles-- a Japanese philosophy which he drew from obscurity into worldwide acceptance. He believed in the importance of support and leadership from the top- level management. He continually urged the top-level executives to take quality control courses, knowing that without the support of the management, these programs would ultimately fail. He stressed that it would take firm commitment from the entire hierarchy of employees to reach the company's potential for success. Another area of quality improvement that Ishikawa emphasized is quality throughout a product's life cycle and not just during production. Although he believed strongly in creating standards yet he felt that standards were like continuous quality improvement programs. They too should be constantly evaluated and changed, he believed. Standards are not the ultimate source of decision-making but customer satisfaction is. He wanted managers to consistently meet consumer needs and from these needs all other decisions should stem. Besides his own developments, Ishikawa drew and expounded on principles from other quality gurus, including those of one man in particular-- W. Edwards Deming, creator of the Plan-Do-Check-Act model (figure 13.1). Ishikawa expanded Deming's four steps into the following six divisions:

Determine goals and targets
Determine methods of reaching goals
Engage in education and training
Implement work
Check the effects of implementation
Take appropriate action

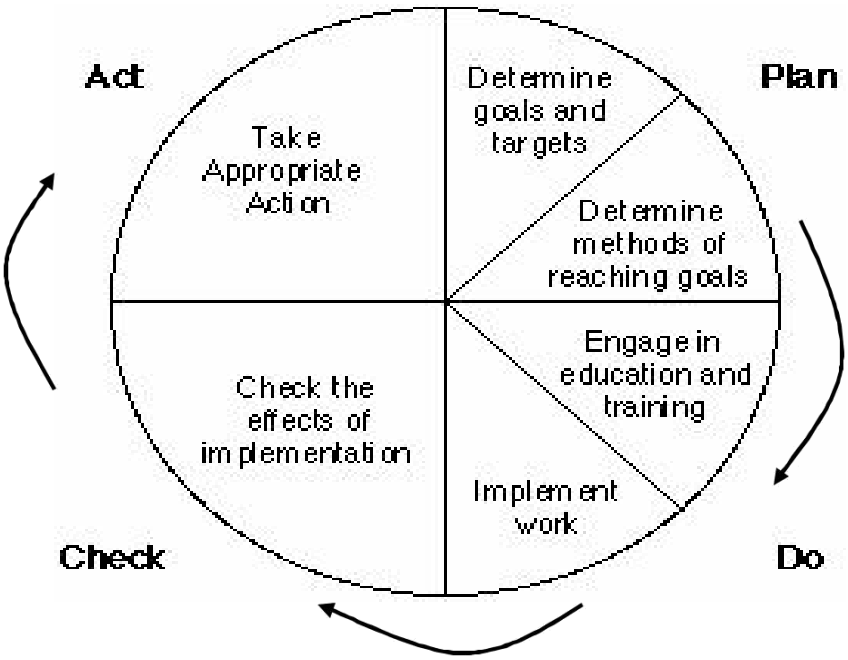


Figure 9.1-- Deming's Plan-Do-Check-Act model

Company-Wide Quality

Ishikawa built on Feigenbaum's concept of total quality and suggested that all employees have a greater role to play. He argued that an over-reliance on the quality professional would limit the potential for improvement. He also maintained that a company-wide participation was required from the top management to the frontline staff. As every area of an organization can affect quality, all areas should study statistical techniques and implement as required with internal and external quality audit programs. He went on to name areas such as engineering, design, manufacturing, sales, materials, clerical, planning, accounting, business and personnel that can not only improve internally but also provide the essential information to allow strategic management decisions to be made concerning the company.

To illustrate this viewpoint, Ishikawa said, "The results of these company-wide activities are remarkable, not only in ensuring the quality of industrial products but also in their contribution to the company's overall business."

Under the "company-wide" Ishikawa umbrella are not just internal quality control activities of a company but also the company itself, the quality of management, human respect, after sales service and customer care. Therefore, he suggested the following:

Company-Wide Quality Benefits

Reduced defects
Improved product quality
Quality improvement becomes the norm

Increased reliability
Reduced costs
Increased quality of production
Waste is identified and reduced
Rework is identified and reduced
Improvement techniques are established and continually improved
Inspection and after-the-fact expenses are reduced
Contracts are rationalized
Sales and market opportunities are increased
Company reputation is increased
Interdepartmental barriers are broken down and communication becomes easier
False and inaccurate data is reduced
Meetings are more effective and focused
Repairs and maintenance are rationalized
Improvement in human relations
Company loyalty has increased

Quality Circles

Quality circle is the main ingredient of Ishikawa's company-wide quality control consisting typically of 5-10 personnel who meet at regular intervals. Led by a supervisor or team leader, they aim to contribute to and improve processes and activities, build up job satisfaction and company loyalty, and utilize existing and hidden resource potential. As part of membership, each member should be fully conversant with statistical quality control techniques and related methodologies in order to achieve quality improvement.

Wherever possible, the quality circles should be encouraged to implement improvements and solutions themselves. Or they can present to the higher management suggestions that identifies an additional training requirement of data presentation and reporting.

This naturally produces an environment where operators are continually looking for solutions to problems, gaining a greater commercial awareness with an ability to "stand back" from the process, greater involvement and at the same time develop by using quality tools.

Ishikawa (Fishbone) Diagram

This diagram effectively identifies "cause and effect" in a brainstorming style session that can be easily understood. The main points of influence are the "Ms" and "Es" (manpower, machines, methods, materials and environment).

It is often used as a team "brainstorming" tool that can trigger and ease out important issues. It is laid out with the contributing causes documented hierarchically with the most pressing problems being at the spine.

The use of the Ms and Es help start it off and ensure logical control. The most effective method of doing this is to select a scribe (the one who documents) and then encourage the rest of the team to contribute. Seeing the ideas on paper often triggers more ideas.

A cause and effect diagram is an analysis tool to display possible causes of a specific problem or condition. Its major benefit is that it pushes you to consider all possible causes of the problem, rather than just the ones that are most obvious.

This diagram is also known as the fishbone diagram. This is because it was drawn to resemble the skeleton of a fish, with the main causal categories drawn as "bones" attached to the spine of the fish, as shown below in figure 9.2.

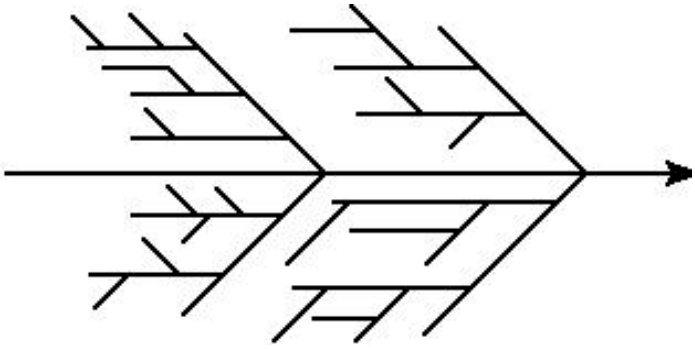


Figure 9.2-- The Fishbone (cause and effect) diagram

Uses of Cause And Effect Diagram

Identifying the potential causes of a problem or issue in an orderly way. For example, why has membership in the band decreased, why is not the phone being answered on time, why is the production process suddenly producing so many defects?
Summarizing major causes under four categories, e.g., people, machines, methods and materials, or policies, procedures, people and plant)

Benefits of the 5 Whys

Helps identify the root cause of a problem
Determine the relationship between different root causes of a problem
One of the simplest tools and is easy to complete without statistical analysis

When are 5 whys most useful?

When problems involve human factors or interactions
In day-to-day business life, it can be used within or without a six sigma project

How to complete the 5 whys?

Write down the specific problem. Writing the issue helps you formalize the problem and describe it completely. It also helps a team focus on the same problem.
Ask why the problem happens and write the answer down below the problem.
If the answer you just provided does not identify the root cause of the problem that you wrote down in step 1, ask why again and write that answer down.
Loop back to step 3 until the team is in agreement that the problem's root cause is identified.
Again, this may take fewer or more times than 5 Whys.

Examples of 5 whys

Problem statement-- Customers are unhappy because they are being shipped products that do not meet their specifications.

Why are customers being shipped bad products? Because manufacturing built the products to a specification which is different from what the customer and the sales person agreed to.
Why did manufacturing build the products to a different specification than that of sales? Because the sales person expedites work on the shop floor by calling the head of manufacturing directly to begin work. An error happened when the specifications were being communicated or written down.
Why does the sales person call the head of manufacturing directly to start work instead of following the procedure established in the company? Because the "start work" form requires the sales director's approval before work can begin and slows the manufacturing process (or stops it when the director is out of the office).
Why does the form contain an approval for the sales director? Because the sales director needs to be continually updated on sales for discussions with the CEO.

In this case, only four whys were required to find out that a non-value added signature authority is helping to cause a process breakdown.

Let us take a look at a slightly more humorous example modified from Marc R's posting of 5 Whys in the *iSixSigma Dictionary*.

Problem statement-- You are on your way home from work and your car stops in the middle of the road.

Why did your car stop?
Because it ran out of gas.

Why did it run out of gas?
Because I did not buy any gas on my way to work.

Why did not you buy any gas this morning?
Because I did not have any money.

Why did not you have any money?
Because I lost it all last night in a poker game.

Why did you lose your money in last night's poker game?
Because I am not very good at "bluffing" when I do not have a good hand.

In both the examples, the final “why” leads the team to a statement (root cause) that the team can take action upon. It is much quicker to come up with a system that keeps the sales director updated on recent sales or teach a person to "bluff" a hand than it is to try to directly solve the stated problems above without further investigation.

5 Whys and the Fishbone Diagram

The 5 Whys can be used individually or as a part of the fishbone (also known as the cause and effect or Ishikawa) diagram. The fishbone diagram helps in exploring all potential or real causes that result in a single defect or failure. Once all inputs are established on the fishbone, you can use the 5 Whys technique to drill down to the root causes.

Take-Away Quotation

"If you don't ask the right questions, you don't get the right answers. A question asked in the right way often points to its own answer. Asking questions is the ABC of diagnosis. Only the inquiring mind solves problems."-- Edward Hodnett

Ishikawa's Message

As with the other Japanese quality gurus, such as Genichi Taguchi, Kaoru Ishikawa has paid particular attention to making technical statistical techniques used in quality attainment accessible to those in industry. Ishikawa's biggest contribution is in simplifying statistical techniques for quality control in industry. At the simplest technical level, his work has emphasized good data collection and presentation, the use of Pareto diagram to prioritize quality improvements and Ishikawa (cause and effect) diagram.

Ishikawa sees the cause and effect diagram (or Ishikawa diagram), like other tools, as a device to assist groups or quality circles in quality improvement. As such, he emphasizes open group communication as critical to the construction of the diagrams. Ishikawa diagrams are useful as systematic tools for finding, sorting out and documenting the causes of variation of quality in production and organizing mutual relationships between them. Other techniques that Ishikawa has emphasized on include the following seven quality control tools:

Control charts
Scatter diagrams
Binomial probability paper
Sampling inspection.

Turning to organizational, rather than technical contributions to quality, Ishikawa is associated with the Company-Wide Quality Control (CWQC) Movement that started in Japan during the period 1955-60 following the visits of Deming and Juran. Under this, quality control in Japan is characterized by company-wide participation from top management to the lower-ranking employees. Further, all of them study statistical methods. The engineering, design, research, manufacturing, sales, materials, clerical and management departments (such as planning, accounting, business and personnel) also participate. Quality control concepts and methods are used for problem solving in the production process, for incoming material control and for new product design control. They are also used for analysis to help top management decide policy, to verify policy being carried out and for solving problems in sales, personnel, labor management and clerical departments. Quality control audits, internal as well as external, form part of this activity.

Ishikawa sees the CWQC as implying that quality does not only mean the quality of product, but also of after sales service, quality of management, the company itself and the human life. The outcomes of such an approach are as follows:

Product quality is improved and becomes uniform
Defects are reduced
Reliability of goods is improved
Cost is reduced
Quantity of production is increased and it becomes possible to make rational production schedules
Wasteful work and rework are reduced
Technique is established and improved
Expenses for inspection and testing are reduced
Contracts between vendor and vendee are rationalized
The sales market is enlarged
Better relationships are established between departments
False data and reports are reduced
Discussions are carried out more freely and democratically
Meetings are operated more smoothly
Repairs and installation of equipment and facilities are done more rationally
Human relations are improved

The members of the circle have mastered statistical quality control and related methods. They all utilize them to achieve significant results in quality improvement, cost reduction, productivity and safety. The seven tools of quality control which are taught to all employees are as follows:

Pareto charts
Cause and effects diagrams
Stratification
Check sheets
Histograms
Scatter diagrams

Shewhart's control charts and graphs

All members of the circle are continuously engaged in self- and mutual development. They are also involved in control and improvement whenever possible. The circles implement solutions themselves. Otherwise, they put strong pressure on management to introduce them. Since management is already committed to the circles, it is ready to listen or act. Circle members receive no direct financial reward for their improvements.

Questions

On which points does the Ishikawa diagram emphasize?
Ishikawa's diagram is one of the seven basic tools of quality management. How will you use it?
Write down the different steps in creating fishbone or Ishikawa diagram?
What are the organizational uses of Ishikawa diagram?
Give examples of Ishikawa diagram.
How will you use Pareto diagram to solve the problems which is one of the tools of quality management as suggested by Ishikawa?

Taguchi

Introduction

Dr. Genichi Taguchi

Biography

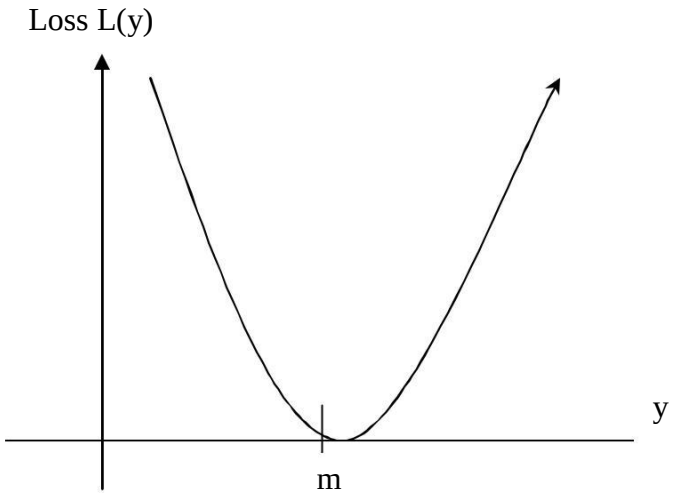


Born on the first day of 1924, Genichi Taguchi studied textile engineering at Kiryu Technical College. After WWII he worked for the Japanese Ministry of Public Health and Welfare and conducted the nation's first study on health and nutrition. He also applied his quality improvement knowledge at Morinaga Pharmaceutical and even worked for a candy maker, Morinaga Sieka, to reduce the melting properties of caramel at room temperature.

Taguchi Philosophy

Genichi Taguchi, a Japanese engineer, realized the importance of cost associated with poor quality and its impact on corporate profitability. Taguchi did not confine himself to the corporate losses alone but took into consideration the losses (due to poor quality) to the society. His principle states that for each deviation there is an incremental economic loss of geometric proportion. The cumulative effect of the functional variations of various products can be very great, although these products may just deviate only a little from the target value of a measurable quality characteristic.

Our traditional view has been that there is no negative effect as long as the products/ components are within their respective engineering specifications. The whole Statistical Quality Control, with its percentage tolerances and the upper and lower control limits is based on this traditional view. In our Statistical Process Control so far, we have seen 3-sigma control limits and “percent” defectives. As long as the process is within these limits, the process was considered to be “in control” or “normal” and it was not to be disturbed. Taguchi, however, (contrary to this view) says that the point to consider is the cumulative impact of the deviations from the target value. Using the Taylor Expansion Series, Taguchi developed a mathematical model in which loss is a quadratic function of the deviation of the quality of interest from its target value. The Taguchi loss function is shown in the figure 10.1.



$L(y) = k (y - m)^2$,
where
y = actual measurement
m = target value
L = Loss, a function of y
k = constant

Figure 10.1-- Taguchi loss function

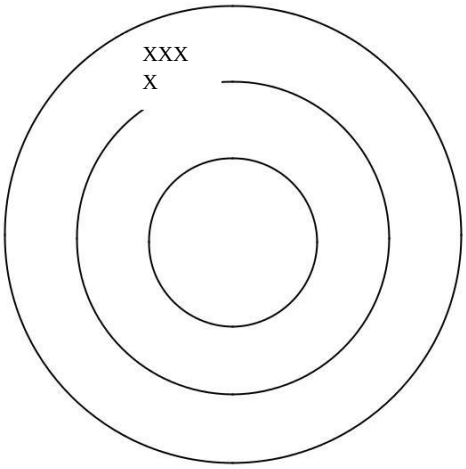


Figure 10.2-- Less accurate but less variable

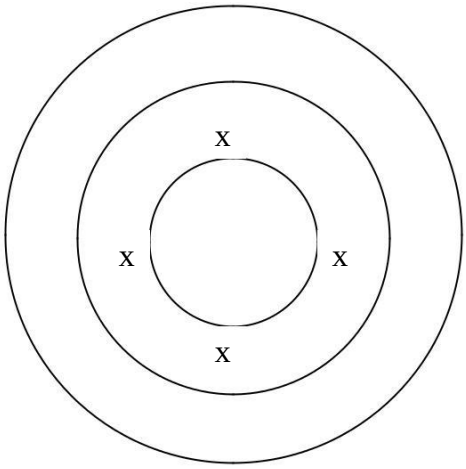


Figure 10.3-- More accurate but more variable

Thus, in Taguchi philosophy, the definition of quality is changed from "achieving conformance to specifications" to "minimizing the variability while achieving the target."

An important aspect of Taguchi philosophy is its linking of the quality of a manufactured product (total loss generated by the product) to the society. If these variations are to be minimized then one has to resort to the Design of Experiments (DOE) in order to identify the factors which are responsible for the variation, to find the relative impact of the factors on the

variability and hence to suitably select a combination of input parameters to achieve the result.

Design of Experiments (DOE)

DOE is a structured method and is not a hit-or-miss experimentation where input parameters are adjusted randomly hoping to achieve process improvement. Taguchi method uses the orthogonal array in order to express the relationship among the factors under investigation. For each level of anyone factor, all levels of other factors occur an equal number of times. This way the experiment is balanced and permits the effect of one factor under study to be separated from the effects of other factors. The design of an orthogonal array does not require that all combinations of factors be tested. Thus, the experiment is cost effective.

If suppose the number of factors is 3 and the levels considered within each factor are 2, the number of experiments (runs) required are (levels) factors = $(2)^3$ = 8. The following simple matrix (table 10.1) depicts one such experiment. The levels chosen are high (1) and low (-1), the factors are X, Y and Z.

If the objective is to maximize the output *P*, the run 7 provides a combination of X, Y and Z which would give the desired result. The above experiment also reveals that the factor X is very significant since its change from -1 to + 1, in runs 5 to 8, has increased the output *P* considerably. Thus, factor X should be very closely controlled while running the production process. The relevance of Taguchi's design of experiments is that we can find a best combination of factors (variables) with only a handful of experiments.

Orthogonal Array				
Run	X	Y	Z	P (output observed)
1	-1	-1	-1	352
2	-1	-1	1	340
3	-1	1	-1	326
4	-1	1	1	362
5	1	-1	-1	404
6	1	-1	1	417
7	1	1	-1	493
8	1	1	1	432

Table 10.1-- Orthogonal array

Robust Design

DOE indicates that varying the factors can affect the product and/or process adversely. Some of the factors may not be within our control, e.g. weather. The challenge before quality engineering is to see that the product performs consistently. This is called "product robustness." The goal is to reduce the sensitivity to uncontrollable factors so that the external variation affects the product

performance as minimally as possible. A toffee manufacturer noticed that their product solidified to a rock hard condition at temperatures below 40°F and became almost soupy above 80°F. Using DOE and appropriately selecting/designing the input process parameters led to a product that was satisfactorily hard in this temperature range. If these kinds of actions toward a "robust design" are not taken, there may be failures due to the external "noise." For instance, the "0" rings which became brittle and failed at low temperature on NASA's Space Shuttle Challenger is an example of a non-robustly designed product.

Quality Circles

Introduction of the Concept

What is a quality circle?

Quality Circle (QC) is a small, voluntary group of employees and their supervisor(s), comprising a team of about 8 to 10 members from the same work area or department group of staff that meets regularly to solve problems relating to their job scope or workplace. QC works on the basis of a continuous and on-going process in an organization. Normally members of a particular QC come from the same workshop who face and share similar problems in their daily work life. Ideally, the group size should be seven or eight to give enough time to each member to actively participate and contribute in each meeting.

The philosophy is that everyone will take more interest and pride in their work if they have a share in the decision-making process or have a say in how their work should be conducted. QC gives employees greater satisfaction and motivation

A man named Kaoru Ishikawa in Japan first developed quality circles in the 1960s. The Union of Japanese Scientists and Engineers (JUSE) were the ones who paid for the research that put the theories about behavior science and quality control together.

Quality circles are useful because the members of the team are from the same workplace and face similar problems. This concept is a management tool that has many benefits for their own work environment. Some examples of those benefits are control and improvement of quality, more effective company communication, using employee problem solving capabilities and more job involvement.

Although the quality circle was developed in Japan yet it spread to more than 50 countries, a development Ishikawa never foresaw. Originally, Ishikawa believed circles depended on factors unique to Japanese society. But after seeing circles thrive in Taiwan and South Korea, he theorized that circles could succeed in any country that used the Chinese alphabet. Ishikawa's reasoning was that the Chinese alphabet, one of the most difficult writing systems in the world, can be mastered only after a great deal of study; thus, hard work and the desire for education became part of the character of those nations. Within a few years, however, the success of circles around the world led him to a new conclusion: Circles work because they appeal to the democratic nature of humankind. "Wherever they are, human beings are human beings," Ishikawa wrote in a 1980 preface to the English translation of the Koryo.

In “How to Operate QC Circle Activities,” Ishikawa calls middle and upper management the parent-teacher association of quality control circles. Although circles were one of the earliest Japanese ideas about quality to be popularized in the West yet Ishikawa was always aware of the importance of top management support. Support from the top is a key element in Japan's all encompassing quality strategy: company-wide quality control (CWQC), perhaps best described in Ishikawa's *What is Total Quality Control? - The Japanese Way*. Ishikawa's work with top management and CWQC covered decades. In the late 1950s and early 1960s, he developed quality control courses for executives for top managers. He also helped launch the “Annual Quality Control Conference” for top management in 1963.

Concept

The concept of quality circle is primarily based upon recognition of the value of the worker as a human being, as someone who willingly participates in his job, his wisdom, intelligence, experience, attitude and feelings. It is based upon the human resource management considered as one of the key factors in the improvement of product quality and productivity. The concept of quality circle has three major attributes:

Quality circle is a form of participation management
Quality circle is a human resource development technique
Quality circle is a problem solving technique

Objective

The objectives of quality circles are multi-faced.

Change in Attitude

From "I don’t care" to "I do care"
Continuous improvement in quality of work life through humanization of work

Self Development

Bring out “hidden potential” of people
People get to learn additional skills

Development of Team Spirit

Individual vs. team-- "I could not do but we did it"
Eliminate inter-departmental conflicts

Improved Organizational Culture

Positive working environment
Total involvement of people at all levels
Higher motivational level

Participate in management process

Benefits of Forming Quality Circles

The benefits gained through QC activities are as follows:

Increase in quality consciousness of employees
Development of an attitude of problem prevention
Promotion of employee motivation
Improvement in the human relations
More effective company communication
More active job involvement
Utilization of employee problem solving capabilities
Contribution to personal development of employees
Encouragement of teamwork
Improvement of work environment
Development of safety awareness
Control and improvement of quality
Productivity improvement
Increased job security

QC activities are voluntarily carried out as part of company-wide quality control.

It took more than two decades for the quality control concept to get acceptance in India after its introduction in Japan. This may be due to the differences in the industrial context in the two countries. Japan needed it for its survival in a competitive market. India had a reasonably protected, sellers market, with consequent lethargy toward efforts to improve quality and productivity. However, with the policy of liberalization of economy and privatization of infrastructure development, contexts changed. The concept now needs to be looked upon as a necessity.

The aim of quality circles is to inculcate effective team dynamics through communication, trust, shared vision, commitment, involvement, empowerment and learning culture among the staff.

The benefits are that QCs:

Promote individual self-development
Promote teamwork and fellowship
Improve overall company performance and corporate image

Organizational Structure

The quality circle has an appropriate organizational structure for its effective and efficient performance. It varies from industry to industry, organization to organization. But it is useful to

have a basic framework as a model. The structure of a quality circle consists of the following elements:

A Steering Committee

This is at the top of the structure. It is headed by a senior executive and includes representatives from the top management personnel and human resources development people. It establishes policy, plans and directs the program and meets usually once in a month.

Coordinator

He may be a personnel or administrative officer who coordinates and supervises the work of the facilitators and administers the program.

Facilitator

He may be a senior supervisory officer. He coordinates the works of several quality circles through the circle leaders.

Circle Leader

Leaders may be from lowest level workers or supervisors. A circle leader organizes and conducts circle activities.

Circle Members

They may be staff workers. Without circle members the program cannot exist. They are the lifeblood of quality circles. They should attend all meetings as far as possible, offer suggestions and ideas, participate actively in-group process and take training seriously with a receptive attitude.

The roles of steering committee, coordinator, facilitator, circle leader and circle members are well defined.

Launching Quality Circles

The major prerequisites for initiating quality circles in any organization is the total understanding of as well as complete conviction and faith in the participative philosophy, on the part of the top and senior management. In the absence of a commitment from the chief executive to support the quality circle movement totally, it would be inadvisable to seriously attempt the starting of quality circles.

The launching of quality circles involves the following steps:

Expose middle level executives to the concept.
Explain the concept to the employees and invite them to volunteer as members of quality circles.
Nominate senior officers as facilitators.
Form a steering committee.
Arrange training of coordinators, facilitators in basics of quality circle approach, implementation, techniques and operation. Later facilitator may provide training to circle leaders and circle members.
A meeting should be fixed preferably one hour a week for the quality circle to meet.
Formally inaugurate the quality circle.
Arrange the necessary facilities for the quality circle meeting and its operation.

Training

Appropriate training for different sections of employees needs to be imparted. Without a proper understanding of the real concept of Quality Circles, both the workers and management might look at this philosophy with suspicion. Each group should know beforehand the commitments and implications involved as well as the benefit that can be obtained from quality circles.

Such training comprises of the following:

Brief orientation program for top management
Program for middle level executives
Training of facilitators
Training for circle leaders and members

Process of Operation

The operation of quality circles involves a set of sequential steps as follows:

Problem identification-- Identify a number of problems by Brainstorming
Problem selection-- Decide the priority by using appropriate tools like Pareto Analysis, Ranking Method and select the problem to be taken up first.
Problem analysis-- Problem is clarified and analyzed by basic problem solving methods like Ishikawa Diagram, Data Collection and Analysis, Process Flow Diagrams, Histograms & Scatter Diagrams..
Generate alternative solutions-- Identify and evaluate causes and generate number of possible alternative solutions by Brainstorming..
Select the most appropriate solution-- Discuss and evaluate the alternative solutions by comparison in terms of certain Criteria's for e.g.investment and return from the investment, cost benefit analysis, safety etc. This enables to select the most appropriate solution.

Prepare plan of action-- Prepare plan of action for converting the solution into reality which includes the considerations "who, what, when, where, why and how" of solving problems.
Present solution to management for approval.
Implementation of solution-- The management evaluates the recommended solution. Then it is tested and if successful, implemented on a full scale.

How to use the concept?

In using the quality circles concept there are three main parts to go through. The steps are identifying, analyzing and solving quality-related issues. After the quality circle is set up the next step would be to train the group. The training is to make sure all the voluntaries understand the order and meaning of the steps and how to go through them.

Following training is the first real step in the Quality circle process-problem identifying. At this step the members of the group are free to brainstorm about the problems they face in the workplace. Within this brainstorming session there are no bad ideas. After the members have some up with everything they can think of they go through the list and analyze each problem individually.

This step of problem analysis is to look closer at one problem at a time and having everyone's input on how to solve it. This step involves opinions from the members and research. The opinions are important because the members in this group are the ones who are faced with the problems at hand. The research can help to show the member what the result or effect will be with the way they may choose to solve a problem. After they are done with the analysis and come up with the solution they have entered the next step.

The last step in quality circles is the solution. The members prepare how they intend to solve the problem that was first presented in the brainstorming. The solution is explained in how it works and what the solution results should be. Those results are then showed to the mangers and group as a whole in a presentation type of meeting. The three steps of identifying, analyzing and solving are all very important in completing the process of a quality circle.

Basic Quality Problem Solving

Basic problem-solving methods play a key role in modern statistical quality improvement applications. Since the 1960s, workers and engineers in Japanese industry have used simple graphical displays, referred to as the "basic seven QC tools" or the "magnificent seven QC tools," to analyze data and present the results of their problem-solving activities. These displays are now universally taught as tools for organization-wide quality improvement activities and they are often incorporated in large-scale systems for statistical process control.

The "basic seven QC tools" are check sheets, Pareto charts, Ishikawa diagrams, flow diagrams, histograms, scatter plots and control charts.

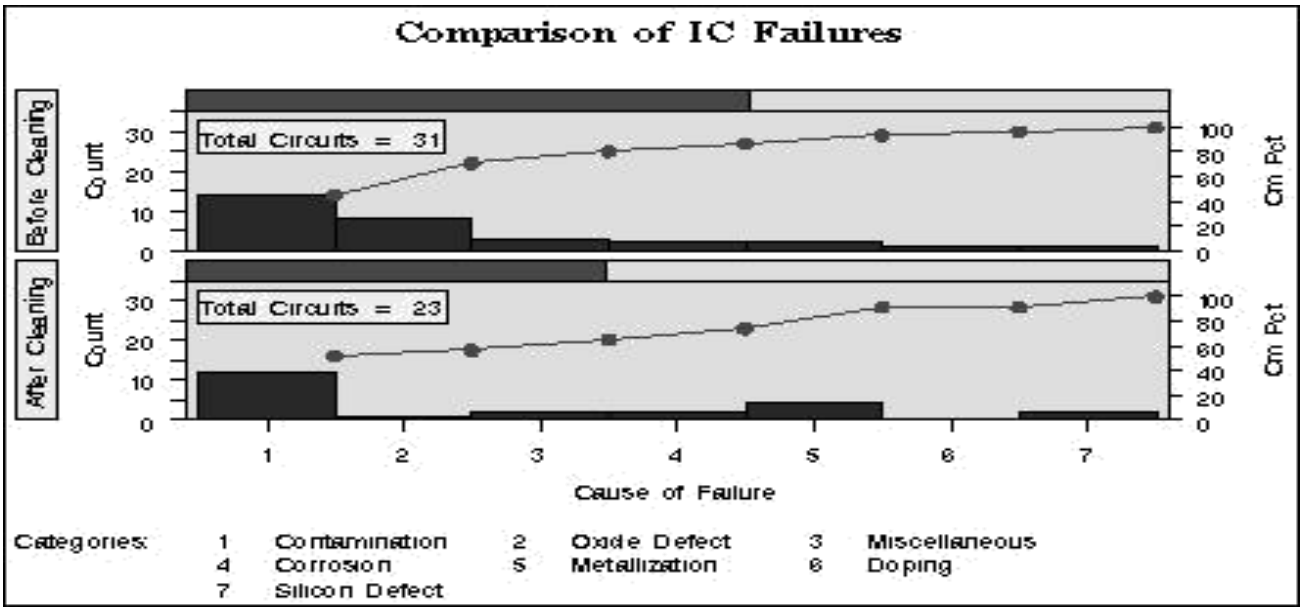


Figure 11.1-- Before and after analysis using a comparative Pareto chart

The Pareto chart is used to determine priorities for quality improvement activities. It is a bar chart that displays the relative frequency of problems in a process or operation. Each bar represents the relative frequency of a problem and the bars are arranged in decreasing order from left to right. Sometimes a curve is superimposed to indicate the cumulative percent of problem frequencies. The chart is named after Vilfredo Pareto (1848-1923), an Italian economist.

Pareto charts provide a tool for visualizing the Pareto principle which states that a small subset of problems (the “vital few”) affecting a common outcome tends to occur much more frequently than the remainder (the "useful many"). The Pareto chart can be used to decide which subset of problems should be solved first, or which problems deserve the most attention. Pareto charts are often constructed to provide a before-and-after comparison of the effect of control or quality improvement measures.

Ishikawa Diagrams (Cause-and-Effect or Ishikawa or Fishbone)

The Ishikawa diagram, also referred to as a cause-and-effect diagram, tree diagram, or fishbone diagram, displays the factors that affect a particular quality characteristic, outcome, or problem. The diagram is named after its developer, Kaoru Ishikawa (1915-1989), a leader in Japanese quality control.

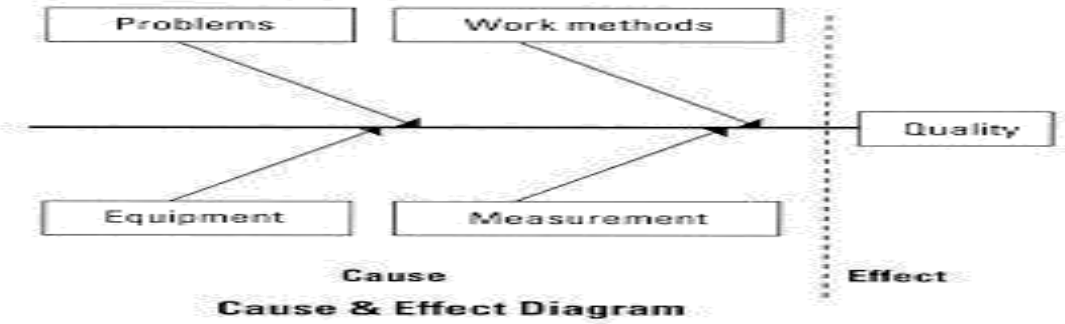


Figure 11.2-- Cause and effect or Ishikawa or fishbone diagram

An Ishikawa diagram is typically the result of a brainstorming session in which members of a group offer ideas on how to improve a product, process, or service. The trunk of the diagram represents the main goal and primary factors are represented as branches. Secondary factors are then added as stems and so on. Creating the diagram stimulates discussion and often leads to increased understanding of a complex problem. Japanese QC circle members often post Ishikawa diagrams in a display area where they are accessible to managers and other groups. In the United States, Ishikawa diagrams are included in presentations by plant personnel to management or customers.

Applicability in Government Organizations

The Public Works Department of Government of Maharashtra is responsible for the construction and maintenance of about two lacs km. of road network in the state and a large number of government-owned buildings spread all over the state. The road network caters for national level traffic to the rural area traffic. The climatic and geographical features also vary from place to place in the state. The ultimate customer of the department is common man and it is not generally easy to satisfy the ultimate needs of this user to the fullest extent merely by taking decision at the top management level.

The subordinate officers and staff working in the field and who are well acquainted with the day-to-day problems in their work areas are the best judges to decide upon the line of action. The top management in Maharashtra P.W.D. realized this need of the time and introduced the concept of quality circle as employee participation method in the organization.

The concept of quality circle was launched in the Public Works Department of Govt. of Maharashtra on 18-11-1997. In a span of about a year 17 quality circles have been formed in Mumbai region wherein 22 problems have been solved so far. 48 quality circles have been formed in Pune region wherein 08 problems have been solved. Nasik region of the P.W.D. has formed 09 quality circles and solutions to 3 problems have been found out. Aurangabad region has formed 21 quality circles and solved seven problems. Nagpur regions have formed 47 quality circles and have found out solution to 57 problems so far.

The results of a short period of one year are found to be very encouraging so far and many of these circles have already come up with solutions to the various work related problems as

evidenced from the last two state level conventions held at Mumbai and Aurangabad respectively. The presentations by the various quality circles at these conventions bear testimony to the fact that the concept of quality circle has been received with much enthusiasm at the grass root level. These presentations also provide concrete evidence fulfilling the expected benefits of the quality circle. Taking inspirations from these conventions, more staff of the Department has come forward to form quality circles, emphasizing the fact that quality circles have come to stay in the Department.

Some of the problems solved by the quality circles in P.W.D. of Maharashtra are as follows:

Eliminating delay in issuing observation memos after inspection of site
Preventing accidents on highways
Reducing electricity bill in office
Avoiding duplication of work
Removal of encroachment from government land
Speeding up pothole filling on roads during monsoon
Up keeping of service records of employees
Maintaining government offices clean
Streamlining reservation system of government rest houses
Improvement in maintenance of government hospital at Solapur

Some of the problems and the solutions thereof are explained briefly below:

Delay in Issue of Observation Memos

The Public Works Department of Maharashtra is divided into six regions each headed by a Chief Engineer. A Superintending Engineer, Vigilance and Quality Circle who with the help of two Executive Engineer and about six Deputy Engineers carries out inspection of the ongoing projects assist each regional Chief Engineer. The samples of the construction material being used on project are collected and independently tested in the Regional Testing Laboratories to ascertain the level of acceptance. The findings of the inspections are communicated to the field engineers in the form of 'observation memo'. It is contemplated that the Execution Engineer in charge of the project ensures immediate compliance of the remarks raised in the observation memo and carries out corrective measures in the ongoing project as well as preventive measures for the future works.

However, very often the observation memos are issued after much delay defeating the very purpose of the observation memo. This problem was identified by the "OMKAR" quality circle formed in the office of Superintending Engineer, Vigilance and Quality Control Circle, Navi Mumbai. The members used various tools and methodology and identified the various root causes that led to this problem and finally solved the problem with requisite foolproofing.

By solving this problem, it became possible to improve the quality of work in the field which ultimately brightened the image of the Department. The formation of quality circle also benefited employees by providing the following:

a. A systematic style of education that helped them grow

Freedom to modify their work habits.
Opportunity to use their brain for development of the department
Opportunity to work as a team
The employees were also motivated to improve work culture, self-improvement recognition and creativity in work.

Preventing Accidents on Highways

It was observed that the accident rate on Sion-Panvel Highway passing through New Mumbai had gone up sharply. The circle members collected the data from the respective police stations and identified the important causes of accidents by using Pareto analysis. They segregated the causes under man, machine, material and method. The circle members found out solutions to the problem such as closing of central verge at all locations except junction, frequent lane marking, installation of caution boards, providing lay-byes for buses etc.

The data collection of accidents for a period three months after implementation of solutions near Shirvane and Turbhe revealed that the cause of accident had been eliminated and no more accidents occurred at those locations had been eliminated and no more accidents happened at those locations again. This way the circle members ensured the effectiveness of the solution implemented. They made presentation to their steering committee for obtaining sanction to other solutions involving more funds.

Questions

Explain the concept of quality circle.
The attitude of an individual or an employee is "I don’t care." What does it mean? Elaborate it with suitable example? How was this attitude changed?
How can the hidden potential of the employees be brought out and what are the advantages of it?
"I could not do but we did it" quality circle member utter this sentence? What do you understand from this?
Explain the Ishikawa diagram
Can you give suitable example of Pareto chart?
Explain “The operation of quality circles.”
Explain the concept of quality circle implemented by PWD.

MODULE 4
Six Sigma

What is six sigma?

Before moving forward in order to understand the concept of six sigma, let us first understand the term sigma and statistics.

Sigma

The term sigma means standard deviation. Standard deviation measures how much variation exists in a distribution of data. It is a key factor in determining the acceptable number of defective units found in a population. Six sigma projects strive for no more than 3.4 defects per million opportunities, yet this number is confusing to many statisticians.

Standard Deviation

Small standard deviation means that data cluster closely around the middle of a distribution and there is little variability among the data. Normal distribution is the bell-shaped curve that is symmetrical about the mean or average value of a population.

Normal Distribution and Standard Deviation

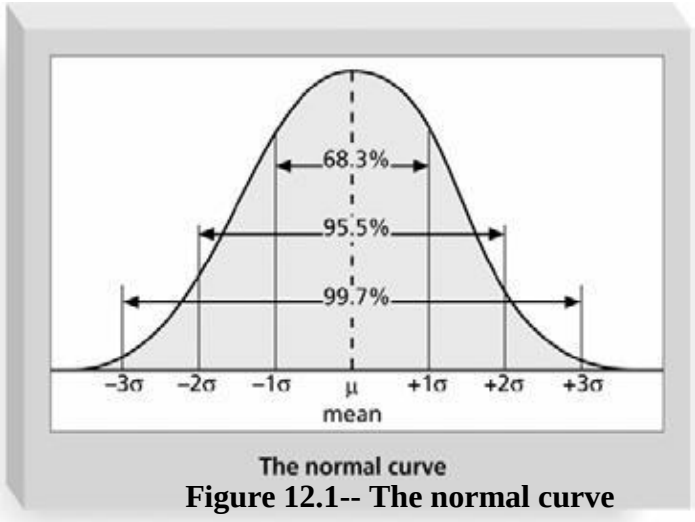


Figure 12.1-- The normal curve

Definition

Six sigma at many organizations simply means a measure of quality that strives for near perfection. Six sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process-- from manufacturing to transactional and from product to service.

Six sigma means a failure rate of 3.4 parts per million or 99.9997% perfect. However, the term in practice is used to denote more than simply counting defects. Six sigma can now imply a whole culture of strategies, tools and statistical methodologies to improve the bottom line of companies. In all, six sigma is a rigorous analytical process for anticipating and solving problems. The objective of six sigma is to improve profits through defect reduction, yield improvement, improved consumer satisfaction and best-in-class product/process performance.

Unlike the statistical term, "sigma" is a measure of conformance to specification. Table 12.1 shows examples.

Six Sigma and Defective Units

Specification Range (in +/- Sigmas)	**Percent of Population Within Range**	**Defective Units Per Billion**
1	68.27	317,300,000
2	95.45	45,400,000
3	99.73	2,700,000
4	99.9937	63,000
5	99.999943	57
6	99.9999998	2

Table 12.1-- Data for the short-term process output

Sigma	Yield	Defects per Million Opportunities (DPMO)
1	31.0%	690,000
2	69.2%	308,000
3	93.3%	66,800
4	99.4%	6,210
5	99.97%	230
6	99.99966%	3.4

Table 12.2-- Data when the process shifts somewhat over a long period of time

As non-conforming rate decreases, "sigma" rating increases. The sigma rating is based on the distribution of a process output as related to a customer requirement. Figure 12.2 shows the short-term process output (solid blue) which is centered in the specification. The short-term variability of the process output is such that the Upper Specification Limit (USL) and the Lower Specification Limit (LSL) are both six standard deviations (called σ or sigma in statistical parlance) away from the center. Recognizing that most of the processes shift somewhat over a long period of time, an arbitrary change of plus or minus 1.5σ is expected to happen, leaving 4.5σ between the shifted average and the specification limit. This means that a process running at a six sigma level in the short term can tolerate a relatively large amount of drift and still make only 3.4 PPM nonconforming over the long term with the dashed blue line.

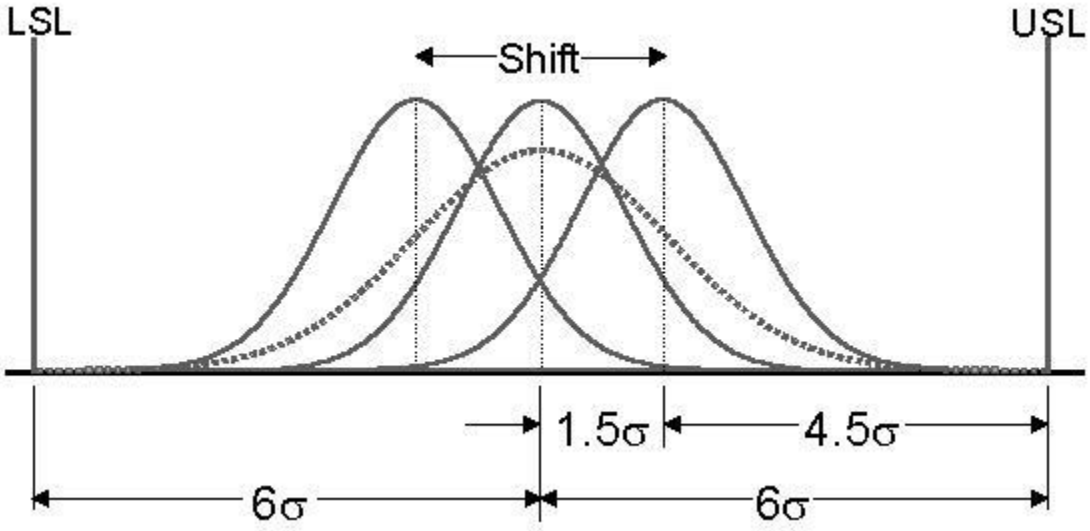


Figure 12.2-- Short-term process output

Phases of Six Sigma

There are six generic implementation phases for six sigma. These are as follows:

Establish management commitment
Business diagnostics
Develop the management infrastructure
Business process identification and metrics
Project selection
Deployment

Training
Project execution
Review

Why is it important?
World-class companies typically operate at about four sigma or 99% perfection. To get to the six-sigma level means cutting down on huge costs and thereby wasted dollars. For example, if you were at four-sigma level, you would be producing products at the rate of 6,200 defectives for every million you produce vs. 3.4 defectives if you are at the six-sigma level. Moreover, six sigma improvement projects typically return in excess of $150k to $250k per project with a black belt returning as much as $1 million to the bottom line each year.

The popularity of six sigma is growing. Some of the companies that have successfully implemented six sigma are as follows:

Motorola (1987)
Texas Instruments (1988)
IBM (1990)
Asea Brown Boveri (1993)
Allied Signal/Kodak (1994)
GE (1995)
Whirlpool
PACCAR
Invensys and Polaroid (1996/98)

Recently, Ford, DuPont, Dow Chemical, Microsoft and American Express have started working on instituting six sigma processes.

When to use it?
Bottom line drives management action. What is your cost of (poor) quality? First you need to determine that. If properly implemented, six sigma implementation can become a profit center for the company. Jack Welch at GE claims that the returns on six sigma implementation amount to about $500 million as of 1998. Remember that six sigma is complementary to other initiatives such as ISO or QS 9000 (which is mainly procedural), total quality management (which is

mainly cultural), and statistical process control (which is primarily statistical process monitoring).

How to use it?

Six sigma focuses on process quality. As such, it falls into the category of a process capability (Cp) technique. Traditionally, a process is considered capable if the natural spread, plus and minus three sigma (a yield of 99.73%), was less than the engineering tolerance. A later refinement considered the process location as well as its spread (Cpk) and tightened the minimum acceptable so that the process was at least four sigma from the nearest engineering requirement. Six sigma requires that processes operate such that the nearest engineering requirement is at least plus or minus six sigma from the process mean. This requires considerable scientific and testing actions. Often, thousands of tests are run on multiple variables to get an understanding of what is going on. Once you determine the process variables, using the other process analysis techniques, you need to consider the ones causing the major losses and work on making them more capable.

Understand who your consumers are and what your product/service is
Review consumer surveys, concession reports and other data
Screen and prioritize issues by severity, frequency/likelihood of occurrence etc
Determine the internal processes causing most of the pain
Find out why and where the defects are occurring
Devise ways to address these defects effectively
Setup a good metrics (six sigma places a lot of emphasis on measurement)

There are a variety of nicknames for the principle players in the initiative.

Champions

Executives with knowledge of six sigma methods
Define projects

Black belts

Full-time position
Lead improvement projects
Serve as change agents
Provide consulting to middle management

Master black belts

Full-time position
Have additional training beyond black belt
training ○ Can train and coach black belts
Provide consulting to management and champions

Green belts

Have black belt training, but stay in present position

Champions and Sponsors

Six sigma champions are high-level individuals who understand six sigma and are committed to its success. In larger organizations, six sigma will be led by a full time, high-level champion, such as an executive vice-president. In all organizations, champions also include informal leaders who use six sigma in their day-to-day work and communicate the six sigma message at every opportunity. Sponsors are owners of processes and systems who help initiate and coordinate six sigma improvement activities in their areas of responsibilities.

Who or what is a black belt?

A person who is part of the leadership structure for process improvement teams are called "black belts" (just as total quality utilized "quality improvement team leaders" to provide structure). Black belts are highly-regarded, technically-oriented product or line personnel who have the ability to lead teams as well as to advise management.

Black Belts

Candidates for black belt status are technically oriented individuals held in high regard by their peers. They should be actively involved in the process of organizational change and development. Candidates may come from a wide range of disciplines and need not be formally trained statisticians or engineers. However, because they are expected to master a wide variety of technical tools in a relatively short period of time, black belt candidates will probably possess a background including college-level mathematics and the basic tools of quantitative analysis. Coursework in statistical methods may be considered a strong plus or even a prerequisite. As part of their training, black belts receive 160 hours of classroom instruction, plus one-on-one project coaching from master black belts or consultants.

Successful candidates will be comfortable with computers. At a minimum, they should understand one or more operating systems, spreadsheets, database managers, presentation programs and word processors. As part of their training, they will be required to become proficient in the use of one or more advanced statistical analysis software packages. Six sigma black belts work to extract actionable knowledge from an organization's information warehouse. To ensure access to the needed information, six sigma activities should be closely integrated with the information systems (IS) of the organization. Obviously, the skills and training of six sigma black belts must be enabled by an investment in software and hardware. It makes no sense to hamstring these experts by saving a few dollars on computers or software.

Master Black Belts-- Overview

Full-time position
Have additional training beyond black belt training
Can train and coach black belts

Provide consulting to management and champions

Who or what is a master black belt?

A master black belt is a person trained in the six sigma methodology who acts as the organization- wide six sigma director or a program manager. He oversees black belts and process improvement projects and provides guidance to the black belts as required. A master black belt teaches other six sigma students and helps them achieve green belt and black belt status.

Master Black Belts

This is the highest level of technical and organizational proficiency. Master black belts provide technical leadership of the six sigma program. Thus, they must know everything the black belts know, as well as understand the mathematical theory on which the statistical methods are based. Master black belts must be able to assist black belts in applying the methods correctly in unusual situations. Whenever possible, statistical training should be conducted only by master black belts. Otherwise, the familiar "propagation of error" phenomenon will occur, i.e. black belts pass on errors to green belts, who pass on greater errors to team members. If it becomes necessary for black belts and green belts to provide training, they should do so only under the guidance of master black belts. For example, black belts may be asked to provide assistance to the master during class discussions and exercises. Because of the nature of the master's duties, communications and teaching skills are as important as technical competence.

Green Belts-- Overview

Have black belt training, but stay in present position

Who or what is a green belt?

A green belt is a person trained in the six sigma methodology who is a team member of six sigma process improvement action teams.

Green Belts

Green belts are six sigma project leaders capable of forming and facilitating six sigma teams and managing six sigma projects from concept to completion. Green belt training consists of five days of classroom training and is conducted in conjunction with six sigma projects. Training covers project management, quality management tools, quality control tools, problem solving and descriptive data analysis. Six sigma champions should attend green belt training. Usually, six sigma black belts help green belts define their projects prior to the training, attend training with their green belts and assist them with their projects after the training.

The structure of a six sigma organization within a business would look something like the following:

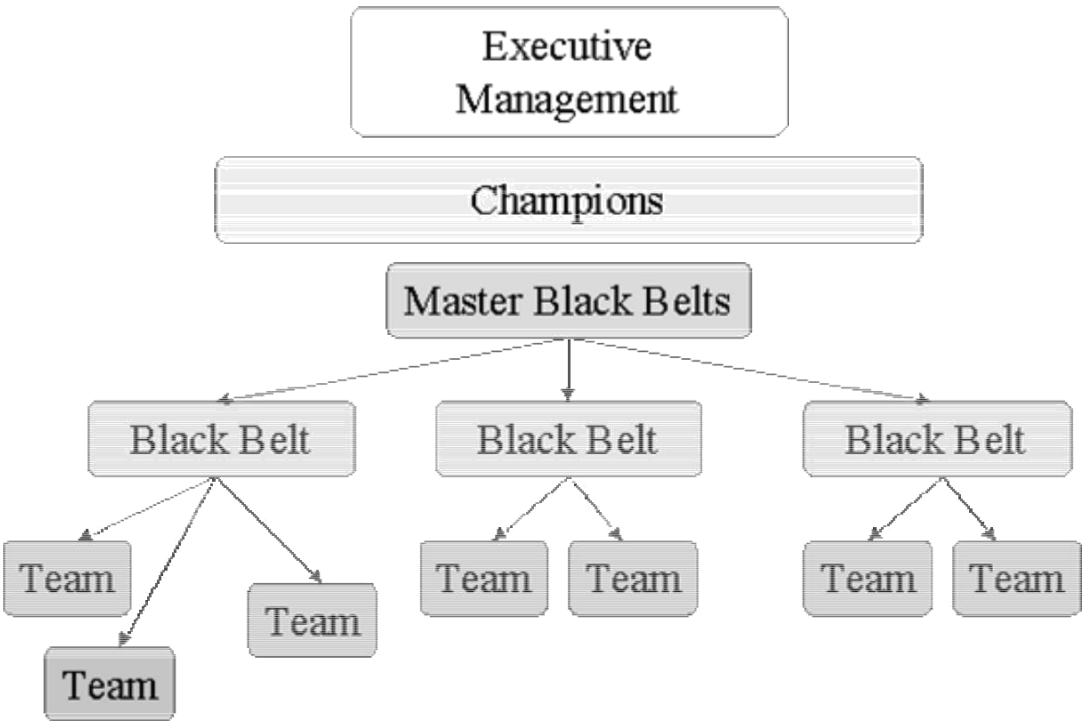


Figure 12.3-- The structure of a six sigma organization

Who drives six sigma?

Usually a top executive or senior manager who "talks the talk" and "walks the walk" of six sigma drives it. This person is the sponsor, a catalyst and the driving force behind the organization's six-sigma implementation.

Six sigma takes a handful of proven methods and trains a small cadre of in-house technical leaders known as six sigma black belts to a high level of proficiency in the application of these techniques. To be sure, some of the methods used by black belts are highly advanced, including the use of up-to-date computer technology. But the tools are applied within a simple performance improvement model known as DMAIC, or Define-Measure-Analyze-Improve-Control. DMAIC can be described as follows:

	Define the goals of improvement activity. At the top level, the goals will be the strategic objectives of the organization, such as a higher ROI or market share. At the operations level, a goal might be to increase the throughput of a production department. At the project level goals might be to reduce the defect level and increase throughput. Apply data mining methods to identify potential improvement opportunities.
	Measure the existing system. Establish valid and reliable metrics to help monitor progress toward the goal(s) defined in the previous step. Begin by determining the current baseline. Use exploratory and descriptive data analysis to help yourself understand the data.
	Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal. Apply statistical tools to guide the analysis.
	Improve the system. Be creative in finding new ways to do things better, cheaper or faster. Use project management and other planning and management tools to implement the new approach. Use statistical methods to validate the improvement.
	Control the new system. Institutionalize the improved system by modifying compensation and incentive systems, policies, procedures, MRP, budgets, operating instructions and other management systems. You may wish to utilize systems such as ISO 9000 to assure that documentation is correct.

Lesson Learned

We learn the following from the successes and failures of six sigma:

A strong, committed management infrastructure and leadership is still required for a successful business.
Personnel employed full-time performing improvement activity can be effective.
Advanced statistical methods offer more possibilities for improvement.
Documentation of financial benefit is the reality for quality program survival.
Business fundamentals should still be addressed.

Questions

Explain the concept of six sigma.
What is DMAIC?
Explain the concept of master belt, black belt and green belt.
Which are the companies who have implemented six sigma?
What can we learn from the successes and failures of six sigma?

MODULE 4

Tools and Techniques-- Pareto and Process Flow Diagram

Pareto Diagram

Alfredo Pareto (1848-1923) conducted extensive studies of distributions of wealth in Europe. He found that there were a few people with a lot of money and many people with little money. This unequal distribution of wealth became an integral part of economic theory. Dr. Joseph Juran recognized this concept as a universal truth that could be applied to many fields. He coined the phrases "vital few" and "useful many."

In restaurant quality problems, the activity could be customer complaints and the factor could be "discourteous customer." For a manufacturer, the activity could be product defect and a factor could be "missing product." Pareto concept, called the 80/20 rule, is that 80 percent of the activity is caused by 20 percent of factors. By concentrating on the 20 percent of the factors (the vital few), a manager can attack 80 percent of the quality problems.

Examples of the vital few are as follows:

A few customers account for the majority of sales.
A few processes account for the bulk of the scrap or rework cost.
A few nonconformities account for the majority of customer complaints.
A few suppliers account for the majority of rejected parts.
A few problems account for the bulk of the process downtime.
A few products account for the majority of the profit.
A few items account for the bulk of the inventory cost.

Some Sample 80/20 Rule Applications

80% of process defects arise from 20% of the process issues.
20% of your sales force produces 80% of your company revenue.
80% of delays in schedule arise from 20% of the possible causes of the delays.
80% of customer complaints arise from 20% of your products or services.

(The above examples are rough estimates.)

The few vital factors can be identified with a Pareto chart or diagram, a bar chart on which the factors are plotted in decreasing order of frequency along the horizontal axis. The chart has two vertical axes, the one on the left showing frequency (as in a histogram) and the one on the right showing the cumulative percentage of frequency. The cumulative frequency curve identifies the few vital factors that warrant immediate managerial attention.

Construction

Determine the categories and the units for comparison of the data, such as frequency, cost or time.
Total the raw data in each category and then determine the grand total by adding the totals of each category.
Reorder the categories from largest to smallest.
Determine the cumulative percent of each category (i.e. the sum of each category plus all categories that precede it in the rank order, divided by the grand total and multiplied by 100).
Draw and label the left-hand vertical axis with the unit of comparison, such as frequency, cost or time.
Draw and label the horizontal axis with the categories. List from left to right in rank order.
Draw and label the right-hand vertical axis from 0 to 100 percent. The 100 percent should line up with the grand total on the left hand vertical axis.
Beginning with the largest category, draw in bars for each category representing the total for that category.
Draw a line graph beginning at the right hand corner of the first bar to represent the cumulative percent for each category as measured on the right hand axis.
Analyze the chart. Usually, the top 20% of the categories will comprise roughly 80% of the cumulative total.

Example-- Pareto Chart for a Restaurant

The manager of a neighborhood restaurant is concerned about the smallest numbers of customers patronizing his eatery. The numbers of complaints have been rising of late. He would like some means of finding out what issues to address and of presenting the findings in a way his employees can understand them.

Solution

The manger surveyed his customers over several weeks and collected the following data:

Complaint	Frequency
Discourteous server	12
Slow service	42
Cold dinner	5
Cramped tables	20
Smoky air	10

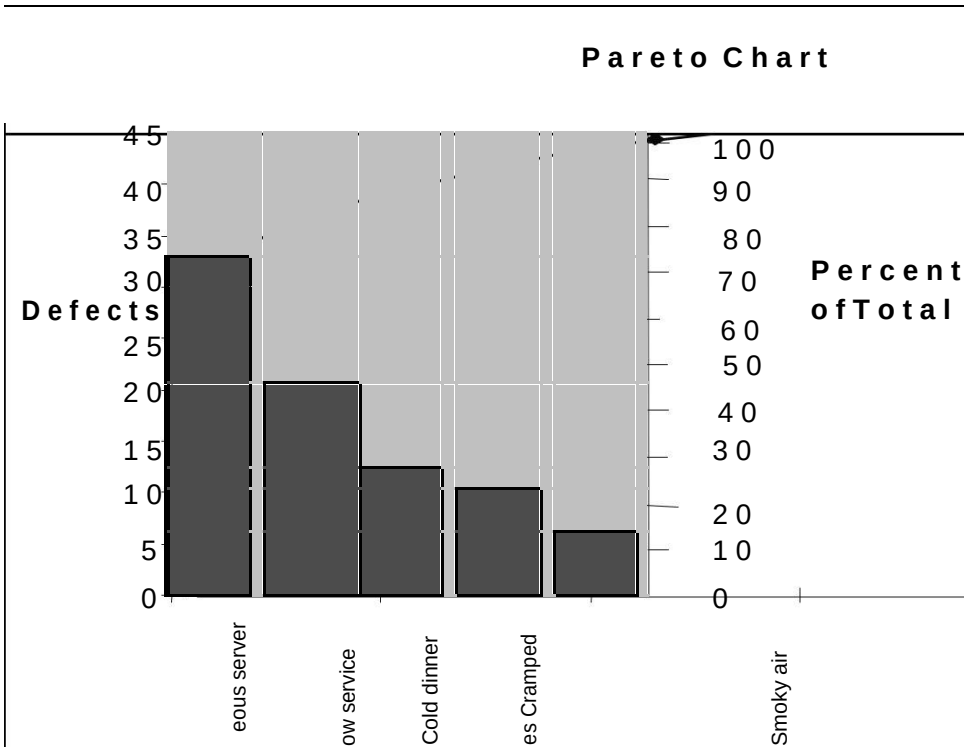


Figure 21.1-- Pareto chart

Decision

It was clear to the manager and all employees which complaints, if rectified, would cover most of the quality problems in restaurant. First, slow service will be addressed by training the existing staff, adding another server and improving the food preparation process. Removing some decorative, but otherwise unnecessary, furniture from dining area and spacing the tables better will solve the problems with cramped tables. The Pareto chart shows that these two problems, if rectified, will account for almost 70 percent of the complaints.

Some possible uses could include the following:

Hotels-- Customer complaints at reception, noise levels in rooms, heating in rooms etc.
Accidents and injuries-- Fractures, eye and foreign bodies, muscle injuries, back injuries, burns, cuts, bruises etc.

Process Flow Diagram

Purpose

A flowchart is a pictorial representation of the steps in a given process. The steps are presented graphically in sequence so that team members can examine the order presented and come to a common understanding of how the process operates.

Flowcharts can be used to describe an existing process or to present a proposed change in the flow of a process. Flowcharts are the easiest way to "picture" a process, especially if it is very complex. Flowcharts should include every activity in the process. A flowchart should be the first step in identifying problems and targeting areas for improvement.

Steps in Flowcharting a Process

Decide on the process of flowchart.
Define the boundaries of the process-- the beginning and the end.
Describe the beginning step of the process in an oval.
Ask yourself ”what happens next?" and add the step to the flowchart as a rectangle. Continue mapping out the steps as rectangles connected by one-way arrows.
When a decision point is reached, write the decision in the form of a question in a diamond and develop the "yes" and "no" paths. Each yes/no path should re-enter the process or exit somewhere.
Repeat steps 4 and 5 until the last step in the process is reached.
Describe the ending boundary/step in an oval.

When drawing a flowchart, constantly ask "what happens next," "is there a decision made at this point," "does this reflect reality," "who else knows this process" etc. When possible, do a walk-through of the process to see if any steps have been left out or extras added that should not be there. The key is not to draw a flowchart representing how the process is supposed to operate, but to determine how it actually does operate. A good flowchart of a bad process will show how illogical or wasteful some of the steps or branches are.

The best way to illustrate the use of these guidelines is to look at a simple example (see below) and follow how each step has been applied.

The first step is to identify the process to be flowcharted and to give the chart a title. In this case, it is “how to fill the car's petrol tank.”
Begin to draw the chart by first describing the event which initiates the process (the “trigger”). In the example, this is “low petrol warning light comes on.”
Then note down each successive action taken. Actions should be described in as few words as possible, but make sure the description is not ambiguous or unclear.
When you reach a point at which the flowchart branches into a number of alternatives and the resulting complexity threatens to overwhelm the exercise, choose the most important alternative to continue flowcharting with. The others can simply be terminated and dealt with in separate flowcharts. Such a point is illustrated in the example where a decision is required on how much petrol is to be put in the tank.
Often you may need to make cross-references to important supporting information (in this example, cross references may be made to, say, a table of preferred brands of petrol, or to a list of cars able to use unleaded petrol).
Continue describing each event, action or decision as it occurs in sequence, until the process is concluded. In the example, this point is reached when the petrol is paid for, the tank is recharged and you are ready to drive off.

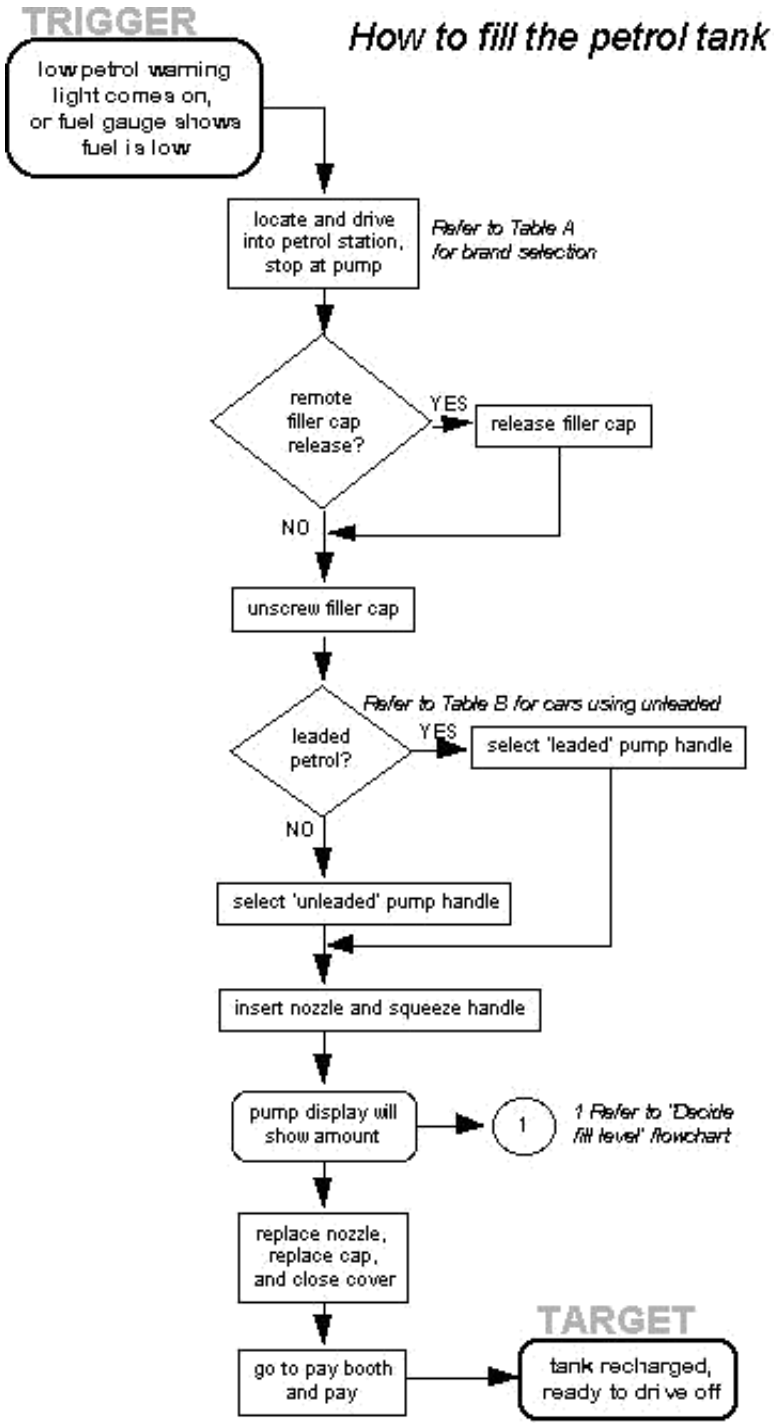
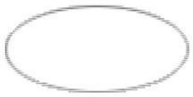
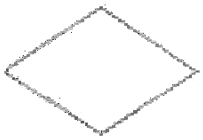


Figure 21.2-- Process flow diagram

Flowcharts help to identify all the key tasks involved. The finished chart can be used for the following purposes:

As a springboard for further discussion of the process
To connect with other flowcharts explaining related activities
To identify points where data can be usefully collected and analyzed
To isolate possible problem areas
To communicate the process to those unfamiliar with it

Symbols in a Flowchart

	Defines the boundaries of a process. Shows the start or stop of a process.
	To show the direction of flow from one activity to the next one in a sequence.
	Designates a single step in a process. Briefly describes the step inside the box.
	A diamond signifies a decision point in the process. Write the type of decision made inside the diamond in the form of a question. The question is answered by two arrows-- "yes" and "no"-- which leads to two different branches.
	A small circle that surrounds a letter signifies where you pick up a process on the same page. Represents a connection.

Tracking "Handovers"

When a flowchart describes a process in which a number of different people, departments or functional areas are involved, it is sometimes difficult to keep track of who is responsible for each step. A useful additional technique for tracking this and for analyzing the number of times a process is "handed over" to different people is to divide the flowchart into columns. Head up each column with the name of the person or function involved in the process. And each time they carry out an action, show it in their column. This is illustrated in the flowchart below which covers a simple purchasing process. It shows how control of the process passes from the person initiating the purchase to the purchasing department and then to the supplier.

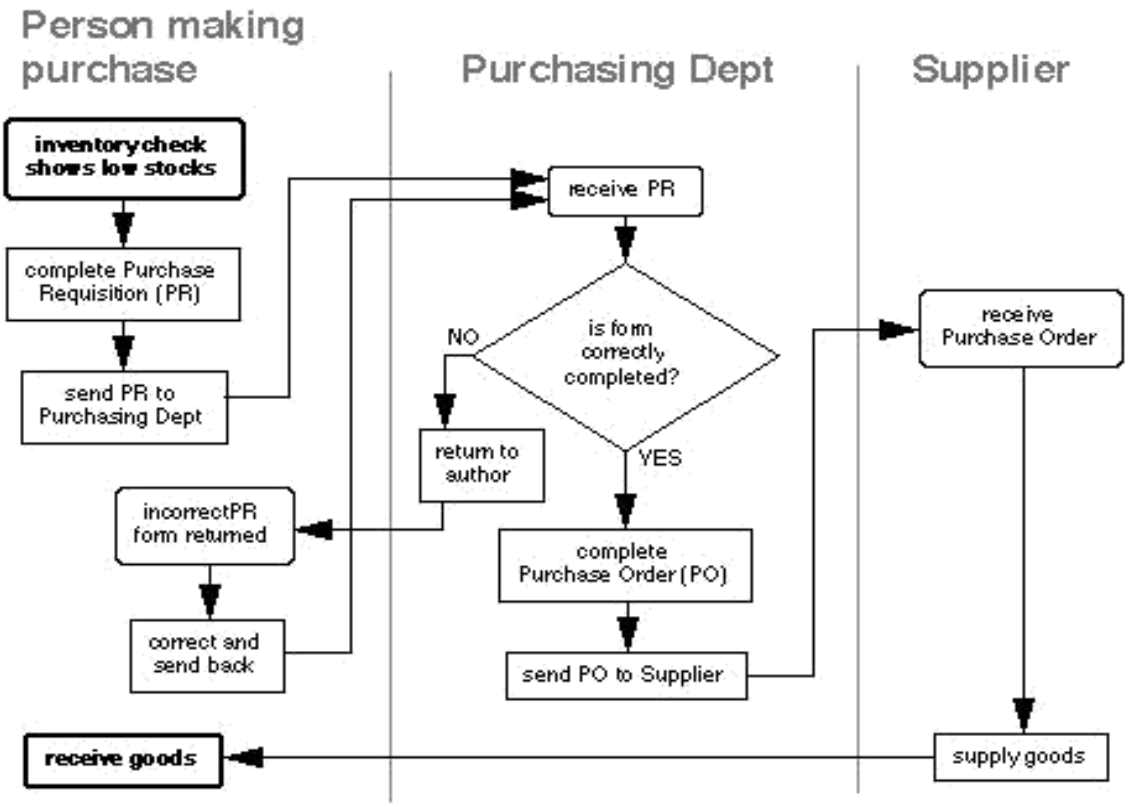


Figure 21.3-- Process flow diagram

MODULE 4

Tools and Techniques- Check sheets & Histograms

Check Sheets

The main purpose of check sheets is to ensure that operating personnel collects the data carefully accurately. Data should be collected in such a manner that it can be quickly and easily used and analyzed. The form of the check sheet is individualized for each situation and is designed by the project team. Figure 22.1 shows a check sheet for paint non-conformities for bicycles.

Figure 22.2 shows a check sheet for temperature. The scale on the left represents midpoint and boundaries for each temperature range. Data for this type of check sheet is frequently recorded by placing an “X” in the appropriate square. In this case, the time has been recorded in order to provide additional information for problem solving.

Whenever possible, check sheets are also designed to show location. For example the check sheet for bicycle paint non-conformities could show an outline of a bicycle with X's indicating the location of the non-conformities. Creativity plays a major role in the design of a check sheet. It should be user-friendly and whenever possible should include information on time and location.

CHECK SHEET

Product: Bicycle 32   Number inspected: 2217

Nonconformity type	Check	Total
Blister	𝍸 𝍸 𝍸 𝍸 |	21
Light spray	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |||	38
Drips	𝍸 𝍸 𝍸 𝍸 ||	22
Overspray	𝍸 𝍸 |	11
Runs	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ||	47
Others	𝍸	5
	Total	144
Number Nonconforming	𝍸 |||	113

Figure 22.1-- Check sheet for bicycle paint non-conformities

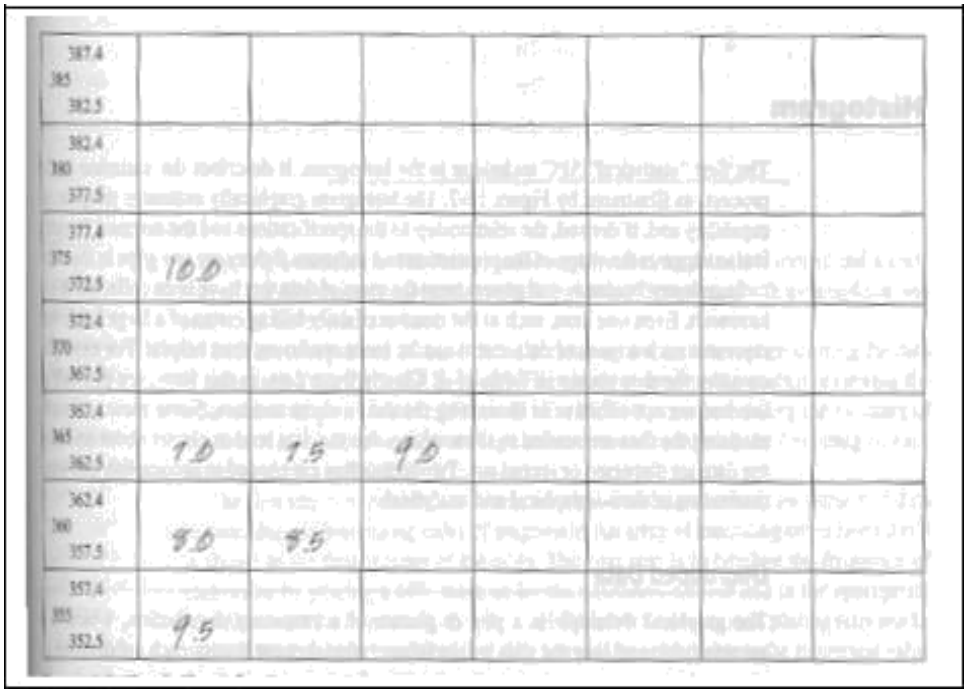


Fig 22.2-- Check sheet

Histogram

Histogram is used to display in bar graph format measurement data distributed by categories.

A histogram is used for the following:

- Making decisions about a process, product or procedure that could be improved after examining the variation. For example, should the school invest in a computer-based tutoring program for low achieving students in Algebra after examining the grade distribution, are more shafts being produced out of specifications that are too big rather than too small?
- Displaying easily the variation in the process. For example, which units are causing maximum difficulty for students, is the variation in a process due to parts that are too long or parts that are too short?

Steps in Constructing a Histogram

- Gather and tabulate data on a process, product or procedure. This could be time, weight, size, frequency of occurrences, test scores, GPA's, pass/fail rates, number of days to complete a cycle, diameter of shafts built etc.
- Calculate the range of the data by subtracting the smallest number in the data set from the largest. Call this value R.
- Decide about how many bars (or classes) you want to display in your eventual histogram. Call this number K. This number should never be less than four and seldom exceeds 12. With 100 numbers, K=7 generally works well. With 1000 pieces of data, K=11 works well.

Determine the fixed width of each class by dividing the range, R by the number of classes K. This value should be rounded to a "nice" number, generally a number ending in a zero. For example, 11.3 would not be a "nice" number. 10 would be considered a "nice" number. Call this number i, for interval width. It is important to use "nice" numbers else the histogram created will have strange scales on the X-axis.

Create a table of upper and lower class limits. Add the interval width (i) to the first "nice" number less than the lowest value in the data set to determine the upper limit of the first class. This first "nice" number becomes the lowest lower limit of the first class. The upper limit of the first class becomes the lower limit of the second class. Adding the internal width (i) to the lower limit of the second class, it determines the upper limit for the second class. Repeat this process until the largest upper limit exceeds the biggest piece of data. You should have approximately K classes or categories in total.

Sort, organize or categorize the data in such a way that you can count or tabulate how many pieces of data fall into each of the classes or categories in your table above. These are the frequency counts and will be plotted on the Y-axis of the histogram.

Create the framework for the horizontal and vertical axes of the histogram. On the horizontal axis, plot the lower and upper limits of each class determined above. The scale on the vertical axis should run from zero to the first "nice" number greater than the largest frequency count determined above.

Plot the frequency data on the histogram framework by drawing vertical bars for each class. The height of each bar represents the number or frequency of values occurring between the lower and upper limits of that class.

Interpret the histogram for skew and clustering problems

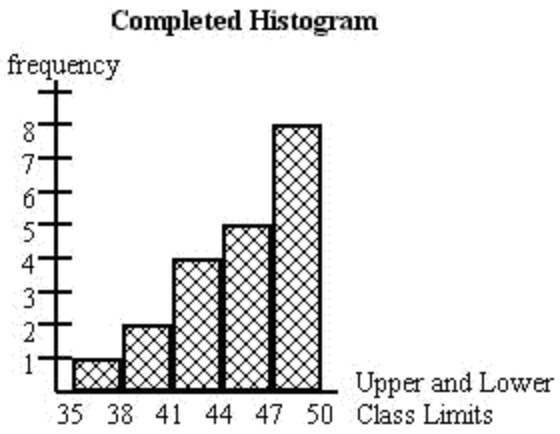
Example

The data below are the spelling test scores for 20 students on a 50- word spelling test. The scores (number correct) are 48, 49, 50, 46, 47, 47, 35, 38, 40, 42, 45, 47, 48, 44, 43, 46, 45, 42, 43 and 47.

The largest number is 50 and the smallest is 35. Thus, the range, R = 15. We will use 5 classes, so K=5. The interval width i = R/K = 15/5 = 3.

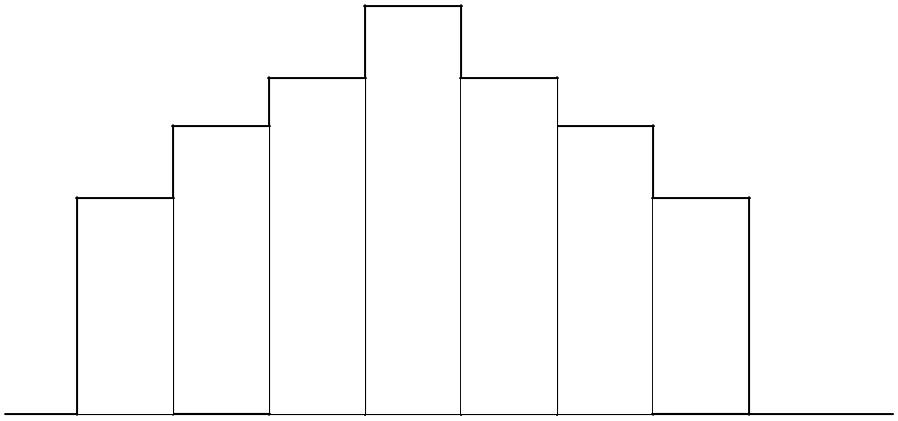
Then we will make our lowest lower limit, the lower limit for the first class 35. Thus, the first upper limit is 35+3 or 38. The second class will have a lower limit of 38 and an upper limit of 41. The completed table (with frequencies tabulated) will look like the following:

Class	Lower Limit	Upper Limit	Frequency
1	35	38	1
2	38	41	2
3	41	44	4
4	44	47	5
5	47	50	8



Examples of Typical Distributions

Normal

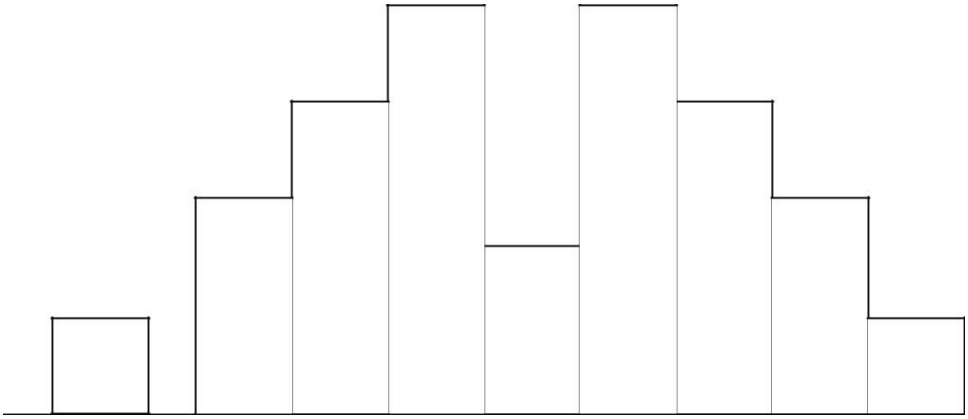


Depicted by a bell-shaped curve

Most frequent measurement appears as center of distribution
Less frequent measurements taper gradually at both ends of distribution

Indicates that a process is running normally (only common causes are present)

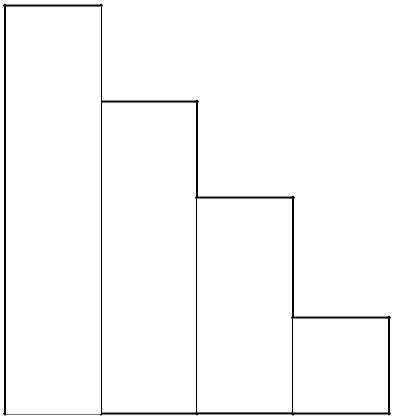
Bi-Modal



Distribution appears to have two peaks
May indicate that data from more than process are mixed together

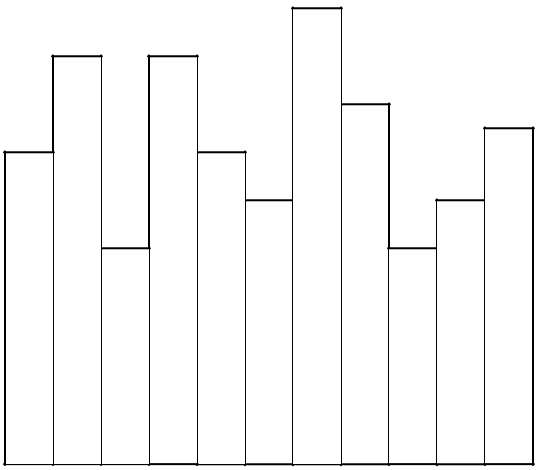
Materials may come from two separate vendors
Samples may have come from two separate machines

Cliff-Like



Appears to end sharply or abruptly at one end
Indicates possible sorting or inspection of non-conforming parts

Saw-Toothed



Also commonly referred to as a comb distribution, appears as an alternating jagged pattern

Often indicates a measuring problem

Improper gage readings
Gage not sensitive enough for readings

Limitations of Technique

Histograms are limited in their use due to the random order in which samples are taken and lack of information about the state of control of the process. Because samples are gathered without regard to order, the time-dependent or time-related trends in the process are not captured. So, what may appear to be the central tendency of the data may be deceiving. With respect to process statistical control, the histogram gives no indication whether the process was operating at its best when the data was collected. This lack of information on process control may lead to incorrect conclusions being drawn and, hence, inappropriate decisions being made. Still, with these considerations in mind, the histogram's simplicity of construction and ease of use make it an invaluable tool in the elementary stages of data analysis.

MODULE 5

Tools and Techniques-- Quality Function Deployment

Introduction

Dr. Mizuno, professor emeritus of the Tokyo Institute of Technology, is credited with initiating the Quality Function Deployment (QFD) system. The first application of QFD was at Mitsubishi Heavy Industries Ltd. in the Kobe Shipyard, Japan, in 1972. After four years of case study development, refinement and training, QFD was successfully implemented in the production of mini vans by Toyota. Using 1977 as a base, a 20% reduction in startup costs was reported in the launch of a new van in October 1979, a 38% reduction by November 1982 and a cumulative 61% reduction by April 1984. Quality function deployment was first introduced in the United States in 1984 by Dr. Clausing of Xerox. QFD can be applied to practically any manufacturing or service industry. It has become a standard practice by most of the leading organizations who also require it for their suppliers.

Quality function deployment is a planning tool used to fulfill customer expectations. It is a disciplined approach to product design, engineering and production and provides in-depth evaluation of a product. An organization that correctly implements QFD can improve engineering knowledge, productivity and quality, and reduce costs, product development time and engineering changes.

QFD focuses on customer expectations or requirements, often referred to as the voice of the customer. It is employed to translate customer expectations, in terms of specific requirements, into directions and actions, in terms of engineering or technical characteristics, that can be deployed through the following:

Product planning
Part development
Process planning
Production planning
Service industries

Quality function development is a team-based management tool in which customer expectations are used to drive the product development process. Conflicting characteristics or requirements are identified early in the QFD process and can be resolved before production.

Organizations today use market research to decide what to produce to satisfy customer requirements. Some customer requirements adversely affect others and customers often cannot explain their expectations. Confusion and misinterpretation are also a problem while a product moves from marketing to design to engineering to manufacturing. This activity is where the voice of the customer becomes lost and the voice of the organization adversely enters the product design. Instead of working on what the customer expects, work is concentrated on fixing what

the customer does not want. In other words, it is not productive to improve something the customer did not want initially. By implementing QFD, an organization is guaranteed to implement the voice of the customer in the final product or service.

QFD helps in identifying new quality technology and job functions to carry out operations. This tool provides a historic reference to enhance future technology and prevent design errors. QFD is primarily a set of graphically oriented planning matrices that are used as the basis for decisions affecting any phase of the product development cycle. Results of QFD are measured based on the number of design and engineering changes, time to market, cost and quality. It is considered by many experts to be a perfect blueprint for quality by design.

Quality function deployment enables the design phase to concentrate on the customer requirements, thereby spending less time on redesign and modifications. The saved time has been estimated at one-third to one-half of the time taken for redesign and modification using traditional means. This saving means reduced development cost and also additional income because the product enters the market sooner.

The QFD Team

When an organization decides to implement QFD, the project manager and team members need to be able to commit a significant amount of time to it, especially in the early stages. The priorities of the projects need to be defined and told to all departments within the organization so that team members can budget their time accordingly. Also, the scope of the project should be clearly defined so that questions about why the team was formed do not arise. One of the most important tools in the QFD process is communication.

There are two types of teams-- designing a new product or improving an existing product. Teams are composed of members from marketing, design, quality, finance and production. The existing product team usually has fewer members because the QFD process will only need to be modified. Time and inter-team communication are two very important things that each team should utilize to their fullest potential. Using time effectively is the essential resource in getting the project done on schedule. Using inter- team communication to its fullest extent will alleviate unforeseen problems and make the project run smoothly.

Team meetings are very important in the QFD process. The team leader needs to ensure that the meetings are run in the most efficient manner and that the members are kept informed. The meeting format should have some way of measuring how well the QFD process is working at each meeting and should be flexible, depending on certain situations. The duration of the meeting will rely on where the team's members are coming from and what needs to be accomplished. These workshops may have to last for days if people are coming from around the world or for only hours if everyone is local. There are advantages to shorter meetings and sometimes much more can be accomplished in a shorter meeting. Shorter meetings allow information to be collected between times that will ensure that the right information is being entered into the QFD matrix. Also, they help keep the team focused on a quality improvement goal.

Benefits of QFD

Quality function deployment was originally implemented to reduce start-up costs. Organizations using QFD have reported a reduced product development time. For example, US car manufacturers of the late 1980s and early 1990s needed an average of five years to put a product in the market, from drawing board to showroom. Whereas Honda used to put a new product in the market in two and a half years and Toyota did it in three years. Both organizations credit this reduced time to the use of QFD. Product quality and, consequently, customer satisfaction improve with QFD due to numerous factors as depicted in figure 23.1.

Improves Customer Satisfaction

Quality function deployment looks past the usual customer response and attempts to define the requirements in a set of basic needs that are compared to all competitive information. All competitors are evaluated equally from customer and technical perspectives. This information can then be prioritized using a Pareto diagram. Management can then place resources where they will be the most beneficial in improving quality. Also, QFD takes the experience and information which are available within an organization and puts them together as a structured format that is easy to assimilate. This is important when an organization's employee leaves a particular project and a new employee is hired.

Reduces Implementation Time

Fewer engineering changes are needed when using QFD. When used properly, all conflicting design requirements can be identified and addressed prior to production. This education in used in operator training and changes in traditional quality control measures. By using QFD, critical items can be identified and monitored from product inception to production. Toyota reports that the quality of their product has improved by one-third since the implementation of QFD.

Promotes Teamwork

Quality function deployment forces a horizontal deployment of communication channels. Inputs are required from all facets of an organization-- from marketing to production to sales. Thus, it ensures that the voice of the customer is being heard and that each department knows what the other is doing. This activity avoids misinterpretation, opinions and miscues. In other words, the left hand always knows what the right hand is doing. Efficiency and productivity always increase with enhanced teamwork.

Provides Documentation

A database for future design or process improvements is created. Data that are historically scattered within operations, frequently lost and often referenced out of context are now saved in an orderly manner to serve future needs. This database also serves as a training tool for new engineers. Quality function deployment is also very flexible when new information is introduced or things have to be changed on the QFD matrix.

The Voice of the Customer

Because QFD concentrates on customer expectations and needs, a considerable amount of effort is put into research to determine customer expectations. This process increases the initial planning stage of the project definition phase in the development cycle. But the result is a total reduction of the overall cycle time in bringing to the market a product that satisfies the customer.

The driving force behind QFD is that the customer dictates the attitude of a product. Customer satisfaction, like quality, is defined as meeting or exceeding customer expectations. Words used by the customers to describe their expectations are often referred to as the voice of the customer. Sources for determining customer expectations are focus groups, surveys, complaints, consultants, standards and federal regulations. Frequently, customer expectations are vague and general in nature. It is the job of the QFD team to analyze these customer expectations into more specific customer requirements. Customer requirements should be taken literally and not incorrectly translated into what organization official's desire.

Quality function deployment begins with marketing to determine what exactly the customer desires from a product. During the collection of information, the QFD team should continually ask and answer numerous questions, such as the following:

What does the customer really want?
What are the customer's expectations?
Are the customer's expectations used to drive the design process?
What can the design team do to achieve customer satisfaction?

There are many different types of customer information and ways that an organization can use to collect data, as shown in figure 23.2. The organization can search (solicited) for the information, or the information can be volunteered (unsolicited) to the organization. Solicited and unsolicited information can be further categorized into measurable (quantitative) or subjective (qualitative) data. Furthermore, qualitative information can be found in a routine (structured) manner or haphazard (random) manner.

Customer information, sources and ways through which an organization can collect data can be described as follows.

Solicited, measurable and routine data are typically found through following ways:

Customer surveys, market surveys and trade trials
Working with preferred customers
Analyzing products from other manufacturers
Buying back products from the field

This information tells an organization how it is performing in the current market.

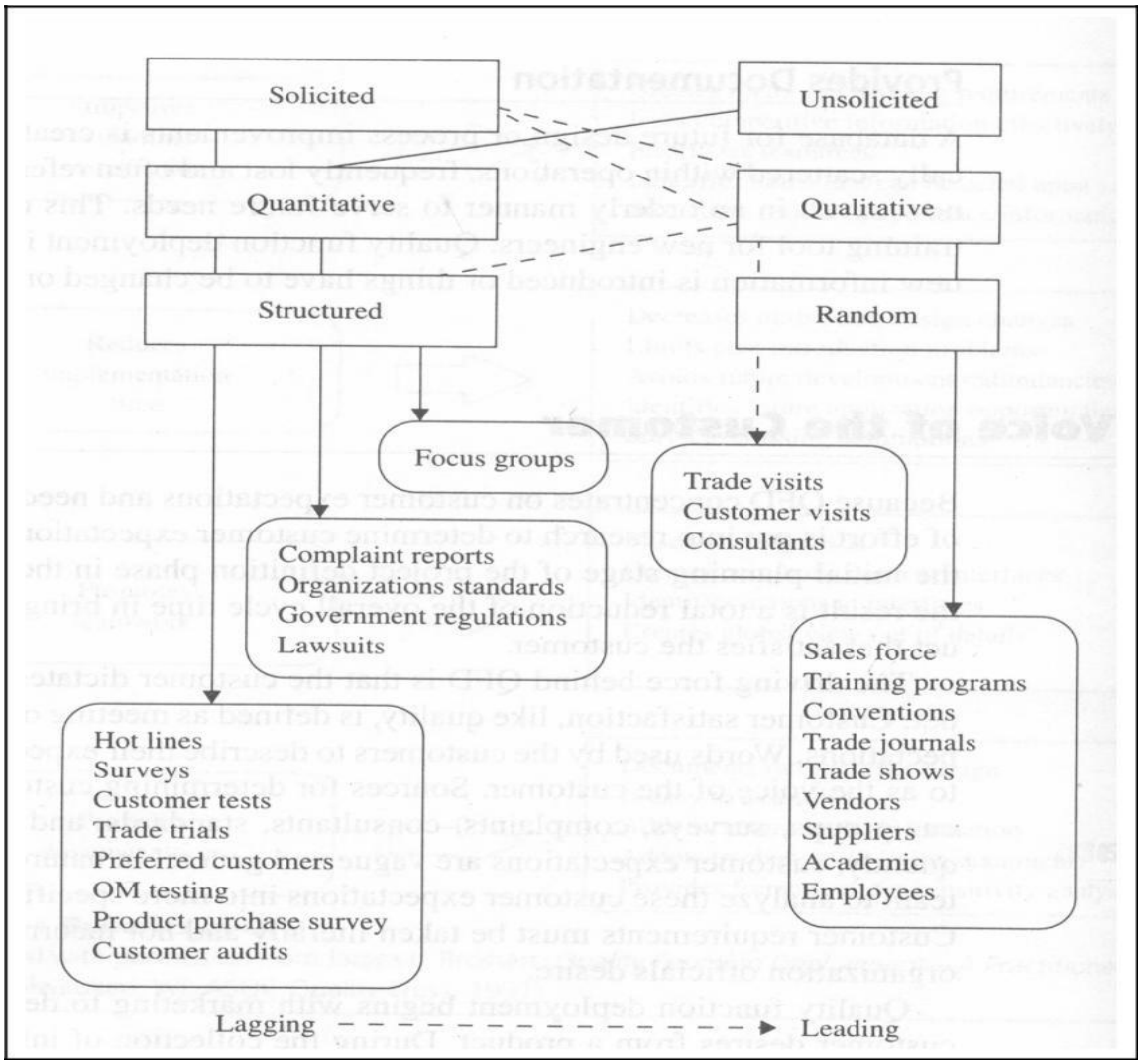


Figure 23.1-- Types of customer information and how to collect it

Unsolicited, measurable and routine data tend to take the form of customer complaints or lawsuits. This information is generally disliked. However, it provides valuable learning information.

Solicited, subjective and routine data are usually gathered from focus groups. The objective of these focus groups is to find out the likes, dislikes, trends and opinions about current and future products.

Solicited, subjective and haphazard data are usually gathered from trade visits, customer visits and independent consultants. These types of data can be very useful. However, they can also be misleading, depending on the quantity and frequency of information.

Unsolicited, subjective and haphazard data are typically obtained from conventions, vendors, suppliers and employees. This information is very valuable and often relates to the true voice of the customer.
The goal of QFD is not only to meet as many customer expectations and needs as possible, but also to exceed customer expectations. Each QFD team should make its product either more appealing than the existing product or more appealing than the product of a competitor. This situation implies that the team has to introduce an expectation or need in its product that the customer is not expecting but would appreciate. For example, cup holders were put into automobiles as an extra bonus, but customers liked them so well that they are now expected in all new automobiles.

Organization of Information

Now that the customer expectations and needs have been identified and researched, the QFD team needs to process the information. Numerous methods include affinity diagrams, interrelationship diagrams, tree diagrams and cause and effect diagrams. These methods are ideal for sorting large amounts of information.

Affinity Diagram

Affinity diagram is the tool that gathers a large amount of data and subsequently organizes the data into groupings based on their natural interrelationships. An affinity diagram should be implemented when thoughts are too widely dispersed or numerous to organize.

New solutions are needed to circumvent the more traditional ways of problem solving. Support for a solution is essential for successful implementation.

This method should not be used when the problem is simple or if a quick solution is needed. The team needed to accomplish this goal effectively should be a multi-disciplinary one that has the required knowledge to delve into the various areas of the problem.

A team of six to eight members should be adequate to assimilate all of the thoughts. Constructing an affinity diagram requires four simple steps:

Phrase the objective.
Record all responses.
Group the responses.
Organize groups in an affinity diagram.

The first step is to phrase the objective in a short and concise statement. It is imperative that the statement be as generalized and vague as possible.

The second step is to organize a brainstorming session in which responses to this statement are individually recorded on cards and listed on a pad. It is sometimes helpful to write down a

summary of the discussion on the back of the cards, so that in the future when the cards are reviewed, the session can be briefly explained.

Next, all the cards should be sorted by placing the cards that seem to be related into groups. Then, a card or word is chosen that best describe each related group, which becomes the heading for each group of responses. Finally, lines are placed around each group of responses and related clusters are placed near each other with a connecting line.

House of Quality

The primary planning tool used in QFD is the house of quality. The house of quality translates the voice of the customer into design requirements that meet specific target values and matches those against how an organization will meet those requirements. Many managers and engineers consider the house of quality to be the primary chart in quality planning.

The structure of QFD can be thought of as a framework of a house, as shown in figure 23.3. The parts of the house of quality are described as follows:

The exterior walls of the house are the customer requirements. On the left side is a listing of the voice of the customer or what the customer expects in the product. On the right side are the prioritized customer requirements or planning matrix. Listed items include customer benchmarking, customer importance rating, target value, scale-up factor and sales point.

The ceiling, or second floor, of the house contains the technical descriptors. Consistency of the product is provided through engineering characteristics, design constrains and parameters.

> The interior walls of the house are the relationships between customer requirements and technical descriptors. Customer expectations (customer requirements) are translated into engineering characteristics (technical descriptors).

The roof of the house is the interrelationship between technical descriptors. Trade offs between similar and/or conflicting technical descriptors are identified.

The foundation of the house is the prioritized technical descriptors. Items such as the technical benchmarking, degree of technical difficulty and target value are listed.

This is the basic structure for the house of quality. Once this format is understood, any other QFD matrices are fairly straightforward and easy to understand.

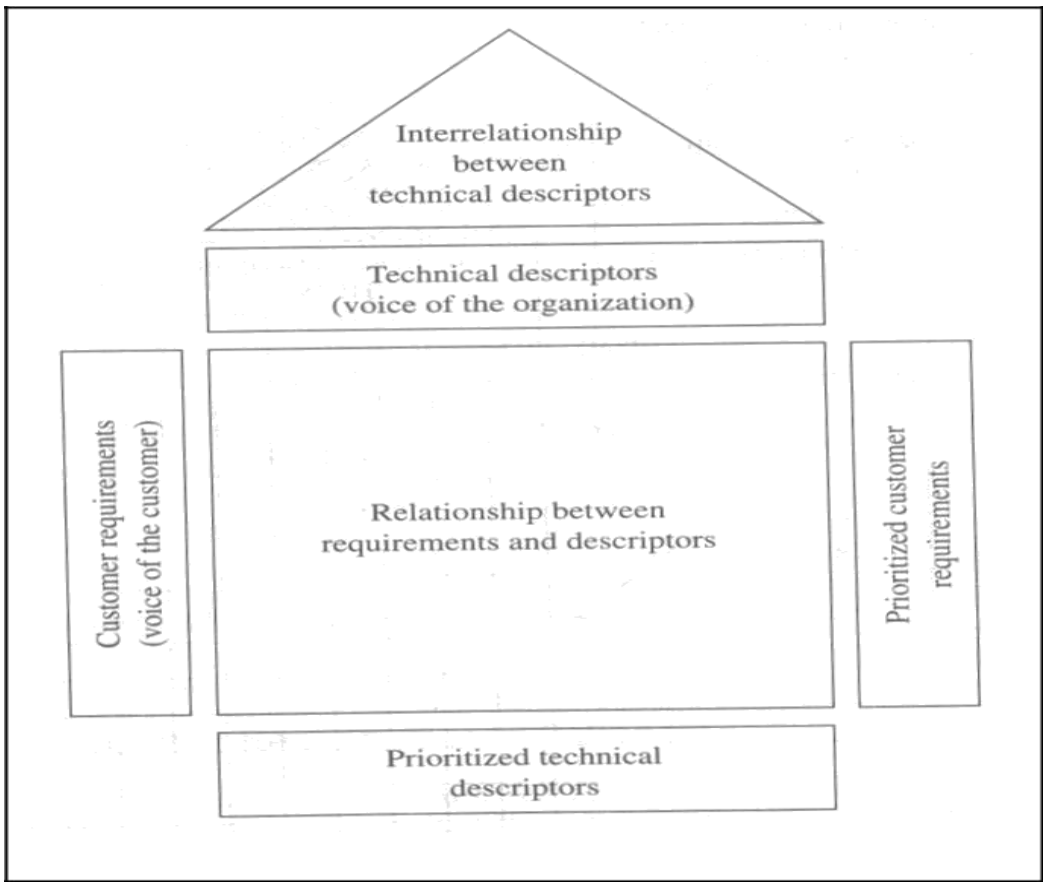


Fig 23.2 Building a House of Quality

The matrix mentioned above may appear to be confusing at first but when one examines each part individually, it is significantly simplified. A basic house of quality matrix is shown in figure 23.3. There is a considerable amount of information contained within this matrix.

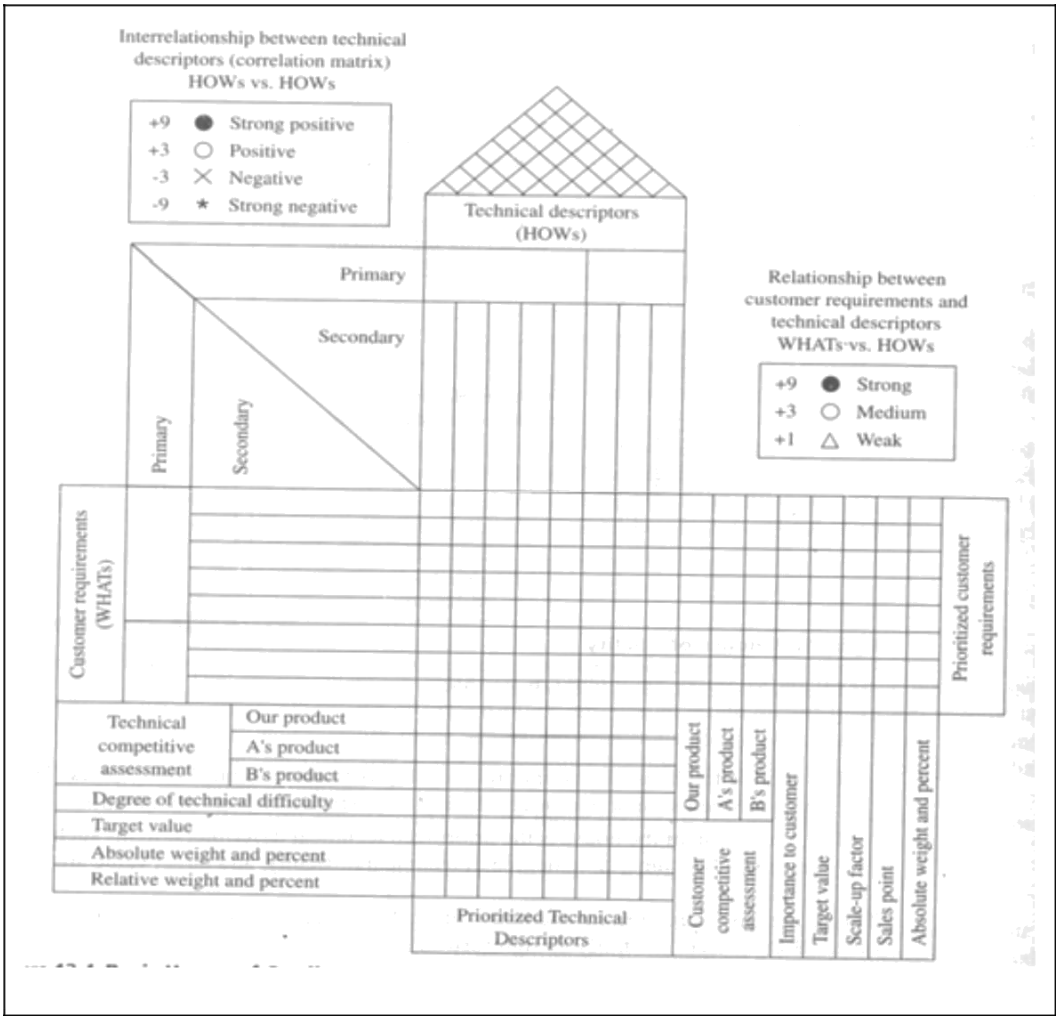


Figure 23.3-- Basic house of quality matrix

Step 1-- List Customer Requirements (WHATs)

Quality function deployment starts with a list of goals/objectives. This list is often referred to as the WHATs that a customer needs or expects in a particular product. This list of primary customer requirements is usually vague and very general in nature. Further definition is accomplished by defining a new, more detailed list of secondary customer requirements needed to support the primary customer requirements. In other words, primary customer requirements may encompass numerous secondary customer requirements. Although the items on the list of secondary customer requirements represent greater detail than those on the list of primary customer requirements, they are often not directly actionable by the engineering staff and require yet further definition. Finally, the list of customer requirements is divided into a hierarchy of primary, secondary and tertiary customer requirements, as shown in figure 23.4. For example, a primary customer requirement might be dependability and the corresponding secondary customer requirements could include reliability, longevity and maintainability.

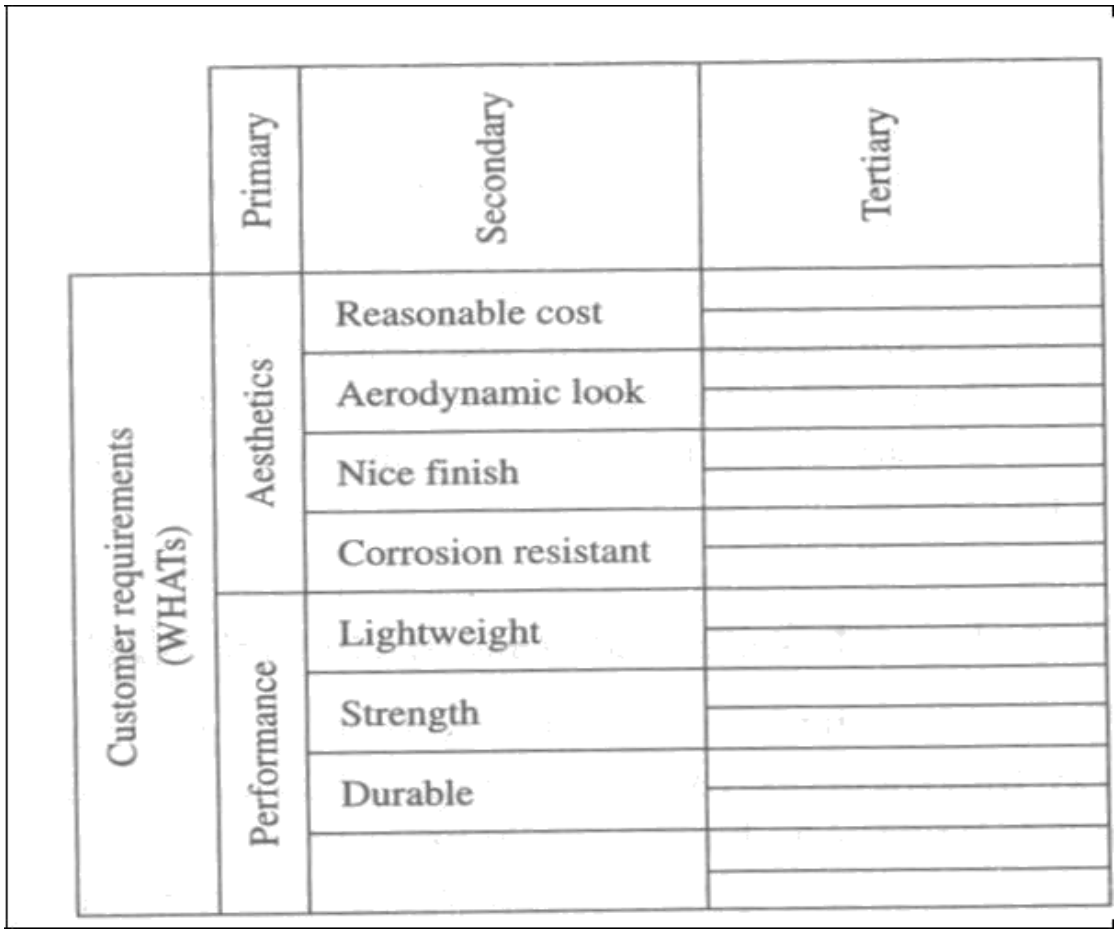


Figure 23.4-- Refinement of customer requirements

Example

A company that manufactures bicycle components such as cranks, hubs, rims etc. wants to expand its product line by also producing handlebar stems for mountain bikes. Begin the development process of designing a handlebar stem for a mountain bike by first listing the customer requirements or WHAT the customer needs or expects in a handlebar stem.
Two primary customer requirements might be aesthetics and performance. Secondary customer requirements under aesthetics might be reasonable cost, aerodynamic look, nice finish and corrosion resistance. Although reasonable cost is not considered aesthetics yet it will be placed under that category for the sake of this example. Secondary customer requirements under performance might be light weight, strength and durability. Many other customer requirements could be listed. However, for simplicity, only the aforementioned ones will be used. Furthermore, it is not necessary to break down the customer requirement to the tertiary level. These primary and secondary customer requirements are shown in figure 23.4

Step 2-- List Technical Descriptors (HOWs)

The goal of the house of quality is to design or change the design of a product in a way that meets or exceeds the customer expectations. Now that the customer needs and expectations have been expressed in terms of customer requirements, the QFD team should come up with engineering characteristics or technical descriptors (HOWs) that will affect one or more of the customer requirements. These technical descriptors make up the ceiling, or second floor, of the house of quality. Each engineering characteristic should directly affect a customer perception and be expressed in measurable terms.

Implementation of the customer requirements is difficult until they are translated into counterpart characteristics. Counterpart characteristics are an expression of the voice of the customer in technical language. Each of the customer requirements is broken down into the next level of detail by listing one or more primary technical descriptors for each of the tertiary customer requirements. This process is similar to refining marketing specifications to system-level engineering specifications. Further definition of the primary technical descriptors is accomplished by defining a list of secondary technical descriptors. This is similar to the process of translating system-level engineering specifications into part-level specifications. These secondary technical descriptors can include part specifications and manufacturing parameters that an engineer can act upon. Often the secondary technical descriptors are still not directly actionable, requiring yet further definition. This process of refinement is continued until every item on the list is actionable. Finally, the list of technical descriptors is divided into a hierarchy of primary, secondary and tertiary technical descriptors as shown in figure 23.5

This level of detail is necessary because there is no way of ensuring successful realization of a technical descriptor that the engineering staff does not know how to accomplish. The process of refinement is further complicated by the fact that through each level of refinement, some technical descriptors affect more than one customer requirement and can even adversely affect one another. For example, a customer requirement for an automobile might be a smooth ride. This is a rather vague statement. However, it is important in the selling of an automobile. Counterpart characteristics for a smooth ride could be dampening, anti-roll and stability requirements which are the primary technical descriptors. Brainstorming among the engineering staff is a suggested method for determining the technical descriptors.

Example

Continue the development process of designing a handlebar stem for a mountain bike by listing the technical descriptors or HOW the company will design a handlebar stem.

Two primary technical descriptors might be material selection and manufacturing process. Secondary technical descriptors under material selection might be steel, aluminum and titanium. Secondary technical descriptors under manufacturing process might be welding, die casting, sand casting, forging and powder metallurgy. Numerous other technical descriptors could be listed, such as finishing process and type of bolt, to name a few. However, for simplicity, only the aforementioned ones will be used. Furthermore, it is not necessary to break down the technical

descriptors to the tertiary level. These primary and secondary technical descriptors are shown in figure 23.6.

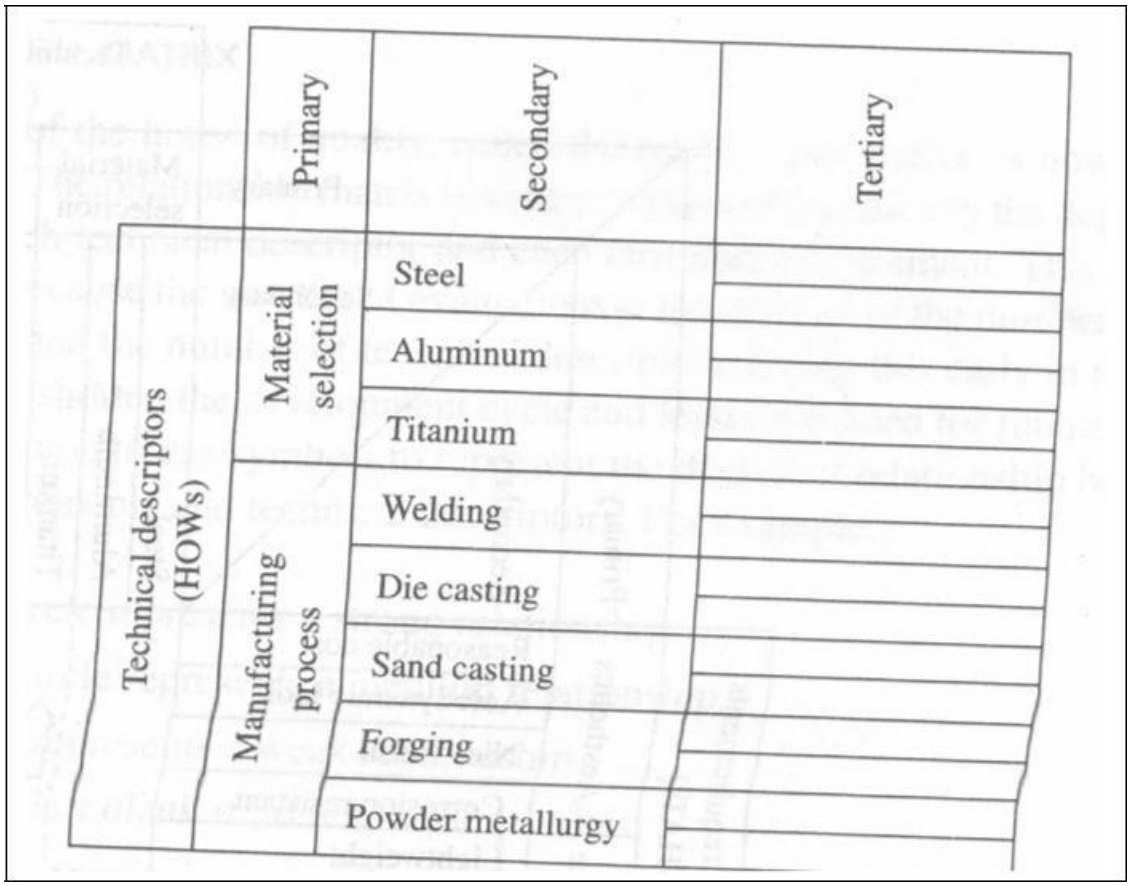


Figure 23.5-- Refinement of technical descriptors

Step 3-- Develop a Relationship Matrix Between WHATs and HOWs

The next step in building a house of quality is to compare the customer requirements and technical descriptors and determine their respective relationships. Tracing the relationships between the customer requirements and the technical descriptors can become very confusing. This is because each customer requirement may affect more than one technical descriptor and vice versa.

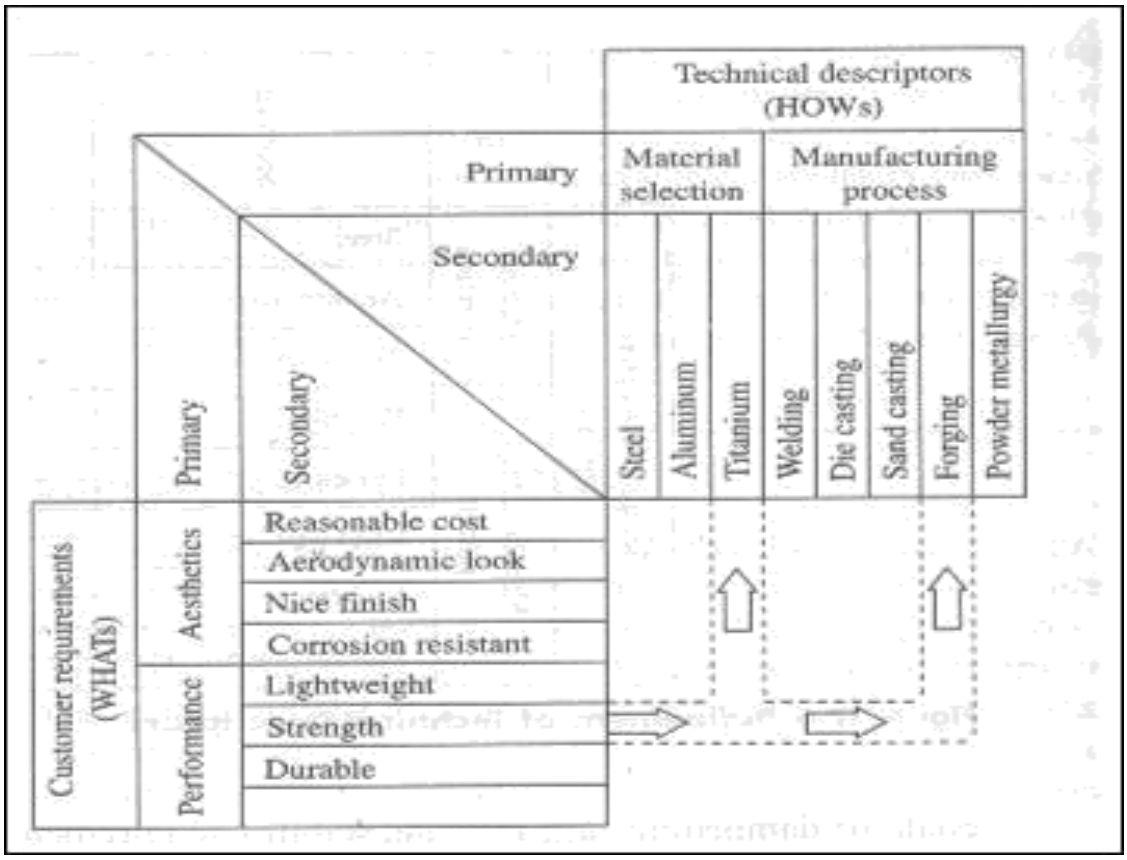


Figure 23.6-- Structuring an L-shaped diagram

Structuring an L-Shaped Diagram

A way to reduce the confusion associated with determining the relationships between customer requirements and technical descriptors is to use an L-shaped matrix, as shown in figure 23.6 L-shape is the two-dimensional relationship that shows the intersection of related pairs of items. It is constructed by turning the list of technical descriptors perpendicular to the list of customer requirements. The L-shaped matrix makes interpreting the complex relations very easy and does not require a significant amount.

Example

Continue the development process of designing a handlebar stem for a mountain bike by structuring an L-shaped diagram.

The L shape is constructed by turning the list of technical descriptors (refer to figure 23.6) perpendicular to the list of customer requirements (refer to figure 23.5). The L-shaped diagram for designing a handlebar stem for a mountain bike is shown in figure 23.7.

Relationship Matrix

The inside of the house of quality, known as the relationship matrix, is now filled in by the QFD team. The relationship matrix is used to represent graphically the degree of influence between each technical descriptor and each customer requirement. This step may take a long time because the number of evaluations is the product of the number of customer requirements and the number of technical descriptors. Doing this early in the development process will shorten the development cycle and lessen the need for future changes.

It is common to use symbols to represent the degree of relationship between the customer requirements and technical descriptors. Examples may include the following:

A solid circle represents a strong relationship.
A single circle represents a medium relationship.
A triangle represents a weak relationship.
The box is left blank if no relationship exists.

It can become difficult to comprehend and interpret the matrix if too many symbols are used. Each degree of relationship between a customer requirement and a technical descriptor is defined by placing the respective symbol at the intersection of the customer requirement and technical descriptor, as shown in figure 30.8. This method allows very complex relationships to be depicted and interpreted with very little experience.

The symbols that are used to define the relationships are now replaced with numbers. Examples:

● = 9
○ = 3
△ = 1

These weights will be used later in determining tradeoff situations for conflicting characteristics and in determining an absolute weight at the bottom of the matrix.

After the relationship matrix has been completed, it is evaluated for empty rows or columns. An empty row indicates that a customer requirement is not being addressed by any of the technical descriptors. Thus, the customer expectation is not being met. Additional technical descriptors should be considered in order to satisfy that particular customer requirement. An empty column indicates that a particular technical descriptor does not affect any of the customer requirements and, after careful scrutiny, may be removed from the house of quality.

Example

Continue the development process of designing a handlebar stem of a mountain bike by adding the relationship matrix to the house of quality.

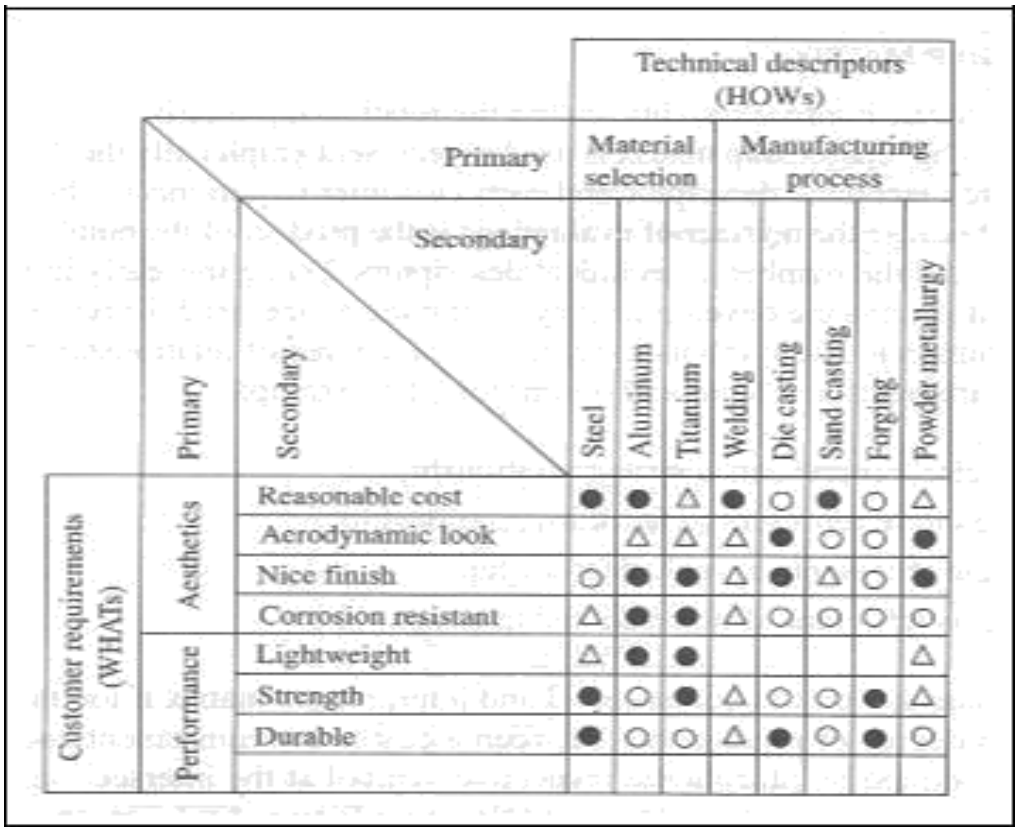


Figure 23.7-- Adding relationship matrix to the house of quality

The relationship matrix is constructed by assigning symbols or numbers to represent the degree of influence between each technical descriptor and each customer requirement. For instance, the relationship between the customer requirement of light weight and the technical descriptor of steel would be weak (+1) because steel is heavier than aluminum and titanium. Conversely, the relationship between the customer requirement of reasonable cost and the technical descriptor of steel would be strong (+9) because steel is cheaper than aluminum and titanium. The relationship matrix for designing a handlebar stem for a mountain bike is shown in figure 23.8. Empty spaces indicate that no relationship exists.

Step 4-- Develop an Interrelationship Matrix between HOWs

The roof of the house of quality, called the correlation matrix, is used to identify any interrelationships between each of the technical descriptors. The correlation matrix is a triangular table attached to the technical descriptors, as shown in figure 23.9. Symbols are used to describe the strength of the interrelationships. Examples:

A solid circle represents a strong positive relationship.
A circle represents a positive relationship.
An X represents a negative relationship.
An asterisk represents a strong negative relationship.

The symbols describe the direction of the correlation. In other words, a strong positive interrelationship would be a nearly perfectly positive correlation. A strong negative interrelationship would be a nearly perfectly negative correlation. This diagram allows the user to identify which technical descriptors support one another and which are in conflict. Conflicting technical descriptors are extremely important because they are frequently the result of conflicting customer requirements and consequently represent points at which tradeoffs should be made.

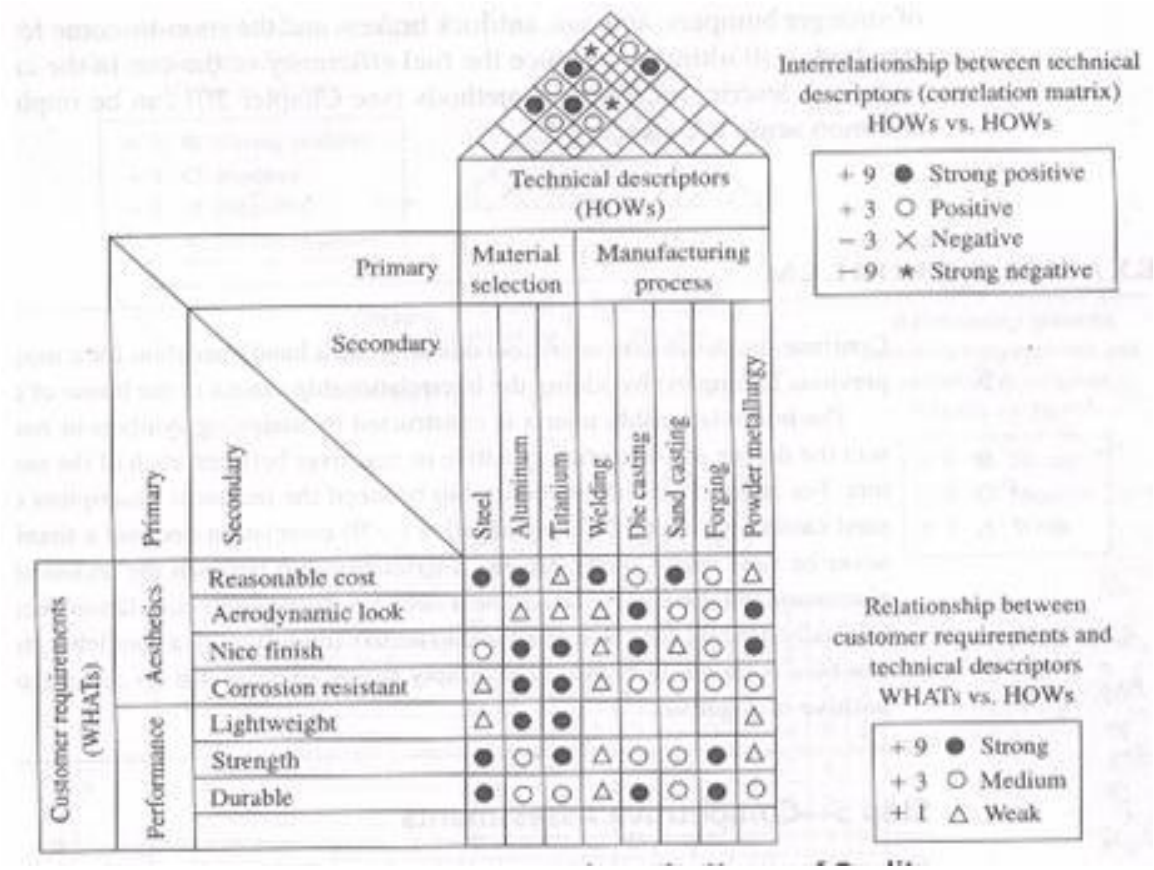


Figure 23.8 Adding interrelationship matrix to the house of quality

Tradeoffs that are not identified and resolved will often lead to unfulfilled requirements, engineering changes, increased costs and poorer quality. Some of the tradeoffs may require high-level managerial decisions to be made. Resolving tradeoffs is essential to shorten product development time.

An example of tradeoffs is in the design of a car, where the customer requirements of high fuel economy and safety yield technical descriptors that conflict. The added weight of stronger bumpers, air bags, antilock brakes and the soon -to-come federal side-impact standards will ultimately reduce the fuel efficiency of the car. In the case of conflicting technical descriptors, Taguchi methods can be implemented, or pure common sense dictates.

Example

Continue the development process of designing a handlebar stem for a mountain bike by adding the interrelationship matrix to the house of quality.

The interrelationship matrix is constructed by assigning symbols or numbers to represent the degree of correlation (positive or negative) between each of the technical descriptors. For instance, the interrelationship between the technical descriptors of titanium and sand casting would be a strong negative (-9) correlation because a titanium part would never be sand cast. Conversely, the interrelationship between the technical descriptors of aluminum and die-casting would be a strong positive (+9) correlation because aluminum is usually die cast. The interrelationship matrix for designing a handlebar stem for a mountain bike is shown in figure 23.8. Empty space indicates that no correlation exists, either positive or negative.

Step 5-- Competitive Assessments

The competitive assessments are a pair of weighted table (or graphs) that depict item for how competitive products compare with current organization products. The competitive assessment tables are separated into two categories-- customer assessment and technical assessment-- as shown in figures 23.9 and 23.10 respectively.

Customer Competitive Assessment

The customer competitive assessment is the block of columns corresponding to each customer requirement in the house of quality on the right side of the relationship matrix, as shown in figure 23.9. The numbers 1 thorough 5 are listed in the competitive evaluation column to indicate a rating of 1 for worst and 5 for best. These rankings can also be plotted across from each customer requirement, using different symbols for each product.

The customer competitive assessment is a good way to determine if the customer requirements have been met and identify areas to concentrate on in the next design. The customer competitive assessment also contains an appraisal of where an organization stands relative to its major competitors in terms of each customer requirement. Both assessments are very important because they give the organization an understanding where its product stands in relation to the market.

Example

Continue the development process designing a handlebar stem for a mountain bike by adding the customer competitive assessment to the house of quality.

The customer competitive assessment is constructed by assigning ratings for each customer requirement form 1 (worst) to 5 (best) for the new handlebar stem and major competitor A's and B's handlebar stem. The customer competitive assessment for designing a handlebar stem for a mountain bike is shown in figure 23.8.

Technical Competitive Assessment

The technical competitive assessment makes up a block of rows corresponding to each technical descriptor in the house of quality beneath the relationship matrix, as shown in figure 23.10 After respective units have been established, the products are evaluated for each technical descriptor.

Similar to the customer competitive assessment, the test data are converted to the numbers 1 through 5. These are listed in the competitive evaluation row to indicate a rating, 1 for worst and 5 for best. These rankings can then be entered below each technical descriptor using the same numbers as used in the customer competitive assessment.

The technical competitive assessment is often useful in uncovering gaps in engineering judgment. When a technical descriptor directly relates to a customer requirement, a comparison is made between the customer's competitive evaluation and the objective measure ranking. Customer requirements and technical descriptors that are strongly related should also exhibit a strong relationship in their competitive assessments. If an organization's technical assessment shows its product to be superior to the competition, the customer assessment should show a superior assessment. If the customer disagrees, a mistake in engineering judgment has occurred and should be corrected.

Example

Continue the development process of designing a handlebar stem for a mountain bike by adding the technical competitive assessment to the house of quality.

The technical competitive assessment is constructed by assigning ratings for each technical descriptor from 1 (worst) to 5 (best) for the new handlebar stem and major competitor A's and B's handlebar stem.

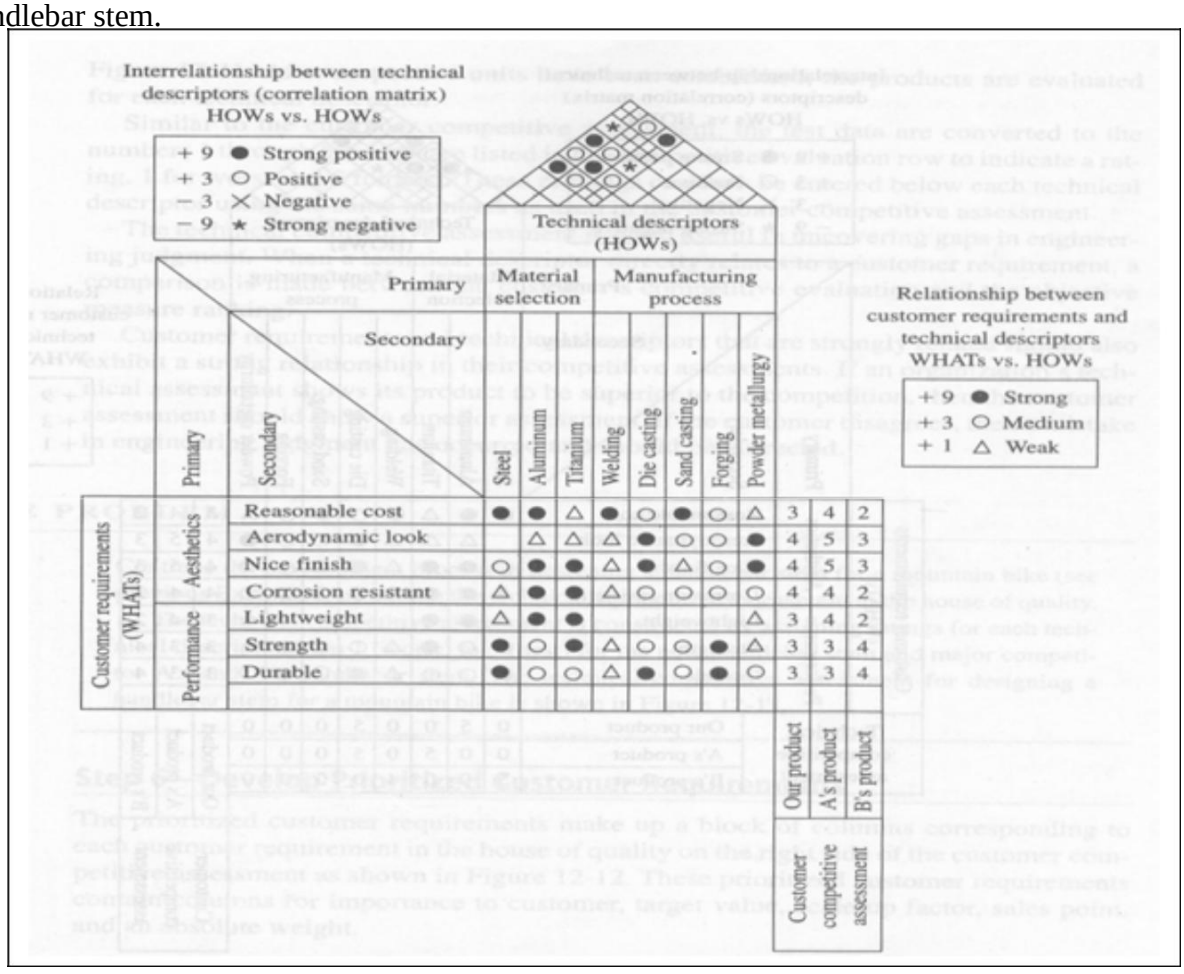


Figure 23.9-- Adding customer competitive assessment to the house of quality

Step 6-- Develop Prioritized Customer Requirements

The prioritized customer requirements make up a block of columns corresponding to each customer requirement in the house of quality on the right side of the customer competitive assessment. These prioritized customer requirements contain columns for importance to customer, target value, scale-up factor, sales point and an absolute weight.

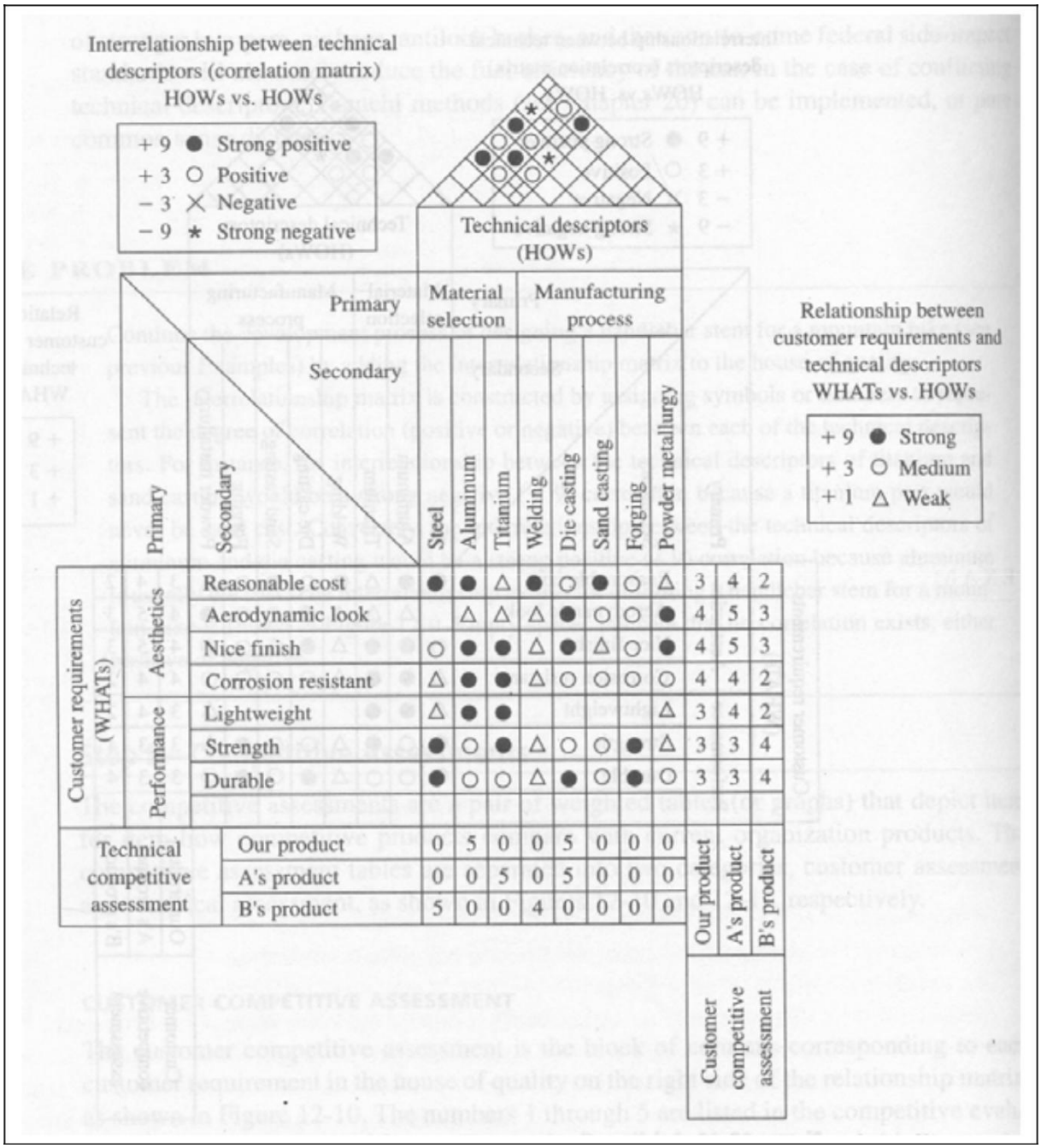


Figure 23.10 Adding technical competitive assessment to the house of quality

Importance to Customer

The QFD team, or, preferably, the focus group, ranks each customer requirement by assigning it a rating. Numbers 1 through 10 are listed in the importance to customer column to indicate a rating of 1 for least important and 10 for very important. In other words, the more important is the customer requirement, the higher is the rating.

Importance ratings represent the relative importance of each customer requirement in terms of each other. Assigning ratings to customer requirements is sometimes difficult. This is because each member of the QFD team might believe different requirements should be ranked higher. The importance rating is useful for prioritizing efforts and making tradeoff decisions.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the importance to customer of each customer requirements.

The importance to customer is determined by rating each customer requirement form 1 (least important) to 10 (very important). For instance, if light weight is important to the customer, it could be assigned a value of 7. Conversely, if durability is not very important to the customer, it could be assigned a value of 3. The importance to customer for designing a handlebar stem for a mountain bike is shown in figure 23.12.

Target Value

The target value column is on the same scale as the customer competitive assessment (1 for worst and 5 for best can be used). This column is where the QFD team decides whether they want to keep their product unchanged, improve the product or make the product better than the competition.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the target value for each customer requirement.

The target value is determined by evaluating the assessment of each customer requirement and setting a new assessment value that keeps the product as it is, improves the product or exceeds the competition. For instance, if light weight has a product rating of 3 and the QFD team wishes to improve their product, the target value could be assigned a value of 4.

Scale-Up Factor

The scale-up factor is the ratio of the target value to the product rating given in the customer competitive assessment. The higher the number, the more effort is needed. Here, the important consideration is the level where the product is now and what the target rating is and deciding whether the difference is within reason. Sometimes, there is no choice because of difficulties in

accomplishing the target. Consequently, the target ratings often need to be reduced to more realistic values.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the scale-up factor for each customer requirement.

The scale-up factor is determined by dividing the target value by the product rating given in the customer competitive assessment. For instance, if lightweight has a product rating of 3 and the target value is 4, the scale-up factor is 1.3. The scale-up factor for designing a handlebar stem for a mountain bike Note that the numbers for scale-up factor are rounded off in the figure.

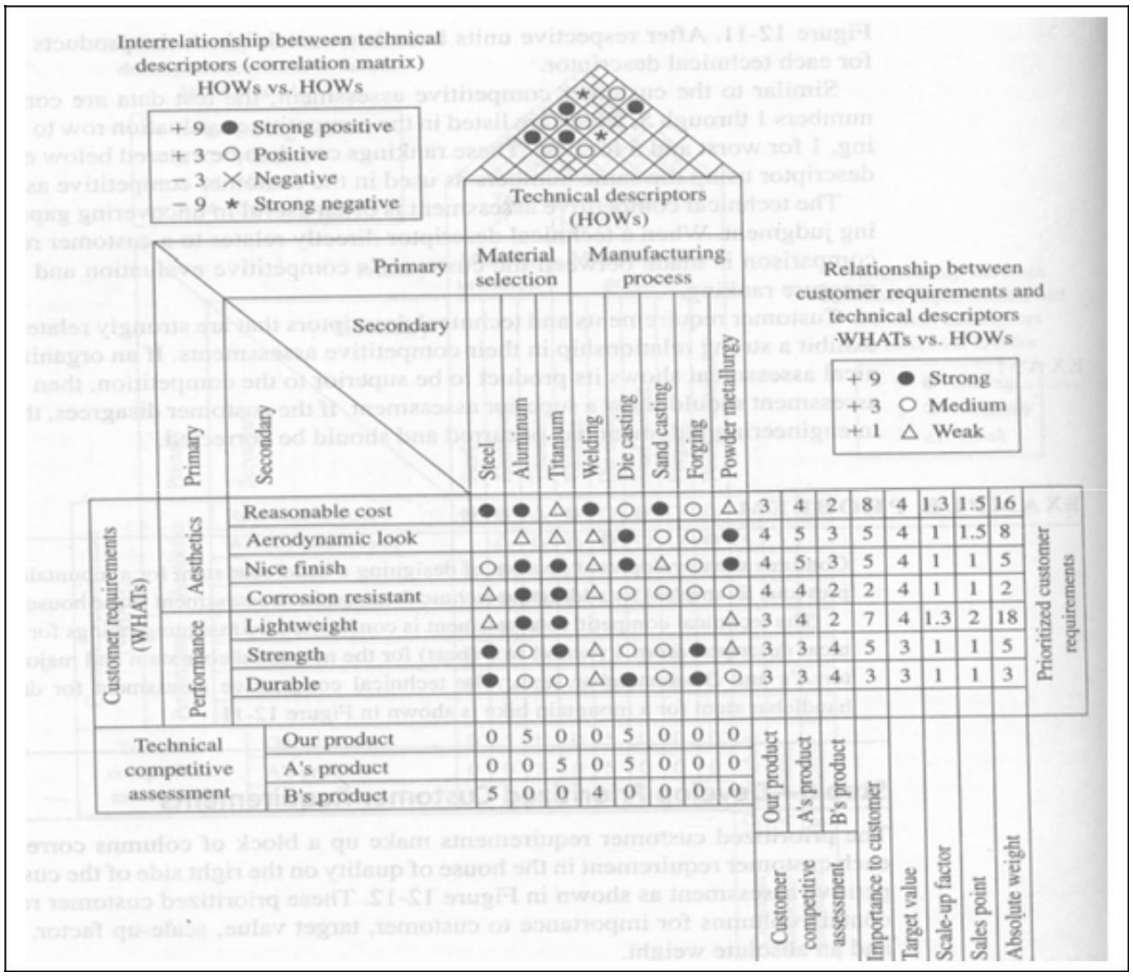


Figure 23.11-- Adding prioritized customer requirements to the house of quality

Sales Point

The sales point tells the QFD team how well a customer requirement will sell. The objective here is to promote the best customer requirement and any remaining customer requirements that will help in the sale of the product. For example, the sales point is a value between 1.0 and 2.0 with 2.0 being the highest.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the sales point for each customer requirements.

The sales point is determined by identifying the customer requirements that will help the sales of the product. For instance, an aerodynamic look could help the sales of the handlebar stem, so the sales point is given a value of 1.5. If a customer requirement will not help the sales of the product, the sales point is given a value of 1. The sales point for designing a handlebar stem for a mountain bike i

Absolute Weight

Finally, the absolute weight is calculated by multiplying the importance to customer, scale-up factor and sales point as follows:

Absolute Weight = (Importance to Customer) x (Scale-up Factor) x (Sales Point)

A sample calculation is included. After summing all the absolute weights, a percent and rank for each customer requirement can be determined. The weight can then be used as a guide for the planning phase of the product development.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the absolute weight for each customer requirement.

The absolute weight is determined by multiplying the importance to customer, scale- up factor and sales point for each customer requirement. For instance, for reasonable cost the absolute weight is 8 x 1.3 x 1.5 = 16. The absolute weight for designing a handlebar stem for a mountain bike. Note that the numbers for absolute weight are rounded off in the figure.

Step 7-- Develop Prioritized Technical Descriptors

The prioritized technical descriptors make up a block of rows corresponding to each technical descriptor in the house of quality below the technical competitive assessment,. These prioritized technical descriptors contain a degree of technical difficulty, target value and absolute and

relative weights. The QFD team identifies technical descriptors that are the most needed to fulfill customer requirements and need improvement. These measures provide specific objectives that guide the subsequent design and provide a means of objectively assessing progress and minimizing subjective opinions.

Degree of Difficulty

Many users of the house of quality add the degree of technical difficulty for implementing each technical descriptor, which is expressed in the first row of the piratical technical descriptors. The degree of technical difficulty, when used, helps to evaluate the ability to implement certain quality improvements.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the degree of difficulty for each technically descriptor.

The degree of difficulty is determined by rating each technical descriptor from 1 (least difficult) to 10 (very difficult). For instance, the degree of difficulty for die-casting is 7, whereas the degree of difficulty for sand casting is 3. This is because it is a much easier manufacturing process. The degree of difficulty for designing a handlebar stem for a mountain bike

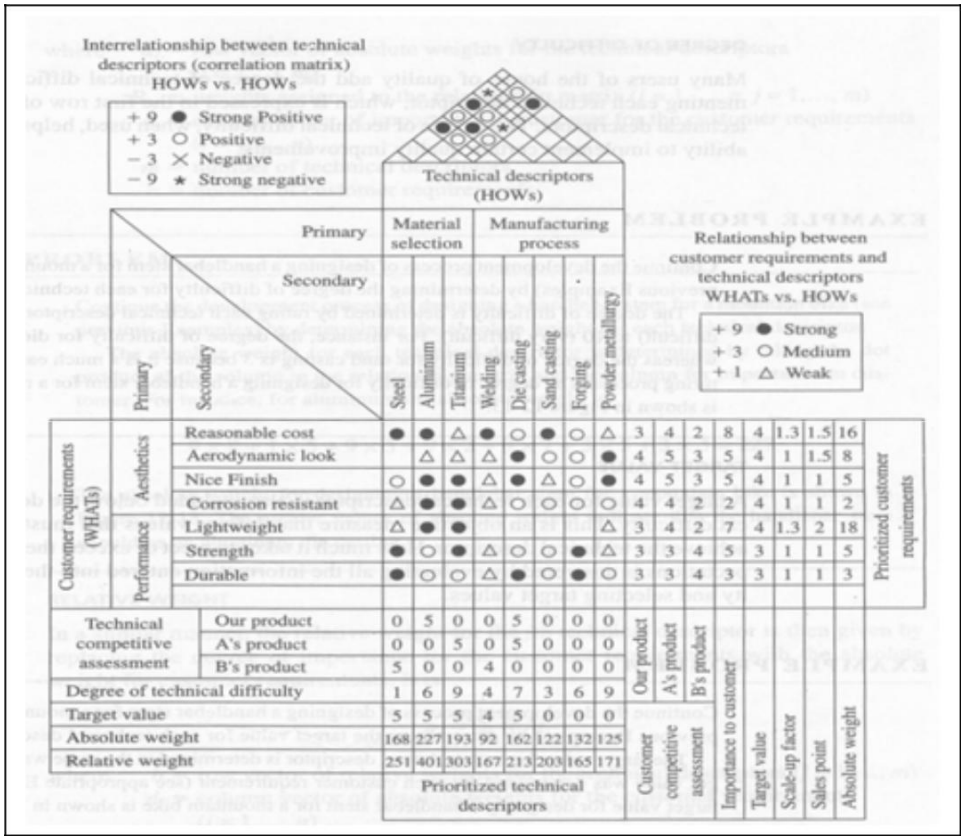


Figure 23.12-- Adding prioritized technical descriptors to the house of quality

Target Value

A target value for each technical descriptor is also included below the degree of technical difficulty. This is an objective measure that defines values that should be obtained to achieve the technical descriptor. How much it takes to meet or exceed the customer's expectations is answered by evaluating all the information entered into the house of quality and by selecting target values.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the degree of difficulty for each technical descriptor.

The target value for each technical descriptor is determined in the same way like the target value was determined for each customer requirement. The target value for designing a handlebar stem for a mountain bike.

Absolute Weight

The last two rows of the prioritized technical descriptors are the absolute weight and relative weight. A popular and easy method for determining the weights is to assign numerical values to symbols in the relationship matrix symbols, as shown in figure 30.8. The absolute weight for the jth technical descriptor is then given by the following equation:

$$a_j = \sum_{i=1}^{n} R_{ij} C_i \sum,$$

where a_j = row vector of absolute weights for the technical descriptors (i = 1,..., m)

R_{ij} = weights assigned to the relationship matrix (i = 1,..., n = 1,..., m)

C_i = column vector of importance to customer for the customer requirements (i = 1,..., n) m = number of technical descriptors

n = number of customer requirements

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the absolute weight for each technical descriptor.

The absolute weight for each technical descriptor is determined by taking the dot product of the column in the relationship matrix and the column for importance to customer. For instance, for aluminum the absolute weight is as follows:

(9 x 8) + (1 x 5) + (9 x 5) + (9 x 2) + (9 x 7) + (3 x 5) + (3 x 3) = 227

The absolute weight for designing a handlebar stem for a mountain bike is shown in figure 23.13. The greater values of absolute weight indicate that the handlebar stem should be aluminum die-casting.

Relative Weight

In a similar manner, the relative weight for the jth technical descriptor is then given by replacing the degree of importance for the customer requirements with the absolute weight for customer requirements. It is as follows:

$$b_j = \sum_{i=1}^{n} R_{ij} d_i ,$$

where b = row vector of relative weights for the technical descriptors (j = 1,..., m)

d_i = column vector of absolute weights for the customer requirements (i = 1,...,n)

Higher absolute and relative ratings identify areas where engineering efforts need to be concentrated. The primary difference between these weights is that the relative weight also includes information on customer scale-up factor and sales point.

These weights show the impact of the technical characteristics on the customer requirements. They can be organized into a Pareto diagram to show which technical characteristics are important in meeting customer requirements. Along with the degree of technical difficulty, decisions can be made concerning where to allocate resources for quality improvement.

Each QFD team can customize the house of quality to suit their particular needs. For example, columns for the number of service complaints may be added.

Example

Continue the development process of designing a handlebar stem for a mountain bike by determining the degree of difficulty for each technically descriptor.

The relative weight for each technical descriptor is determined by taking the dot product of the column in the relationship matrix and the column for absolute weight in the prioritized customer requirements. For instance, for die-casting the relative weight is as follows:

$$(3 \times 16) + (9 \times 8) + (9 \times 5) + (3 \times 2) + (0 \times 18) + (3 \times 5) + (9 \times 3) = 213$$

The relative weight for designing a handlebar stem for a mountain bike. The greater values of relative weight also indicate that the handlebar stem should be aluminum die-casting.

Conclusion

Quality function deployment-- specifically, the house of quality-- is an effective management tool. In this, customer expectations are used to drive the design process or improvement in the service industries. Some of the advantages and benefits of implementing QFD are as follows:

An orderly way of obtaining information and presenting it
Shorter product development cycle
Considerably reduced start-up costs
Fewer engineering changes
Reduced chance of oversights during the design process
An environment of teamwork
Consensus decisions
Everything is preserved in writing

QFD forces the entire organization to constantly be aware of the customer requirements. Every QFD chart is a result of the original customer requirements that are not lost through misinterpretation or lack of communication. Market benefits because specific sales points that have been identified by the customer can be stressed. Most importantly, implementing QFD results in a satisfied customer.

Questions

Answer the following questions by either working individually or in a team.

List four or more primary customer requirements for one or more of the following production items or service industries. Also, refine the primary customer requirements to a second level.

Mountain bike
Racing bike
Pizza
Textbook
Automatic teller machine
Automobile cruise control
Coffee maker
Computer mouse
Rechargeable driver
University academic department
Call center
Restaurant
Hospital or medical center
Department store
Website for computer sales
Hair salon
Grocery store

List six or more primary technical descriptors for one or more of the selections used in the exercise in question one. Make an attempt to address all the customer requirements from the exercise and refine the secondary technical descriptors to a second level.

Form an L-shaped matrix and complete the relationship matrix, including weights, for one or more of the selections used in question one and two.

Complete the interrelationship matrix for one or more of the selections used in question two.

Compare two similar products or service industries based on the customer assessment of the customer requirements used in question one. Choose one of the products to be your organization's product.

Compare two similar products or service industries based on technical assessment of the technical descriptors used in question two. Choose one of the products to be your organization's product.

MODULE 4

Tools and Techniques-- Design of Experiments (DOE)

Introduction

Design of Experiments (DOE) is a series of techniques, which involve the identification, and control of parameters that have a potential impact on the performance and reliability of a product design and/or the output of a process. The objective is of optimizing product design, process design, process operation and limiting the influence of noise factors. The methodology is used when an analysis of the effect on system outputs of different values of design parameters is required. The objective is to optimize the values of these design parameters to make the performance of the system immune to variation. The concept can be applied to the design of new products and processes, or to the redesign of existing ones. The following are the objectives:

To optimize product design, process design and process operation
To achieve minimum variation of best system performance
To achieve reproducibility of best system performance in manufacture and use
To improve the productivity of design engineering activity
To evaluate the statistical significance of the effect of any controlling factor on the outputs
To reduce cost

DOE techniques, in particular for process improvement, involve the identification and control of those parameters or variables (termed factors) that have a potential influence on the output of a process, choosing two or more values (termed levels) of these variables and running the process at these levels. Each combination of factors and levels or experimental run is called a trial. The basic idea is to conduct a small number of experiments with different parameter values and to analyze their effect on a defined output such as plating thickness. Based on the analysis, a prediction of system performance can be made.

Methods of Experimentation

Most people in business, to a greater or lesser extent, experiment in some or the other way. For example, adjusting a variable to produce a desirable result, taking an action to discover a reaction and testing a hypothesis. There are a number of methods of experimentation such as the following:

Trial and error (the step-by-step method of changing one factor at a time)
Full factorial (i.e. the classical method)
Fractional factorial

One of the objectives of industrial experimental design is to be confident that a difference in output attributable to a change in the level of a factor is significant in relation to any experimental error and other factors that were part of the experimental design.

Trial and Error Method

The trial and error method usually means unsystematic changes of factor levels using the experience of the experimenter(s) as the guiding principle. The first experiment is run with all the factors at the first chosen level and the results of the run are recorded. The second experiment is run by changing the first factor to its second option and again recording the results of the run. Then keeping this factor at that optimum level, variations are made to another factor to find its optimum with the other factors being kept constant and so on. Assumptions are then made about the preference for the lower or higher levels for each of the factors. This approach is familiar and easy to use and understand. However, it is widely criticized not least for the fact that no information is provided about any interactions that may occur between any two of the factors tested and therefore reproducibility is poor. It is also inefficient, resource intensive and costly. In addition, it is not easy to hold, from experiment to experiment, the factors constant and this in itself creates variation.

Full Factorial Method

The full factorial approach considers all combinations of the factors, which are being tested. In this way, all possible interactions between the factors are investigated to find the best combination. For example, three factors with two levels each (i.e. level 1 and level 2) would need 23 (= 8) trials, as shown in table 24.1.

Trial Number	Control Factors		
	A	B	C
1	1	1	1
2	1	1	2
3	1	2	1
4	1	2	2
5	2	1	1
6	2	1	2
7	2	2	1
8	2	2	2

Table 24.1-- Full factorial method

This may be feasible for a small number of factors and when experimentation is easy. But even with, say, seven factors at two levels, the minimum number of trials would be 27 (= 128). Despite the fact that both the main effects and interactions can be measured in a thorough and

pure scientific manner, the time and costs associated with running such a large number of experiments is usually considered to be prohibitive and unrealistic in industrial situations. Also, much of the information obtained from the trials would be from combinations of factors that are of little practical value. This problem may be overcome by the use of fractional factorial designs.

Fractional Factorial

To overcome the disadvantage of the number of trials necessary in a full factorial design, fractional factorial designs are used where the chosen fraction of the full design gives an even and balanced spread throughout all the factors being studied. Typically, a quarter of the 128 experiments required for seven factors at two levels would involve just 32 experiments.

It was three Englishmen who took the lead on this problem of experimental size-- Fisher (1925) in the 1920s primarily in agriculture and Plackett and Burman (1946) in process-orientated manufacturing in the 1940s. Their method of experimentation was to change several factors at the same time in a systematic way so as to ensure the reliable and independent study of the main factors and interaction effects. They constructed orthogonal arrays with a limited number of runs as a subset of the full factorial layout. The subsets are “balanced” in terms that an even number of each level of each factor is tested during the running of the experiment, i.e. the array is balanced between columns rather than between trials. The technique of orthogonal arrays enables the size of the experiment to be reduced to a practicable level by carrying out only a fraction of the total number of combination of factors. However, in doing this, interaction information will be sacrificed. It is, therefore, important to use the technical knowledge of those involved in the experiment to ensure that this loss of information is relatively insignificant. A typical Fisher array is shown in table 24.2.

Runs	Factors						
	A	B	C	D	E	F	G
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

Table 24.2-- A typical fisher array

It can be seen that in the array, the columns represent the independent variables or factors to be studied and tested at one of two levels and the rows represent the tests or experiments to be performed. In an experiment which has eight experimental runs (i.e. L8), the first option or level of factor A, Al is tested four times and the second option or level of factor A, A2 is also tested

four times. In addition to this, during the experimental run, the array tests all the combinations of options or levels of any two factors. Thus, Al is tested against both B1 and B2. Similarly, A2 is tested against B1 and B2. The other property that orthogonal arrays have, due to their full factorial heritage and balance, is the ability to study the effects of interactions between factors. The number of interactions that can be studied is dependent on the size of the array.

The simple analysis of an orthogonal array is done by averaging the responses that are applicable to the level of each factor. Therefore, in the Fisher array shown in table 24.2, factor Al is given by averaging the results obtained from running experiments numbers 1 to 4 and factor A2 by averaging the results obtained from running experiments numbers 5 to 8. The difference between level 1 and level 2 of each factor is an indication of the significance of that factor in influencing the response measured. Generally, the larger the difference, the greater is the significance.

Analysis of the orthogonal array enables the strength of each level of each factor to be measured and their relative significance in influencing the designated output (e.g., bond strength) to be assessed. Analysis of variance is used to estimate the significance that any factor has in influencing the measured response in relation to "error" (e.g., measurement and inconsistency in the setting of factor levels) in the experimental system.

The efficiency of these orthogonal arrays, in addition to the L8 already described, is further illustrated by the example of L4 (3 independent factors at two levels and involving four experimental runs), L12 (11 factors at two levels and 12 experimental runs) and L4 (4 factors at three levels and nine experimental runs). The experiments are not necessarily performed in the order of 1, 2, 3 and 4. Instead, the preference is to perform them in random order, unless it is advisable that they be carried out in sub-groups. Undertaking the runs in random order is the best way to protect the experiment from the occurrence of unforeseen changes.

The arrays suggested by Taguchi (1986) give economies of scale and time in the cost of experimentation. They are also practical to use in a team environment. Then, maximum use is made of technical knowledge which exists within the team for details such as the choice of factors, the setting of the levels, whether to study an interaction between factors and not least the choice of responses of the experimental runs. There are a small number of orthogonal arrays or experimental designs that constitute a fundamental set of arrays. These are sometimes referred to as the "cookbook."

The following experiment outlines the concept of orthogonal arrays. It concerns part of the process used in the pharmaceutical industry in the manufacture of medicines in tablet form. To produce uniform tablets in terms of size and content, the initial process of mixing the drug solution and the carrying medium is paramount. It is vital that the particle size, the even distribution of the drug (content uniformity) and the moisture content are controlled with small variation around the target value prior to feeding into the tablet making part of the operation. The three measured responses are, therefore, particle size, content uniformity and moisture content. Table 24.3 shows the layout of the experiment. The orthogonal array is an L8. The results of each experimental run from the particular combination of the factors in the run are given in table 24.4. The results of each experiment are an average from a satisfactory sample size.

The experiment will indicate the combination that gives the best result, but there may be a better combination. This is done by analyzing the effect of each factor. The output or response of the relevant experiment where the information occurs is simply added up and averaged so that comparisons may be made between level 1 and level 2 of each factor. Comparisons of the relative difference between level 1 and level 2 and between each factor can then be made as to the significance of each factor in affecting the response or output of the experiment. An example of the calculations made is shown in table 24.5. The average of the experimental run is 3.96.

	Control Factors	Level 1	Level 2
A	Mixing speed	High	Low
B	Drying temperature	High	Low
C	Chopping speed	Long	Short
D	Drying mechanism	Type A	Type B
E	Drying time	Long	Short
F	Mixing time	Long	Short
G	Solution addition rate	Fast	Slow

Table 24.3-- Experimental layout-- Powder granulation

	A	B	C	D	E	F	G	Particle Size
1	High	High	Long	Type A	Long	Long	Fast	3.8
2	High	High	Long	Type B	Short	Short	Slow	4.5
3	High	Low	Short	Type A	Long	Short	Slow	5.3
4	High	Low	Short	Type B	Short	Long	Fast	4.9
5	Low	High	Short	Type A	Short	Long	Slow	4.4
6	Low	High	Short	Type B	Long	Short	Fast	2.9
7	Low	Low	Long	Type A	Short	Short	Fast	2.3
8	Low	Low	Long	Type B	Long	Long	Slow	3.6

Table 24.4-- Results of experimental runs

Because of the balanced construction of the orthogonal array, it is permissible to view the significance of each of the factors, relative to each other in terms of their effect on influencing the value of the output or response, in this case “particle size” (see table 24.6). Thus, mixing speed (A), solution addition rate (G), chopping speed (C) and mixing time (F) have the greatest effect in that order and drying time (E) and drying temperature (B) are in this example of no relative significance at all. It is helpful to look at these effects graphically and in comparison with the factorial effect on the variation of the responses within the sample of each experimental run. The other useful property that the balance of the array gives is the additive effect of each of the main control factors in the value of the response, beyond the experimental average. In this

example, particle size is required to be as small as possible. The effect below average is shown in table 24.7.

If the experiment has been conceived properly and shows variation in the results of the different combination of factors in each experimental run, it would be expected to see approximately half of the control factors having some additive effect on the output for a two-level array. The total below average, in this case, can now be used as a prediction of the result if the process is set up using a combination of factor level settings that reflect their best effect on the output, in this case A2, C1, Fl and G1. The other factors B, D and E can be set at the level where least cost is incurred. This may be B2-- lowest temperature, E2-- shortest drying time and perhaps either Dl or D2 according to the lower capital cost or the lower operating cost.

A1	= ¼ (3.8 + 4.5 + 5.3 + 4.9)	= 18.5/4	= 4.625
A2	= ¼ (4.4 + 2.9 + 2.3 + 3.6)	= 13.2/4	= 3.300
B1	= ¼ (3.8 + 4.5 + 4.4 + 2.9)	= 15.6/4	= 3.900
B2	= ¼ (5.3 + 4.9 + 2.3 + 3.6)	= 16.1/4	= 4.025

Table 24.5-- Response table-- Means

	A	B	C	D	E	F	G
Level 1	4.625	3.9	3.550	3.950	3.900	4.175	3.475
Level 2	3.300	4.025	4.375	3.975	4.025	3.750	4.450
Difference	1.325	0.125	0.825	0.025	0.125	0.425	0.975

Table24.6-- Analysis of the experiment

A2	Mixing speed	= 3.96 - 3.300	= 0.660
G1	Solution add. rate	= 3.96 - 3.475	= 0.485
C1	Chopping speed	= 3.96 - 3.550	= 0.410
F2	Mixing time	= 3.96 - 3.750	= 0.210
Total below average		= 3.96 -1.765	= 2.195

Table 24.7-- Analysis of the experiment

As the orthogonal array is only a subset of the full factorial array (in this case, 8 or 128), it is obligatory to conduct a confirmation run and to compare the results, which are obtained with the prediction. The closer the confirmation run is to the prediction, the better has been the team thinking in the construction of the experiment in terms of the following:

The response chosen
The factors affecting the responses
The levels chosen for the factors and their accurate setting
The measurement system and accuracy
Considerations of interaction and uncontrollable factors that may affect the response

From the analysis of the experiment, it is clear which level of each factor would be preferred for a desired output. By looking at what happened to the output when each factor was moved from level 1 to level 2, it can also be seen which factors have the greatest effect on the output. Where there is only a small difference, the factor has little effect. On the other hand, where the differences in levels of a factor are greatest, this is the factor, which is most significant. It is always helpful to present the results in a graphical form to facilitate the understanding of the data and its communication.

MODULE 4

Control Charts

Introduction to Control Charts

Sources of Variation

As we know, no two products or services are exactly alike because the processes used to produce them contain many sources of variation, even if the processes are working as intended. For example, the diameter of two crankshafts may vary because of differences in tool wear, material hardness, operator skill, or temperature during the period in which they were produced. Similarly, time required to process two credit card applications varies because of the load on the credit card department, the financial background of the applicant and the skill and attributes of the employees. Nothing can be done to eliminate variation in process output completely, but management can investigate the causes of variation to minimize it.

Common Causes

There are two basic categories of variation in output:

Common Causes and Assignable Causes

Common causes of variation are purely random, unpredictable sources of variation that are unavoidable with the current process. For example, a machine that fills cereal boxes will not put exactly the same amount of cereal in each box. If you weighed a large number of boxes filled by the machine and plotted the results in a scatter diagram, the data would tend to form a pattern that can be described as a distribution. The mean, spread and the shape may characterize such a distribution.

1. Mean is the sum of the observations divided by the total number of observations:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

x_i = Observations of a quality characteristic (such as weight)

$\bar{x}$ = Mean

n = total no. of observations

Spread is the measure of the dispersion of observations about the mean. Two measures commonly used in practice are the range and the standard deviation. Range is the difference between the largest observation in a sample and the smallest. Standard deviation is the square root of the variance of distribution. An estimate of the population standard deviation based on sample is given by

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

x_i = Observations of a quality characteristic (such as weight)

$\bar{x}$ = Mean

n = total no. of observations

= Standard deviation of a sample.

Two common shapes of process distribution are symmetric and skewed. A Symmetric distribution has the same number of observations above and below the mean. A skewed distribution has preponderance of observations either the above or below the mean.

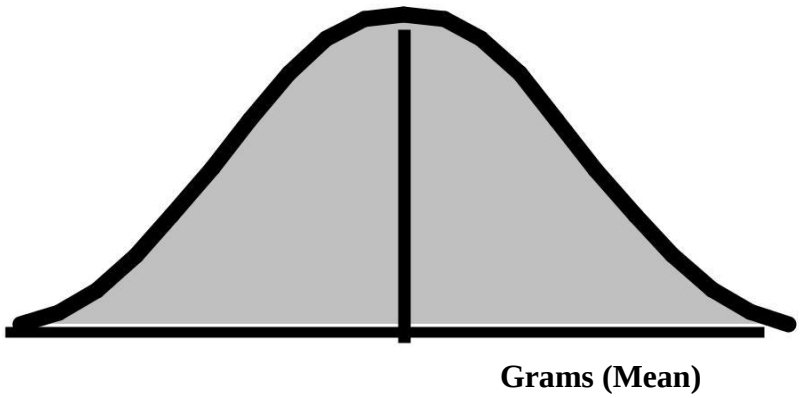


Figure 25.1 Distribution for the box-filling machine

If the process variability comes solely from causes of variation, a typical assumption is that distribution is symmetric, with most of observations near the center. Figure 25.1 shows the distribution for the box-filling machine when only common causes of variation are present. The mean weight is 425 grams and the distribution is symmetric relative to mean.

Assignable Causes

The second category of variation, assignable causes of variation, also known as special causes, includes any variation causing factors that can be identified and eliminated. Assignable causes of variation include an employee needing training, or a machine needing repair. Let us return to the example of box filling machine.

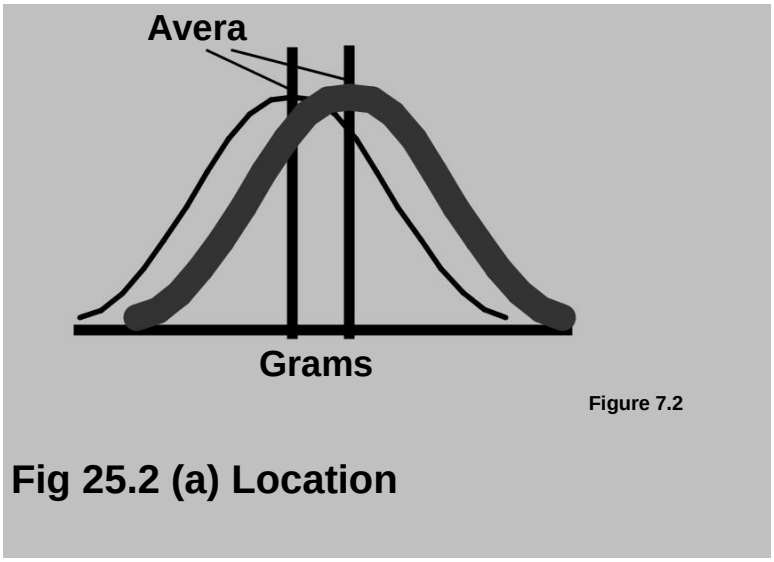


Figure 7.2

Fig 25.2 (a) Location

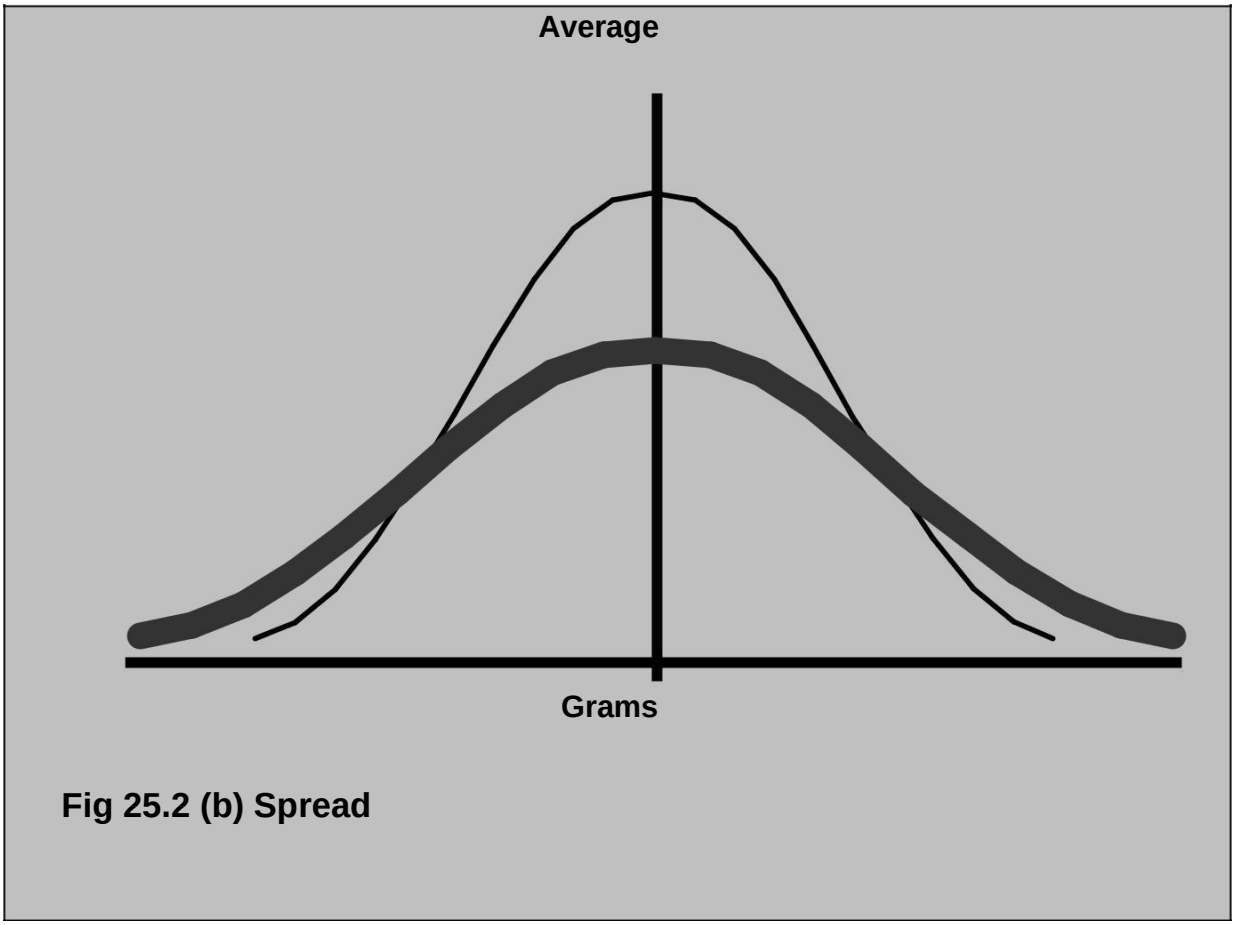


Fig 25.2 (b) Spread

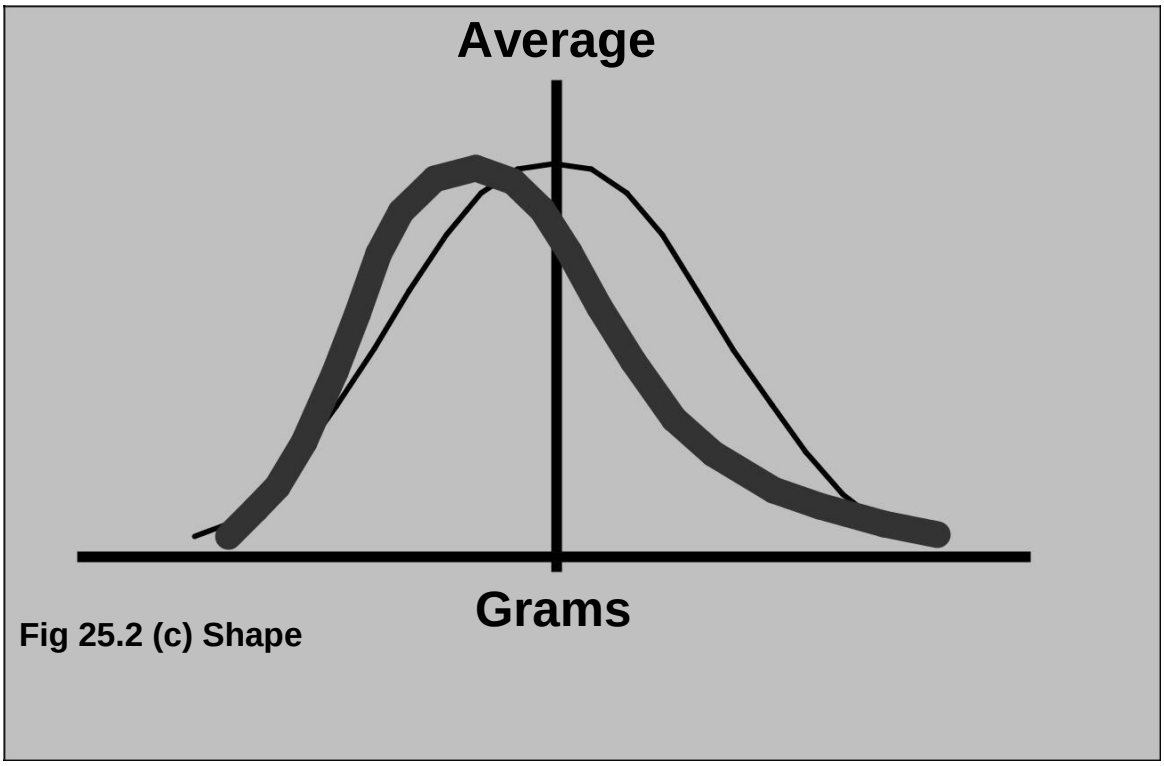


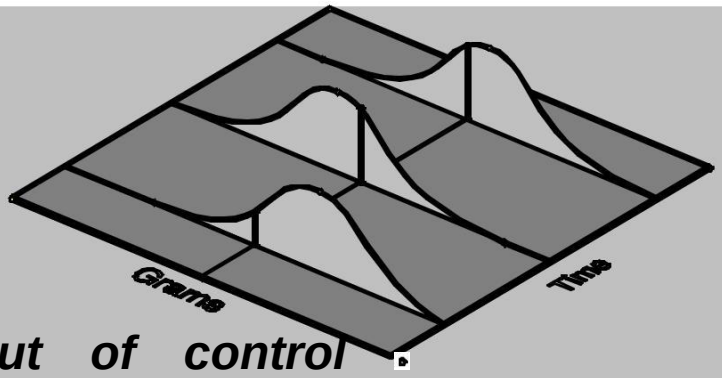
Fig 25.2 (c) Shape

Above figure 25.2 shows how assignable causes can change the distribution of the output for the box-filling machine. The thin curve shows is the process distribution when only common causes of variation are present. The thick line curve depicts a change in the distribution because of assignable causes.

In figure25.2 (a), the thick curve indicates that the machine put more cereal than planned in all the boxes, thereby increasing the average weight of each box. In figure 25.2 (b), an increase in the variability of the weight of cereal in each box affected the spread of distribution. Finally in figure 25.2 (c), the thick line indicates that the machine produced lighter than heavier boxes. Such a distribution is skewed, i.e. it is no longer symmetric to the average value.

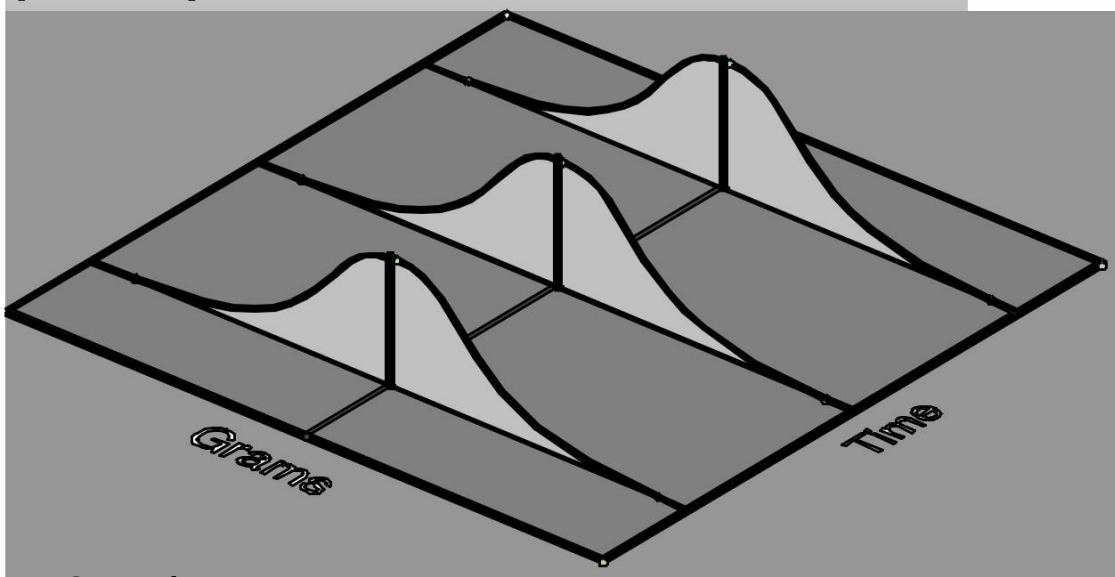
A process is said to be in statistical control when the location, spread or shape of its distribution does not change over time. After the process is in statistical control, managers use SPC procedures to detect the onset of assignable causes so that they can be eliminated.

Figure 25.3 (a) shows the differences between a process that is in statistical control and the one that is not. In figure 25.3 (a), the machine is generating different distributions of cereal box weight over time, indicating assignable causes that need to be eliminated. In figure25.3 (b), the distribution of weight is stable over time. Consequently, the process is in statistical control.



Out of control (Assignable causes present)

Figure 25.3 (a)



In Control
(No assignable causes)

Figure 25.3 (b)

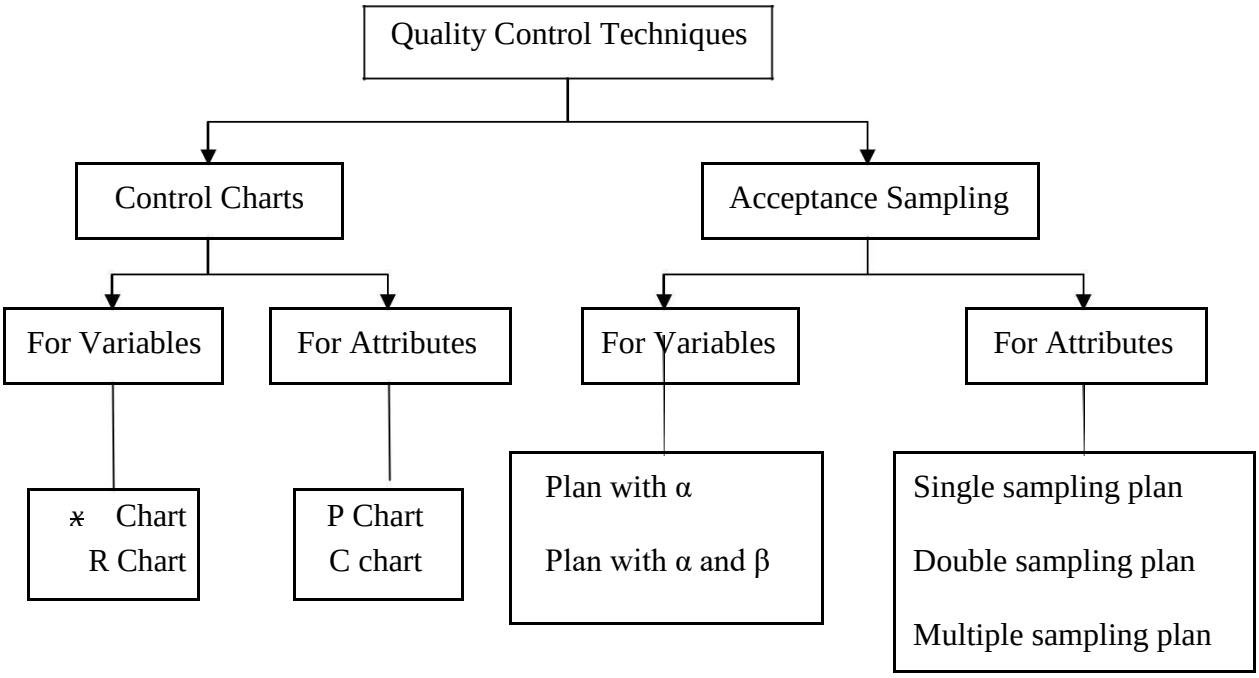


Figure 25.4-- Generalized representation of control chart

Classification of Quality Control Techniques

Control charts are used to control in-process quality. Acceptance sampling plans are aimed to control the quality of incoming raw material, semi-finished products and finished products.

Type of Data

The measurement data in SQC (Statistical Quality Control) can be classified into variable data (or continious data) and attribute data (orDiscrete Data).

Variable data are continuous in nature and are measurable on a sliding scale. These data can have a range of values and provide more information than the attribute data. Examples of variable data are-- dimensions, voltage, weight etc.

Attribute data are discrete in nature and can be binary. An example of attribute data is an accept/reject test of a shift using Go/No Go gauges.

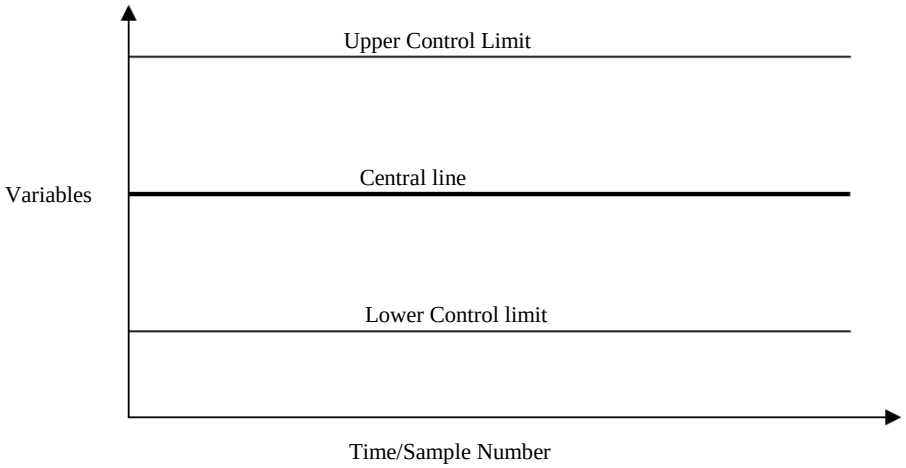


Figure 25.5-- Generalized representation of control chart

Control Charts

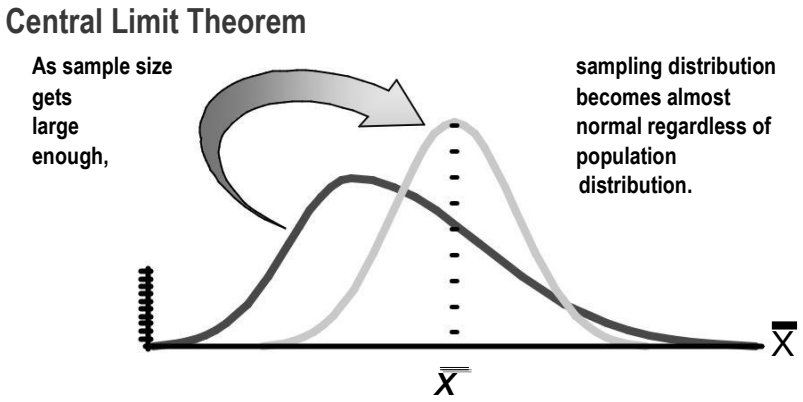
Control charts show the performance of a process from two points of view. First, they show a snapshot of the process at the moment data is collected. Second, they show the process trend as time progresses. Process trends are important because they help in identifying the out of control status if it actually exits. Also, they help to detect variations outside the normal operational limits and to identify the causes of variations. Above figure shows the generalized representation of control chart.

In figure 25.4, the x -axis shows the observation number in sequence. The y-axis shows the sample values of the observations. There are three lines, namely Upper Control Limit (UCL), Lower Control Limit (LCL) and central line. The central line is with respect to the average of the observations.

The UCL and LCL jointly specify the range over which each sample observation can lie. After plotting all the sample observations on the chart, we should look for the pattern of those plots. If any sample observation is outside of these two limits, we can conclude that the process is out of control and definitely requires corrective action.

Theoretical Basis of Control Charts

Here we will revise our statistics in relation to SQC. The concept how statistics is helpful in control chart is explained by the following sketches. Reference



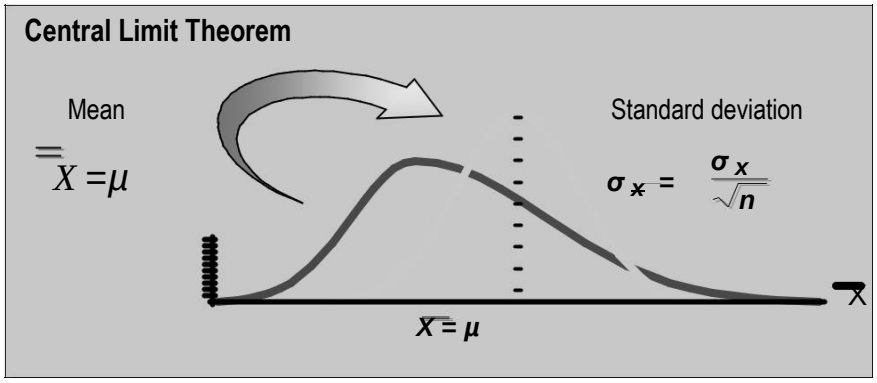


Figure 25.6-- Central limit theorem

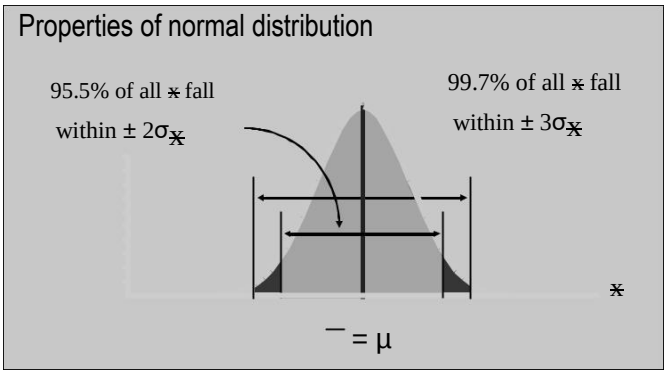


Figure 25.7-- Properties for normal distribution

Control Charts for Variables

As the name indicates, these charts will use the variable data of a process. *X* Chart gives an idea of the central tendency of the observations. These charts will reveal the variations between sample observations. R chart gives an idea about the spread (dispersion) of the observations. This chart shows the variations within the samples.

X Chart and R Chart

Procedure to Construct *X* Chart and R Chart

Identify the process to be controlled.
Select the variable of interest.
Decide a suitable sample size (n) and number of samples to be collected (k)
Collect the specified number of samples over a given time interval.
Find the measurement of interest for each piece within the sample.
Obtain the mean (*X)* of each sample. ($X = [\sum x_{ij}]/n$) .
Also obtain the range R of each sample ($R = \text{Max } x_i - \text{Min } x_i$).
Then obtain $\bar{\bar{x}}$ and $\bar{R}$ { $\bar{\bar{x}} = [\sum X]/k$, $\bar{R} = [\sum R]/k$.

7. Establish the control limits for *X* and R chart.

The values for A_2, D_4 and D_3 for different sample size are given in table 25.1

Figure25.9

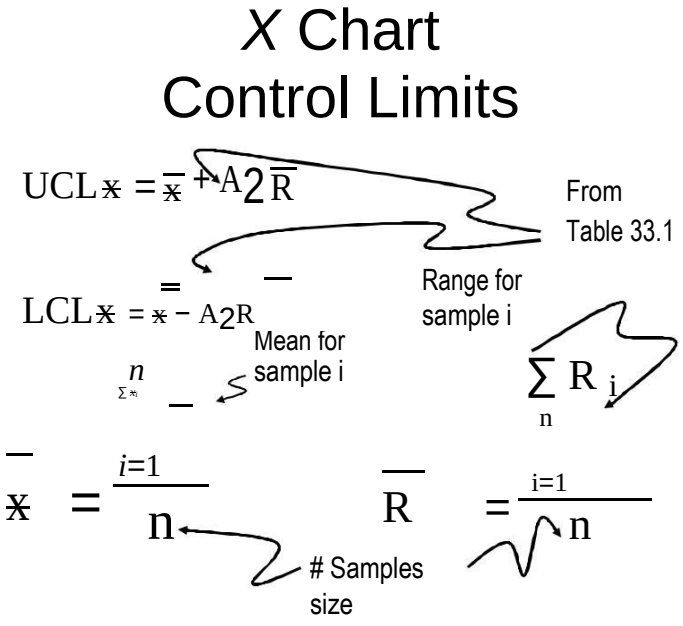

X Chart
Control Limits
UCL = + A2
LCL = − A2
From
Table 33.1
Range for
sample i
Mean for
sample i
Samples
size

Table 25.1 Factors for Computing Control Chart Limits

Sample Size, n	Mean Factor, A_2	Upper Range, D_4	Lower Range, D_3
2	1.880	3.268	0
3	1.023	2.574	0
4	0.729	2.282	0
5	0.577	2.115	0
6	0.483	2.004	0
7	0.419	1.924	0.076
8	0.373	1.864	0.136
9	0.337	1.816	0.184
10	0.308	1.777	0.223
12	0.266	1.716	0.284

Chart Control Limits

$$UCL_R = D_4 \bar{R}$$

$$LCL_R = D_3 \bar{R}$$

From Table 33.1

$$\bar{R} = \frac{\sum_{i=1}^{n} R_i}{n}$$

R_i: Range for Sample *i*

n: # Samples size

8. Incorporate the control limits on X and R charts.
   Plot X and R-values in X and R charts, respectively.
   Hunt for assignable causes when the process is out of control.

We say that a process is out of control if

Some points are outside the extreme control limits (UCL and LCL).
There exists a predominant trend among the plots of the points on one side of the chart with respect to the central line.
There exists an erratic shift in the process.

When *X* chart is used along with R chart, it tells when to leave the process alone and when to chase and hunt for the cause which leads to variation.

Example 25.1

The following data were obtained over a five-day period to indicate *X* and R control chart for a quality characteristic of a certain manufacturing product that had required a substantial amount of rework. All the figures apply to the product made on a single machine by a single operator. The sample size was 5. Two samples were taken per day comment on the process using *X* and R charts.

Sample number	Observations					*X*	R
	1	2	3	4	5		
1	10	12	13	8	9	10.4	5
2	7	10	8	11	9	9	4
3	11	12	9	12	10	10.8	3
4	10	9	8	13	11	10.2	5
5	8	11	11	7	7	8.8	4
6	11	8	8	11	10	9.6	3
7	10	12	13	13	9	11.4	4
8	10	12	12	10	12	11.2	2
9	12	13	11	12	10	11.6	3
10	10	13	7	9	12	10.2	6
						$\sum X$ =103.2	$\sum$ R = 39

Table 25.2

$$\bar{\bar{X}} = \sum X / k = 103.2/10 = 10.32$$

and $$\bar{R} = \sum R/k = 39/10 = 3.9$$

From table 25.2, for n = 5 , $A_2 = 0.58$, $D_4 = 2.11$ and $D_3 = 0$

Control limits for *X*

$$UCL_X = \bar{\bar{x}} + A_2 \bar{R} = 10.32 + 0.58 \times 3.9$$

$$= 12.585$$

$$LCL_X = \bar{\bar{x}} - A2\,\bar{R} = 10.32 - 0.58 \times 3.9$$
$$= 8.058$$

Control limits for *X*

$$UCL_R = D_4 \bar{R} = 2.11 \times 3.9$$
$$LCL_R = D_4 \bar{R} = 0 \times 3.9 = 0$$

The above control limits for *X* and R charts are shown in figure 25.5 and figure 25.6 respectively. The sample *X* and R-values are plotted on the respective figures.

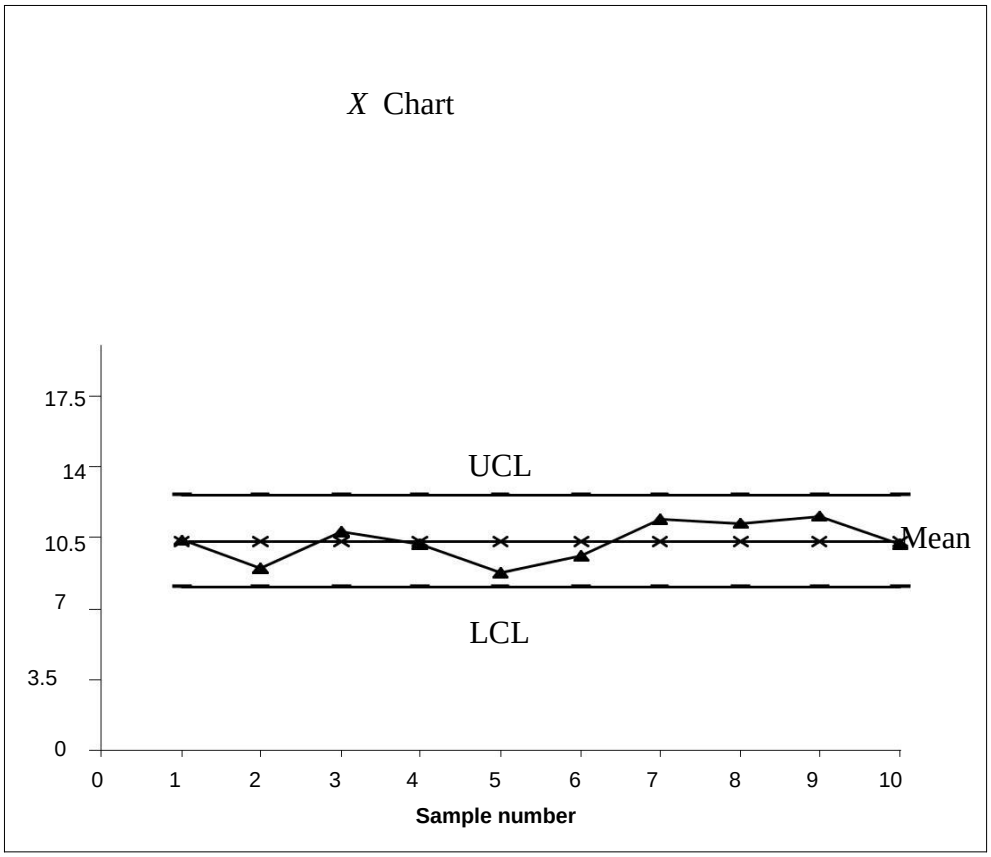


Figure 25.10-- *X* chart

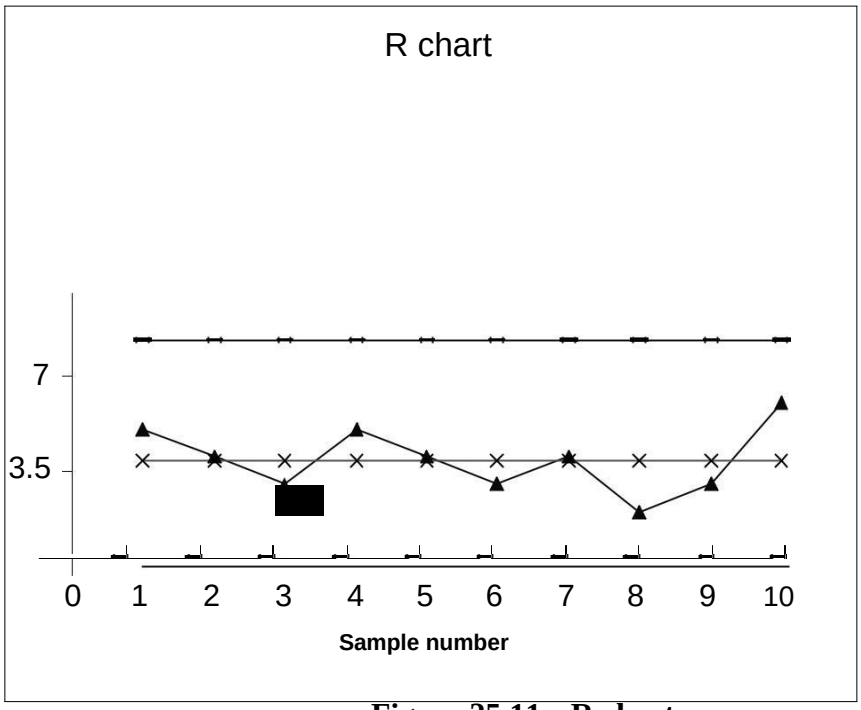


Figure 25.11-- R chart

Comment-- All the points in *X* chart are within the control. All the points on the r chart are also within the control limits. But there is a dominant up-trend toward right hand side of *X* chart. So, we have to hunt for reasons for variations. This may be due to tool wear, operator fatigue etc.

MODULE 1

Quality Management Systems

Introduction

The central need for reliable products in the Second World War defense procurement focused on tight specifications and consistency in product. This was essential if the operational researchers were to see the efficiency of their models converted into military victory. The responsibility was seen quite naturally to rest with the suppliers because checks could not reasonably or effectively be carried out on the battleground. Not surprisingly, therefore, post-war developments saw the quality drive being governed by different industries with different systems of standards.

The International Organization for Standardization (ISO) was founded in 1946.It is headquartered in Geneva, Switzerland. Its mandate is to promote the development of international standards to facilitate the exchange of goods and standards worldwide. The purpose of ISO is to facilitate global consensus agreements on international quality standards. It has resulted in a system for certifying suppliers to make sure they meet internationally accepted standards for quality management.

It is a non-government organization. ISO has as its members the national standards organizations for more than 130 countries.

During the 1970s it was generally acknowledged that the word quality had different meanings within and among industries and countries and around the world.

In 1979, the British Standards Institute (BSI) in the United Kingdom, utilizing the quality standards of the US Department of Defense standards MIL-Q9858 of the 1950s as the basis, published the first general standards BS 5750 that applied to a broad range of businesses and organizations.

In the same year, BSI, recognizing the need for standardization for quality management and assurance, submitted a formal proposal to ISO to develop international standards for quality assurance techniques and practices.

Using standard that already existed in the United Kingdom and Canada as a basis, ISO established generic quality standards, primarily for manufacturing firms that could be used worldwide. The ISO 9000 series of quality-management standards, guidelines and technical reports was first published in 1987 and it is reviewed at least every five years.
The ISO 9000 series was heavily based on BS 5750, but reflected international requirements and lessons learnt from eight years use of BS 5750.

In the meantime, other standards were developed for the European Community (EN 29000). Now, ISO 9000, BS 5750 and EN 29000 have been harmonized and are equivalent. Most of the member countries of ISO have adopted the ISO 9000 series as their national standards. Likewise,

thousands of organizations throughout the world have quality systems registered to one of the standards.

In the United States, the American National Institute/American Society publishes the national standards for Quality (ANSI/ASQ) as the ANSI/ASQ Q9000 series. The ISO 9000 Series of Standards is generic in scope.

By design, the series can be tailored to fit any organization's needs, whether it is large or small, a manufacturer or a service organization.

Its purpose is to unify quality terms and definitions used by industrialized nations and use those terms to demonstrate a supplier's capability of controlling its processes.

In very simplified terms, the standards require an organization to say what it is doing to ensure quality, then do what it says and finally document or prove that it has done what it said.

The objective of quality management is to quickly produce safe products with low costs to achieve customer satisfaction.

Example

In the agri-food sector, quality management is especially important for the following reasons:

- Agricultural products often perish because of physiological processes and microbiological contamination.
- Agricultural products are very heterogeneous and the quality parameters for components like sugar, size and color which are very important for processing have to be controlled.
- A large number of farms produce agricultural products on a small scale (LUNING et al., 2002).

Many different quality systems have been developed in the agri- food sector during the past ten years and will continue to be developed. Reasons are, in particular, numerous food scandals and globalization. These quality systems are organized in different ways. There are contractually coordinated chain organizations and chain organizations with "regulated" or "participative" quality management. The consequences include, e.g., different information flows in these quality systems (HELBIG, 2002).

ISO 9000

ISO 9000 is a generic system that specifies, in very broad terms, the necessary components of a quality management system. Rather than being specific to any one industry, it details the basic requirements of the quality function for all industries.

Certification ISO 9000 was originally published in 1987 by the International Organization for Standardization, a worldwide federation of national standards bodies, headquartered in Geneva,

Switzerland. The organization was founded in 1946 to develop a common set of standards for manufacturing, trade and communications. Today more than 90 countries are members, each with a representative. The representative for the United States is the American National Standards Institute (ANSI).

The concept of Certification ISO 9000 was developed in part because of the European push toward a fully integrated common market. It was recognized that for the common market to exist, there would have to be assurance of quality across borders. The European Economic Community, (now the European Union, or EU), adopted Certification ISO 9000 as the basic minimal quality management system for selling certain products (electronic components and construction equipment) within the European Union

ISO 9000 Series of Standards

The five standards of the series are described briefly below:

ISO 9000, "Quality Management and Quality Assurance Standards Guidelines for selection and use," explains fundamental quality concepts, defines key terms and provides guidelines for selecting, using and tailoring the ISO 9001, 9002 and 9003 standards. It is the roadmap for the use of the entire series.

ISO 9001, "Quality Systems-Model for Quality Assurance in Design, Development, Production, Installation, and Servicing," is the most comprehensive standard in the series. It contains 20 elements covering the need for an effective quality system, from the receipt of a contract through the design/development stage and finally the service required after delivery.

ISO 9002, "Quality Systems-Model for Quality Assurance in Production, Installation, and Servicing," addresses the prevention, detection and correction of problems during production and installation. It is for the use of those organizations that are not involved in design. This standard addresses 19 of the 20 elements covered in the 9001 standard.

ISO 9003, "Quality Systems-Model for Quality Assurance in Final Inspection and Test," is the least comprehensive of the standards, covering 16 of the 20 elements in 9001. It is not a quality control system. ISO 9003 addresses only those requirements for the detection and control of problems found during final inspection and testing.

ISO 9004-1, "Quality Management and Quality System Elements-Guidelines," provides guidance for a supplier to use in developing and implementing a quality system and in determining the extent to which each quality system element is applicable. It examines each of the elements in greater detail. In this respect it is useful for internal auditing purposes.

Other Quality Systems

The ISO 9000 series was most recently revised and updated in 2000.

ISO 9000:2000, Quality Management Systems-Fundamentals and Vocabulary, is the starting point for understanding the standards. It defines the fundamental terms and definitions used in the ISO 9000 family of standards, guidelines and technical reports.
ISO 9001:2000, Quality Management Systems-Requirements, is the requirement standard a company uses to assess its ability to meet customer and applicable regulatory requirements in order to achieve customer satisfaction.
ISO 9004:2000, Quality Management Systems-Guidelines for performance improvements, provides detailed guidance to a company for the continual improvement of its quality-management system in order to achieve and sustain customer satisfaction.
ISO 9001, 9002 and 9003 standards have been consolidated into the single revised ISO 9001:2000 standard.
The ISO 9001:2000 standard replaces the ISO 9001:1994, ISO 9002:1994 and ISO 9003:1994 standards. Although an organization can continue to be certified to these standards until December 2003, if they so choose.

Many companies around the world require that companies they do business with (e.g., suppliers) have ISO 9000 certification. In that way, despite possible language, technology and cultural differences, a company can be sure that the company it is doing business which meets uniform standards.

If a manufacturer wants to purchase from a non-certified supplier, the manufacturer should visit the supplier and examine its processes, past performances, workers' credentials and so on to verify that the supplier can meet the required quality levels and performance schedule.

Certification involves getting the proper documents, initiating the required procedures and practices, and conducting internal audits (first party certification).
This can be followed by a second- or third-party audit as desired.
In a two-party system, a customer would audit the quality system of a supplier for acceptability resulting in costly multiple audits.
The best certification of a firm is through a third party.
A third-party company called a registrar is the only authorized entity that can award ISO 9000 certification.

Registrars are accredited by an authoritative national body and are contracted by companies for a fee to evaluate their quality-management system to see if it meets the ISO 9000 standards.

A quality system certification involves the assessment and periodic surveillance audit of the adequacy of a supplier's quality system by a registrar.

When a supplier's system conforms to the registrar's interpretation of the standard, the registrar issues a certification to that effect to the supplier.

This certification ensures customers or potential customers that a supplier has a quality system in place and it is being monitored.

Once passed by the third-party audit, a firm is certified and may be registered and recorded as having achieved ISO 9000 status and it becomes part of a registry of certified companies recognized throughout the world.

There are various reasons for implementing a quality system that conforms to an ISO standard:

Customer or marketing are suggesting or demanding compliance to a quality system
Need for improvements in processes or systems
Desire for global deployment of products and services
As more and more organizations become registered, they are requiring their subcontractors or suppliers to be registered, creating a snowball effect

Most of the organizations have found that implementing ISO 9000 systems have benefited them in the following ways:

Fewer on-site audits by customers
Increased market share
Improved quality, both internally and externally (fewer complaints)
Improved product and service quality levels from suppliers
Greater awareness of quality by employees
A documented formal system
Reduced operating costs

AS 9000

The Aerospace Standards

The aerospace industry requires that all elements of production and supply chain operate to levels of quality and performance that assure safe and reliable products. The Americas Aerospace Quality Group (AAQG) in cooperation with many aerospace companies developed specific requirements for quality systems that are to be implemented and maintained by the complete production and supply chain in the manufacture of products used in aviation and space applications.

AS9000/AS9100

AS9100 includes ASQ9001:2000 quality system requirements and specifies additional requirements for the quality system of the aerospace industry.

Examples of common and unique aerospace requirements found in AS9000/AS9100 are as follows:

Identification and Control of Key Characteristics
Stamp Control
Foreign Object Detection (FOD)
Requirements Flow Down
Tooling Control
Customer and Regulatory Agency Involvement and Approval

AS9101A Quality System Assessment

The checklist corresponding to AS9100 Revision A.

AS9102 Aerospace First Article Inspection Requirement

Established the requirements for First Article Inspection. The purpose of First Article Inspection is to provide objective evidence that all engineering design and specification requirements are properly understood, accounted for, verified and documented.

AS9103 Variation Management of Key Characteristics

Established variation management requirements for key characteristics. This standard also specifies general requirements and provides a process to achieve those requirements.

AS9120

This standard includes ISO 9001:2000 quality management system requirements and specifies additional requirements for a quality management system for the aerospace industry applicable to stockiest distributors.

AS9131 Quality Systems Non-Conformance Documentation

This document defines to supplier/subcontractor common information and documentation required to inform customers, when applicable about nonconformity (Customer-provider use).

Tooling and Equipment (TE 9000)

The Industries Tooling and Equipment Supplement to QS-9000

The Tooling and Equipment (TE) is an addition to the QS-9000, a requirement by most tooling and equipment suppliers within the automotive industry.

The Standards Council of Canada (SCC) accredits registration bodies to register organizations to the requirements of TE-9000 as part of its qualification program for QS-9000 (automotive).

TE-9000 outlines the fundamental quality management system expectations of automotive companies for their tooling and equipment suppliers

QS 9000 Purpose

Improving Relationships to Improve Quality

"The goal of developing your suppliers is based on the need to provide high quality to the customer"
Enhance quality systems for suppliers
Eliminate redundant requirements
Reduce costs
Fundamentally different from ISO 9000
Designed to help suppliers to automakers provide evidence of standardized processes for dealing with customers
Major automobile manufacturer's setup teams with suppliers to help in development

Advantages

Organization for International Standards
European standards for quality
Standards are broad and vague to adapt to different cultures
Does not provide framework for organizational improvement and change
Companies document quality systems in manuals to facilitate trade through supplier conformance
Success has created various other standards such as QS 9000

Disadvantages

Not all countries accept ISO registrars
Mainly for exporting firms
Barrier to trade
Time consuming
Costly
Difficult for small firms to afford

Discourages free thinking and employee empowerment

Questions

What is ISO?
Briefly explain the objectives of each of the five ISO 9000 standards.
Which are the five ISO 9000 series of standards?
Write in brief about The ISO 9000 series which was most recently revised and updated in 2000.
Explain QS 9000 & TE 9000.
What are the advantages and disadvantages of ISO?

MODULE 1
Quality Management Systems-I

Introduction

The International Organization for Standardization (ISO) was founded in 1946 in Geneva, Switzerland, where it is still based. Its mandate is to promote the development of international standards to facilitate the exchange of goods and services worldwide. ISO is composed of more than 90 member countries. The United States representative is the American National Standards Institute (ANSI).

The ISO Technical Committee (TC) 176 develops a series of international standards for quality systems which were first published in 1987. The standards (ISO 9000, 9001 and 9004) were intended to be advisory and were developed for use in two-party contractual situations and internal auditing. However, with their adoption by the European Community (EC) and a worldwide emphasis on quality and economic competitiveness, the standards have become universally acceptable.

Most of the countries have adopted the ISO 9000 series as their national standards. Likewise, thousands of organizations throughout the world have quality systems registered to the standard. In the United States, the national standards are published by the American National Institute/American Society for Quality (ANSI/ASQ) as the ANSI/ASQ Q9000 series. Government bodies throughout the world, including the United States, are also using the standards. US government agencies using the series are the Department of Defense (DOD) and the Food and Drug Administration (FDA).

In a two-party system, the supplier of a product or service would develop a quality system that conforms to the standards. The customers would then audit the system for acceptability. This two-party system results in both supplier and customer having to participate in multiple audits which can be extremely costly. This practice is replaced by a third-party registration system.

A quality system registration involves the assessment and periodic surveillance audit of the adequacy of a supplier's quality system by a third party, who is a registrar. When a system conforms to the registrar's interpretation of the standard, the registrar issues a certificate of registration to the supplier. This registration ensures customers or potential customers that a supplier has a quality system in place and it is being monitored.

Benefits of ISO Registration

There are various reasons for implementing a quality system that conforms to an ISO standard. The primary reason is that customers are suggesting, or market is demanding, compliance to a quality system. Other reasons include required improvements in processes or systems and a desire for global deployment of products and services. As more and more organizations become registered, they require their subcontractors or suppliers to be registered, creating a snowball

effect. Consequently, in order to maintain or increase market share, many organizations are finding that they should be in conformance with an ISO standard. Internal benefits that can be received from developing and implementing a well-documented quality system can far outweigh the external pressures.

A study of 100 Italian manufacturing firms was undertaken to determine if there was any improvement in performance after registration. Significant improvement was noted in the following areas:

Internal quality as measured by the percent of scrap, rework and nonconformities at final inspection
Production reliability as measured by the number of breakdowns per month, percent of time dedicated to emergencies and percent of downtime per shift
External quality as measured by product accepted by customers without inspection, claims of nonconforming product and returned product
Time performance as measured by time to market, on-time delivery and throughput time
Cost of poor quality as measured by external nonconformities, scrap and rework

On the negative side, prevention and appraisal costs increased. Additional examples of benefits after registration are as follows:

The American Institute of Certified Public Accountants (AICPA) now has a quality system that works. Also, there was a 4% improvement in gross margins which was the largest improvement in their history.
North town Ford automobile dealership in Toronto, Ontario, raised customer satisfaction and loyalty by 20%. It experienced a 55% increase in customers who would recommend the dealership.
United Airlines reduced the average engine overhaul cycle time from 120 days to 60 days.
Cleveland Center for Joint Reconstruction has experienced lower costs and more control and consistency in the care it provides.

ISO 9000 Series of Standards

The ISO 9000 series of standards is generic in scope. By design, the series can be tailored to fit any organization's needs, whether it is large or small, a manufacturer or a service organization. It can be applied to construction, engineering, health care, legal and other professional services as well as the manufacturing of anything from nuts and bolts to spacecraft. Its purpose is to unify quality terms and definitions used by industrialized nations and use those terms to demonstrate a supplier's capability of controlling its processes. In simplified terms, the standards require an organization to say what it is doing to ensure quality, then do what it says and finally document or prove that it has done what it said.

The three standards of the series are described briefly below:

ISO 9000:2000

Quality Management Systems (QMS) fundamentals and vocabulary discusses the fundamental concepts related to the QMS and provides the terminology used in the other two standards.

ISO 9001:2000

QMS requirements is the standard used for registration by demonstrating conformity of the QMS to customers, regulator and the organization's own requirements.

ISO 9004:2000

QMS guidelines for performance improvement provide guidelines that an organization can use to establish a QMS focused on improving performance.

Sector-Specific Standards

The ISO 9000 system is designed as a simple system that could be used by any industry. Other systems have been developed that are specific to a particular industry such as automotive or aerospace. These systems use the ISO 9001 as the basic framework and modify it to their needs. There are currently three other quality systems in place-- AS9100, ISO/TS 16949 and TL 9000.

One of the problems with sector-specific standards is the need for suppliers with customers in different industries to set up quality systems to meet each sector's requirements. For example, a packaging supplier that services the aerospace, automobile and telecommunications industries would need to set up its system to accommodate not only ISO 9001 but three other standards. In addition, the Registration Accreditation Board (RAB) points out that sector-specific standards have created a need for specialized auditors and training courses. On the positive side, the standardization of requirements beyond ISO 9001 makes compliance by key suppliers and implementation by major customers much easier.

AS9100

This aerospace industry quality system was officially released by the Society of Automotive Engineers in May 1997. Its development and release represents the first attempt to unify the requirements of NASA, DOD and FAA while satisfying the aerospace industry's business needs. In March 2001, the International Aerospace Quality Group (IAQG) aligned AS9100 with ISO 9001:2000. Industry-specific interpretations and methodologies are identified in italics and bold type. These additions are accepted aerospace approaches to quality practices and general requirements. Aerospace organizations in Europe, Japan and the US will certify registrars and auditors.

ISO/TS 16949

This standard is entitled "Quality Systems Automotive Suppliers-- Particular Requirements for the Application of ISO 9001." It harmonizes the supplier quality requirements of the US big three as provided in *QS 9000 Third Edition* with the French, German and Italian automakers. The standard has been also approved by Asian automakers. The goal of this technical specification is the development of fundamental quality systems that provide for continuous improvement, emphasizing defect prevention and the reduction of variation and waste in the supply chain. There are three following basic levels:

ISO 9001
Sector-specific requirements
Company-specific requirements

Appropriate levels for division-specific, commodity-specific and part-specific requirements are required for these. Registrars will need to be certified to the standard and their number will be limited.

It is assumed that this standard will show the same rate of improvement as QS 9000. OM reported that supplier parts-per-million defect rate improved by about 85% for the first five years of the use of QS 9000.

<table>
<tr><td colspan="3">ISO 9001 Requirements</td></tr>
<tr><td colspan="3">Common TL 9000 Requirements (QSR)-- Book 1</td></tr>
<tr><td>Hardware Specific Requirements</td><td>Software Specific Requirements</td><td>Service Specific Requirements</td></tr>
<tr><td colspan="3">Common TL 9000 Requirements (QSM)-- Book 2</td></tr>
<tr><td>Hardware Specific Measurements</td><td>Software Specific Measurements</td><td>Service Specific Measurements</td></tr>
</table>

Figure 27.1-- The structure of the TL 9000 standard

TL 9000

The Quality Excellence for Suppliers of Telecommunications Forum (QUEST) wrote TL 9000 to consolidate the various quality system requirements within the telecommunications industry. This forum was created to develop the standard wherein suppliers such as Motorola and Lucent and telecom service providers such as Verizon, Southwestern Bell and AT&T would have an equal vote in developing the new strategy. It is a specific set of requirements based on ISO 9001 that defines the design, development, production, delivery, installation and maintenance of telecommunications products and services. Customers and suppliers receive a number of benefits which include the following:

Continuous improvement
Enhanced customer-supplier relationships
Efficient management of external audits

Worldwide standards
Increased competitiveness that results in overall cost reduction
Industry benchmarks for performance metrics
A platform for improvement initiatives

Figure 27.1 shows the structure of the TL 9000 standard and its five layers. The first layer is the ISO 9000 requirements. It is followed by Book 1 called *TL 9000 Quality System Requirements (QSR)* which establishes a common set of requirements applicable to hardware, software and services. The second layer of Book 1 provides specific requirements for hardware, software and services. In the first layer of Book 2 called *Quality System Measurements (QSM)*, the common industry measurements such as billing errors are specified. In the last layer, the specific measurements for hardware, software and services are defined.

The unique feature of the standard is the use of the metrics specified in the QSM book to communicate and monitor actual results. Cost and performance-based metrics provide information to enable the industry to measure progress and evaluate results of quality system implementation. The University of Texas at Dallas (UTD) administers the QSM. Participants report specially coded metrics information to UTD which stores and analyzes the data. Descriptive statistics such as mean, range, median, standard deviation and best in industry is calculated. This information is available to the over 200 forum members on the forum's Website. A supplier's identity remains anonymous at all times. Each organization can benchmark its performance against the industry standard and determine which of their processes need improvement, thereby improving customer-supplier relations.

ISO 9001 Requirements

The standard has following eight clauses:

Scope
Normative references
Definitions
Quality management systems
Management responsibility
Resource management
Product and/or service realization
Measurement, analysis and improvement

The first three clauses are for information while the last five are requirements that an organization should meet.

The application of a system of process within an organization, together with their identification and interactions and the managing of these processes, is referred to as the process approach. This approach emphasizes the importance of the following:

Understanding and fulfilling the requirements
The need to consider processes in terms of value added

Obtaining results of process performance and effectiveness
Continual improvement of processes based on objective measure

Scope

The purpose of the standard is for the organization to demonstrate its ability to provide a product that meets customer and regulatory requirements and achieves customer satisfaction.

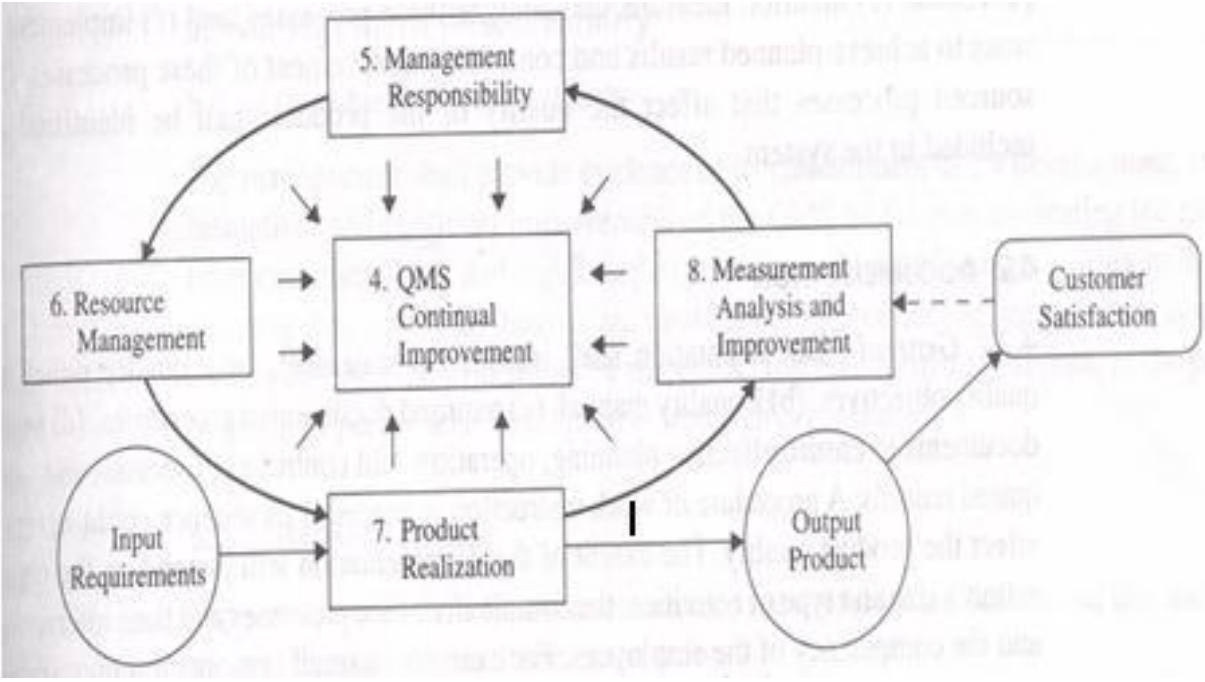


Figure 27.2-- Model of a process-based quality management system

This purpose is accomplished by evaluating and continually improving the system rather than the product. The requirements of the standard are intended to be applicable to all types and sizes of organization. Requirement in clause 7, product realization which is not appropriate to an organization, can be excluded.

Normative Reference

ISO 9000:2000 Quality Management Systems-- Fundamentals and vocabulary are a normative reference that provides applicable concepts and definitions.

Terms and Definitions

For the purposes of this standard, the terms and definitions given in ISO 9000:2000 apply. In addition, the supply chain is defined as follows:

Supplier → Organization → Customer

Quality Management System (QMS)

I. General Requirements

The organization should establish, document, implement and maintain a QMS and continually improve its effectiveness. The organization should also do the following

Identify needed processes such as management activities, provision of resources, product realization and measurement.
Determine their sequence and interaction.
Determine criteria and methods for effective operation and control of these processes.
Ensure the availability of resources and information necessary to support and monitor these processes.
Monitor, measure and analyze these processes.
Implement actions to achieve planned results and continual improvement of these processes.

Outsourced processes that affect the quality of the product should be identified and included in the system.

Documentation

a. General Documentation

It should include the following:

Statements of a quality policy and quality objectives
A quality manual
Required documented procedures
Needed documents to ensure effective planning, operation and control of processes
Required records

A procedure or work instruction is needed if its absence could adversely affect the product quality. The extent of the documentation should depend on the organization's size and type of activities, the complexity of the processes and their interactions and the competency of the employees. For example, a small organization may verbally notify a manager of an upcoming meeting, whereas a large organization would need written notification. The standard should satisfy the contractual, statutory and regulatory requirements and the needs and expectations of customers and other interested parties. Documentation may be in any form or type of medium.

b. Quality Manual

A quality manual should be established and maintained that includes the following:

All the scope of the QMS with details and justification for any exclusions
The documented procedures or reference to them
A description of the interaction among the QMS

processes **c. Control of Documents**

Documents required by the QMS should be controlled. A documented procedure should be in place to define the control needed to do the following:

Approve documents prior to use
Review, update and re-approve as necessary
Identify the current revision status
Ensure that current versions are available at the point of use
Ensure that documents are legible and readily identified
Identify and distribute documents of external origin
Provide for the prompt removal of obsolete documents and suitably identify those that may be retained

Documented procedure means that the procedure is established, documented, implemented and maintained.

d. Control of Records

Records should be established and maintained to provide evidence of conformity to requirements and the effective operation of the QMS. They should be legible, readily identifiable and retrievable. A documented procedure should be established to define the controls needed for the identification, storage, protection, retrieval, retention time and disposition of records. Records can be used to document tractability and to provide evidence of verification, preventive action and corrective action.

Management Responsibility

I. Management Commitment

Top management should provide evidence of its commitment to the development, implementation and continual improvement of the QMS by doing the following:

Communicating the need to meet customer, legal and regulatory expectations
Establishing a quality policy
Ensuring that quality objectives are established
Conducting management reviews
Ensuring the availability of resources

Top management is defined as the person or group of people who directs and controls an organization.

II. Customer Focus

Top management should ensure that customer requirements are determined and met with the aim of enhancing customer satisfaction.

III. Quality Policy

Top management should ensure the following with regard to the quality policy:

It is appropriate to the organization's purpose or mission.
It includes a commitment to comply with requirements and continually improve the effectiveness of the QMS.
It provides a framework for establishing and reviewing the quality objectives.
It is communicated and understood within the organization.
It is reviewed for continuing stability.

The quality policy gives the overall intention and direction of the organization related to quality.

IV. Planning

a. Quality Objectives

Top management should ensure that quality objectives are established at relevant functions and levels within the organization and include product requirements. They should be measurable and consistent with the quality policy. In addition, they should ensure that customer expectations are met. Quality objectives are something sought or aimed for related to quality. For example, finishing department scrap will be reduced from 5.0% to 4.3% and the first line supervisor is the person responsible for it.

b. Quality Management System Planning

Top management should ensure that the planning of the QMS is accomplished in order to meet the requirements of the QMS as stated in the general requirements as well as the quality objectives. In addition, the integrity of the QMS is maintained when changes are planned and implemented.

V. Responsibility, Authority and

Communication a. Responsibility and Authority

Top management should ensure that responsibilities and authorities are defined and communicated within the organization. Responsibilities can be defined in job descriptions,

procedures and work instructions. Authorities and interrelationships can be defined in an organizational chart.

b. Management Representative

Top management should appoint a member of the management, regardless of his/her other duties, who should have the responsibility and authority including the following:

Ensuring that processes needed for the QMS system are established, implemented and maintained
Reporting to top management on the performance of the QMS and any need for improvement
Ensuring the promotion of awareness of customer requirements throughout the organization

Appointment of a member of top management as the representative can contribute to the effectiveness of the QMS.

c. Internal Communication

Top management should ensure that appropriate communication channels are established within the organization and that communication takes place regarding the QMS. Typical communication techniques are management workplace briefing, recognition of achievement, bulletin boards, e-mail and in-house news brochures.

VI. Management Review

a. General

Top management should review the QMS at planned intervals to ensure its continuing suitability, adequacy and effectiveness. This review should include assessing opportunities for improvement and the need for changes to the QMS including the quality policy and quality objectives. Records from the reviews should be maintained.

b. Review Input

The input to the review should include information on the following:

Results of audits
Customer feedback
Process performance and product conformity
Status of corrective and preventative performance
Follow-up actions from previous management reviews
Changes that could affect the QMS
Recommendations for improvement

c. Review Output

The output from the review should include any decisions and actions related to the following:

Improvement of the effectiveness of the QMS and its processes
Improvement of the product related to customer requirements
Resource needs

Top management can use the outputs as inputs to improvement opportunities.

Resource Management

I. Provision of Resources

The organization should determine and provide the resources needed to implement and maintain the QMS and continually improve its effectiveness and to enhance customer satisfaction by meeting customer requirements. Resources may be people, infrastructure, work environment, information, suppliers, natural resources and financial resources. Resources can be aligned with quality objectives.

Human

Resources a. General

Personnel performing work that affects product quality should be competent on the basis of appropriate education, training, skills and experience.

Competence, Awareness and Training

The organization should do the following:

Determine the necessary competence for personnel performing work affecting product quality
Provide training or take other actions to satisfy these needs
Evaluate the effectiveness of the actions taken
Ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives
Maintain appropriate records of education, training, skills and experience

Competency is defined as the demonstrated ability to apply knowledge and skills. It can be contained in the job description by function, group or specific position. Training effectiveness can be determined by before and after tests, performance or turnover. ISO I 10015 Guidelines for Training help organizations in complying with this standard.

III. Infrastructure

The organization should determine, provide and maintain the infrastructure needed to achieve conformity to product requirements. Infrastructure includes, as applicable, the following:

Buildings, workspace and associated utilities
Process equipment (both hardware and software)
Supporting services (such as transport or communication)

IV. Work Environment

The organization should determine and manage the work environment needed to achieve conformity to product requirements. Creation of a suitable work environment can have a positive influence on employee motivation, satisfaction and performance.

7. Product Realization

I. Planning of Product Realization

The organization should plan and develop the processes needed for product realization. Planning of product realization should be consistent with the requirements of the other processes of QMS. In planning product realization, the organization should determine the following, as appropriate:

Quality objectives and requirements for the product
The need to establish processes, documents and provide resources specific to the product
Required verification, validation, monitoring, inspection and test activities specific to the product and the criteria for product acceptance
Records needed to provide evidence that the realization processes and resulting product or service meet requirements.

The output of this planning should be in a form suitable for the organization's method of operations. A document specifying the processes of the QMS (including the product realization processes) and the resources to be applied to a specific product, project or contract can be referred to as a quality plan. The organization may also apply the requirements given in the III point to the development of the product realization processes.

Customer-Related Processes

a. Determination of Requirements Related to the Product

The organization should determine the following:

Requirements specified by the customer, including the requirements for delivery and post-delivery activities

Requirements not stated by the customer but necessary for specified or intended use, where known
Statutory and regulatory requirements related to the product
Any additional requirements determined by the

organization **b. Review of Requirements Related to the Product**

The organization should review the requirements related to the product. This review should be conducted prior to the organization's commitment to supply a product to the customer. For example, submission of tenders, acceptance of contracts or orders, acceptance of changes to contracts or orders etc. The review should ensure the following:

Product requirements are defined
Contract or order requirements differing from those previously expressed are resolved
The organization has the ability to meet the defined requirements

Records of the results of the review and actions arising from the review should be maintained. Where the customer provides no documented statement of requirement, the customer requirements should be conformed by the organization before acceptance. Where product requirements are changed, the organization should ensure that relevant documents are amended and that relevant personnel are made aware of the changed requirements. 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 catalogs or advertising materials.

c. Customer Communication

The organization should determine and implement effective arrangements for communicating with customers in relation to the following:

III. Design and Development

a. Design and Development Planning

The organization should plan and control the design and development of the product. During the design and development planning, the organization should determine the following:

The design and development stages
The review, verification and validation that are appropriate to each design and development stage
The responsibilities and authorities for design and development

The organization should manage the interfaces between different groups involved in design and development to ensure effective communication and clear assignment of responsibility. Planning output should be updated, as appropriate, as the design and development progresses.

b. Design and Development Inputs

Inputs relating to product requirements should be determined and records maintained. These should include the following:

Functional and performance requirements
Applicable statutory and regulatory requirements
Where applicable, information derived from previous similar designs
Other requirements essential for design and development

These inputs should be reviewed for adequacy. Requirement should be complete, unambiguous and not in conflict with each other.

c. Design and Development Outputs

The outputs of design and development should be provided in a form that enables verification against the design and development input and should be approved prior to release. Design and development outputs should do the following:

Meet the input requirements for design and development
Provide appropriate information for purchasing, production and for service provision
Contain reference product acceptance criteria
Specify the characteristics of the product that are essential for its safe and proper use **d. Design and Development Reviews**

At suitable stages, systematic reviews of design and development should be performed in accordance with planned arrangements for the following purposes:

To evaluate the ability of the results of design and development to meet requirements
To identity any problems and propose necessary actions

Participants in such reviews should include representatives of functions concerned with the design and development and state(s) being reviewed. Records of the results of the reviews and any necessary actions should be maintained. Risk assessment such as FMEA, reliability prediction and stimulation techniques can be undertaken to determine potential failures in products or processes.

e. Design and Development Verification

Verification should be performed in accordance with planned arrangements to ensure that the design and development outputs meet the design and development input requirements. Records of the results of verifications and any necessary actions should be maintained.

Verification confirms, through objective evidence, that the specified requirements have been fulfilled. Confirmation can comprise the following activities:

Performing alternate calculations
Comparing the new design specification to a similar proven design specification, undertaken tests and demonstrations
Reviewing documents prior to

issue **f. Design and Development Validation**

Design and development validation should be performed in accordance with the planned arrangement. This is to ensure that the resulting product is capable of meeting the requirements for the specification application or intended use when known. Wherever practicable, validation should be completed prior to the delivery or implementation of the product. Records of the result of validation and any necessary action should also be maintained. Validation confirms, through objective evidence, that the requirements for a specific intended use have been fulfilled.

g. Control of Design and Development Changes

Design and development changes should be identified and records maintained. The changes should be reviewed, verified and validated, as appropriate and approved before implementation. The review of design and development changes should include evaluation of the effect of the changes on constituent parts and product already delivered. Records of the results of the review of changes and any necessary actions should be maintained.

IV. Purchasing

a. Purchasing Process

The organization should ensure that purchased product conforms to the specified purchase requirements. The type and extent of control applied to the supplier and the purchased product should be dependent upon the effect of the purchased product on subsequent product realization or the final product. The organization should evaluate and select suppliers based on their ability to supply product in accordance with the organization's requirements. Criteria for selection, evaluation and re-evaluation should be established. Records of the results of evaluations and any necessary actions arising from the evaluation should be maintained. This standard does not apply to item such as office and maintenance suppliers, unless they are a product.

b. Purchasing Information

Purchasing information should describe the product to be purchased, including, where appropriate, the following:

Requirements for approval of product, procedures, processes and equipment

Requirements for qualification of personnel
QMS requirements

The organization should ensure the adequacy of specified requirements prior to their communication to the supplier.

c. Verification of Purchased Product

The organization should establish and implement the inspection or other activities necessary for ensuring that purchased product meets specified purchased requirements. Where the organization or its customer intends to perform verification at the supplier's premises, the organization should state the intended verification arrangements and methods of product release in the purchasing information.

Production and Service Provision

a. Control of Production and Service Provision

The organization should plan and carry out production and service provision under controlled conditions. Controlled conditions should include, as applicable, the following:

The availability of information that describes the characteristics of the product
The availability of work instructions, as necessary
The use of suitable equipment
The availability and use of monitoring and measuring devices
The implementation of monitoring and measurement
The implementation of release, delivery and post-delivery

activities **b. Validation of Processes for Production and Service Provision**

The organization should validate any processes for production and service provision where the resulting output cannot be verified by subsequent monitoring or measurement. This includes any processes where deficiencies become apparent only after the product is in use or the service has been delivered. Validation should demonstrate the ability of these processes to achieve planned results. The organization should establish arrangements for these processes including, as applicable, the following:

Defined criteria for review and approval of the processes
Approval of equipment and qualification of personnel
Use of specific methods and procedures
Requirements for records
Revalidation

c. Identification and Tractability

Where appropriate, the organization should identify the product by suitable means throughout product realization. The organization should identify the product status with

respect to monitoring and measurement requirements. Where tractability is a requirement, the organization should control and record the unique identification of the product. In some industry sectors, configuration management is a means by which identification and tractability are maintained. Identification can frequently be accomplished with a production router or traveler.

d. Customer Property

The organization should exercise care with customer property while it is under the organization's control or being used by the organization. The organization should identify, verify, protect and safeguard customer property provided for use or incorporation into the product. If any customer property is lost, damaged or otherwise found to be unsuitable for use, this should be reported to the customer and records maintained. Customer property can include intellectual property.

e. Preservation of Product

The organization should preserve the conformity of product during internal processing and delivery to the intended destination. This preservation should include identification, handling, packaging, storage and protection. Preservation should also apply to the constituent parts of a product.

VI. Control of Monitoring and Measuring Devices

The organization should determine the monitoring and measurement to be undertaken and the monitoring and measuring devices needed to provide evidence of conformity of product to determined requirements. The organization should establish processes to ensure that monitoring and measurement can be carried out and are carried out in a manner that is consistent with the monitoring and measurement requirements. Where it is necessary to ensure valid results, measuring equipment should be

calibrated or verified at specified intervals or prior to use, against measurement standards (Where no such standards exist, the basis used for calibration or verification should be recorded)
adjusted or re-adjusted as necessary
identified to enable calibration status to be determined
safeguarded from adjustments that would invalidate the measurement result
protected from damage and deterioration during handling, maintenance and storage

In addition, the organization should assess and record the validity of the previous measuring results when the equipment is not found in conformation to requirements. The organization should take appropriate action on the equipment and any product affected. Records of the results of calibration and verification should be maintained. When used in the monitoring and measurement of specified requirements, the ability of computer software to satisfy the intended application should be confirmed. This should be undertaken prior to initial use and reconfirmed as necessary.

The following can be used for guidance:

ISO 10012-1-1992: Quality Assurance Requirements for Measuring Equipment, Part 1
ISO 10012-2-1997: Quality Assurance for Measuring Equipment, Part 2
ISO 17025-1999: General Requirements for the Competence of Testing and Calibration Laboratories

Measurement, Analysis and

Improvement I. General

The organization should plan and implement the monitoring, measurement, analysis and improvement processes needed for the following purposes:

To demonstrate conformity of the product
To ensure conformity of the QMS
To continually improve the effectiveness of the QMS

This should include determination of applicable methods, including statistical techniques, and the extent of their use.

Monitoring and Measurement

a. Customer Satisfaction

As one of the measurements of the performance of the QMS, the organization should monitor information relating to customer perception as to whether the organization has met customer requirements. The methods for obtaining and using this information should also be determined.

b. Internal Audit

The organization should conduct internal audits at planned intervals to determine whether the QMS conforms to the planned arrangements, to the requirements of this standard and to the requirements established by the organization. It should also be done to determine if QMS is effectively implemented and maintained. An audit program should be planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the result of previous audits. The audit criteria, scope, frequency and methods should be defined. Selection of auditors and conduct of audits should ensure objectivity and impartiality of the audit process. Auditors should not audit their own work. The responsibilities and requirements for planning and conducting audits and for reporting results and maintaining records should be defined in a documented procedure. The management responsible for the area being audited should ensure that actions are taken without undue delay to eliminate detected non-conformities and their causes. Follow-up activities should include the verification of the actions taken and the reporting of verification results. ISO

19011 guidelines on quality and/or environmental management auditing can be used for guidance.

c. Monitoring and Measurement of Processes

The organization should apply suitable methods for monitoring and, where applicable, measurement of the QMS processes. These methods should demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, correction and corrective action should be taken, as appropriate, to ensure conformity of the product.

d. Monitoring and Measurement of Product and Service

The organization should monitor and measure the characteristics of the product to verify that product requirements have been met. This should be carried out at appropriate stages of the product realization process in accordance with the planned arrangements. Evidence of conformity with the acceptance criteria should be maintained. Records should indicate the person(s) authorizing release of product. Product release and service delivery should not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and, where applicable, by the customer.

III. Control of Non-conforming Product

The organization should ensure that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. The controls and related responsibilities and authorities for dealing with nonconforming product should be defined in a document procedure. The organization should deal with non-conforming product in one or more of the following ways:

By taking action to eliminate the detected nonconformity
By authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer
By taking action to preclude its original intended use or application

Records of the nature of non-conformities and any subsequent actions taken, including concessions obtained, should be maintained. When non-conforming product is corrected, it should be subject to re-verification to demonstrate conformity to the requirements. When non-conforming product or service is detected after delivery or use has started, the organization should take action appropriate to the effects, or potential effects, of the non-conformity.

IV. Analysis of Data

The organization should determine, collect and analyze appropriate data to demonstrate the suitability and effectiveness of the QMS and to evaluate where continual improvement of the effectiveness of the QMS can be made. This should include data generated as a result of

monitoring and measurement and from other relevant sources. The analysis of data should provide information relating to the following:

V. Improvement

a. Continual Improvement

The organization should continually improve the effectiveness of the QMS through the use of the following:

Quality policy
Quality objectives
Audit results
Analysis of data
Corrective and preventive actions
Management review

b. Corrective Action

The organization should take action to eliminate the cause of nonconformities in order to prevent recurrence. Corrective actions should be appropriate to the effects of the nonconformities encountered. A documented procedure should be established to define requirements for the following:

Reviewing nonconformities (including customer complaints)
Determining the causes of nonconformities
Evaluating the need for action to ensure that nonconformities do not recur
Determining and implementing action needed
Records of the results of action taken
Reviewing corrective action

taken **c. Preventive Action**

The organization should determine action to eliminate the causes of potential non-conformities in order to prevent their occurrence. Preventive actions should be appropriate to the effects of the potential problems. A documented procedure should be established to define requirements for the following purposes:

Determining potential nonconformities and their causes
Evaluating the need for action to prevent occurrence of nonconformities
Determining and implementing action needed
Records of results of action taken
Reviewing preventive action taken

Preventive action is taken to prevent occurrence while corrective action is taken to prevent reoccurrence.

Eight total quality management principles form the basis for the QMS standards. These are the following ones:

Customer focus
Leadership
Employee involvement
Process approach
System approach to management
Continual improvement
Factual approach to decision making
Mutually beneficial supplier relationships

These principles are similar to the core values of the Malcolm Baldrige National quality Award.

Implementation

There are a number of steps which are necessary to implement a quality management system.

1. Top Management Commitment

The most important step in implementing a quality system that will meet or exceed an ISO 9000 standard is to acquire the full support of upper management. The Chief Executive Officer (CEO) should be willing to commit the resources necessary to achieve certification. This is critical to the success of the project. Without the CEO's support, the process may continuously run into unnecessary roadblocks or even be doomed to failure. Because top management is assigned specific responsibilities in the standard, it is necessary that they be involved in its implementation.

2. Appoint the Management Representative

Once the commitment has been made, the process can proceed by adopting a project team approach and treating it the same way as any other business undertaking. The next step is the appointment of a management representative. This person is responsible for coordinating the implementation and maintenance of the quality system. He/she is the contact person for all parties involved in the process, both internal and external. The representative can be a

member of the top management group who is able to ensure that the quality system is effectively implemented, documented and maintained. The implementation of the quality system should involve everyone in the organization.

This step requires an awareness program. Because the process is going to affect every member of the organization as well as require their input, it stands to reason that everyone should understand the quality system. They should know how it would affect day-to-day operations and the potential benefits. This information can be relayed through short, one-hour awareness training sessions. It should be ensured that everyone knows the intent of the standard.

At the Cleveland Center for Joint Reconstruction, staff buy-in did not happen until they realized that the new system would allow them to make a difference in their day-to-day activities.

After everyone has been informed of the organization's intentions to develop the quality system, an implementation team should be assembled. This team should be drawn from all levels and areas of the organization so that it is representative. Committees for each of the five clauses may be used. The team should identify the QMS processes and their sequence and interaction. It is important to keep the project visible for all employees.

The implementation team, supervisors and internal audit team should be trained. This activity can be accomplished by sending team leaders for training and having them train the other team members. It can also be done by bringing the training in-house for all team members through a one- or two-day seminar.

This activity develops a time schedule for the implementation and registration of the system. This time frame will vary depending on the size and type of organization and the extent of its existing quality system. Most of the organizations can complete the entire process in less than 1.5 years. It is necessary to divide the implementation process into manageable units. Also, the opportunity should be provided for the celebration of small victories.

Select Element Owners

The implementation team selects owners for each of the system elements. Many of these owners will be members of the implementation team. Owners may be assigned more than one element. Each owner has the option of selecting a team to assist in the process. The more is the number of people involved, the more effective is the system.

Review the Present System

Carry out a review of the present quality system. Copies of all the quality manuals, procedures, work instructions and forms presently in use are obtained. These documents are sorted into the system elements to determine what is available and what is needed to complete the system. This activity is a gap analysis and can be performed by the element owners and their teams or by an external consultant.

Write the Documents

Prepare written quality policy and procedure manuals. These can be combined into one document. Write appropriate work instructions to maintain the quality of specific functions. This process should involve every employee because the best person to write a work instruction is the one who performs the job on a regular basis. Stream International Crawfordsville, Indiana, encouraged employees to expose the flaws in existing processes and document new processes that would work correctly. However, it is important to be prudent when creating documentation. Too much documentation or complicated documentation will destroy the system.

Install the New System

Integrate the policies, procedures and work instructions into the day-to-day workings of the organization and document what is being done. It is not necessary for all elements to be implemented at the same time. It should be ensured that all people are trained.

Internal Audit

Conduct an internal audit of the quality system. This step is necessary to ensure that the system is working effectively and to provide management with information for the comprehensive management review. Minor corrections to the system are made as they occur. A cross-section of trained people should be used for the audit team.

Management Review

Conduct a management review. The management review is used to determine the effectiveness for the system in achieving the stated quality goals. The system is revised as needed.

Reassessment

This step is optional. If a good job has been done on the previous steps, reassessment is not necessary.

Registration

This step has three parts-- choosing a registrar, submitting an application and conducting the registrar’s system audit. Considerations in choosing a registrar include cost, lead-time, customer's acceptance of the registrar and the registrar's accreditation and familiarity with your industry. The application for registration should also include supplying the registrar with the policy and procedure manuals for their review. The time involved in the registrar's system audit will vary depending on the size and complexity of the organization and the number of auditors involved. A registrar's audit usually lasts one to three days and will consist of an opening meeting to describe the process the auditors will follow, the audit itself and a closing meeting to discuss the findings of the audit.

Some pitfalls to successful implementation are as follows:

Using a generic documentation program or another organization's documentation program
Over documentation or documentation that is too complex
Using external consultants without internal ownership and involvement
Limiting documentation to text rather than other types of media
Neglecting to obtain top management's involvement
Developing a system that does not represent what actually occurs

A quality system is the method used to ensure that the quality level of a product or service is maintained. The system documentation can be viewed as a hierarchy containing four tiers, as shown in figure 27.3. All documentation moves from one level to the next in a descending order. If the system is properly structured, changes at one level will seldom affect the levels above it, but may affect those below.

Policy

The first tier of documentation is the policy manual. This is the document that defines "it will be done" and "why." A quality policy manual should be written in a way that it is clear, precise, practical and easy to understand. The "why" can be stated just once as a quality policy statement. This statement should be a short, simple definition of the organization's quality intentions. Example:

"Quality is the responsibility of each Tempset employee. We pledge to continuously provide products and services that meet or exceed customer expectations."-- Tempset Inc., St. Louis, Mo.

The remainder of the policy manual addresses "what" will be done to comply with the standard being used. Another way of looking at the policy manual is to think of it as the commandments of the system. Each element of the standard is addressed individually and usually requires one page or less.

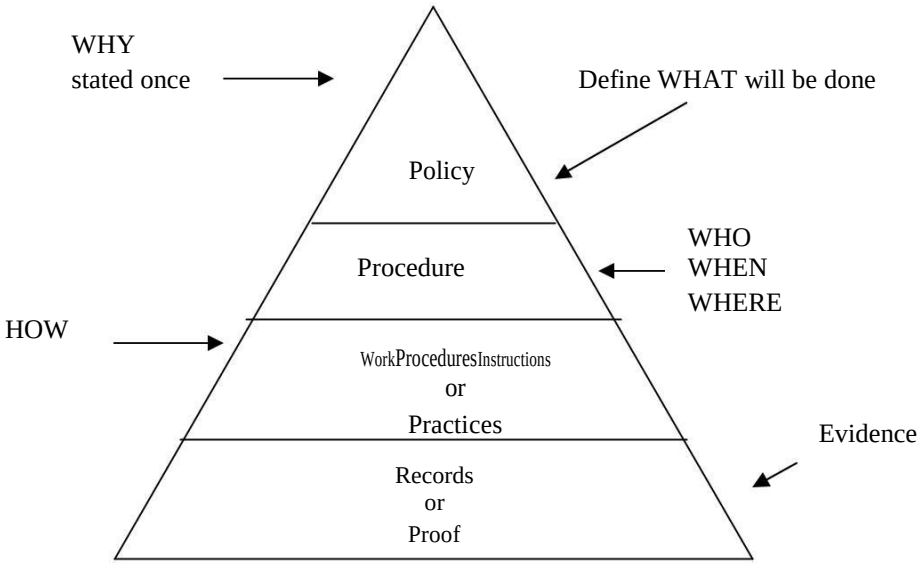


Figure 27.3-- The documentation pyramid

Procedure

The second tier of documentation is the quality procedures. These procedures describe the methods that will be used to implement and perform the stated policies. The procedures define who should perform specific tasks, when the task should be done and where documentation will be made showing that the task was performed. Procedures should be oriented so that they apply to all areas within the organization. They dictate the strategies that will be used to ensure the quality of the system. Procedures are more detailed than the policies. However, they too should be written in a manner that will allow for easy understanding. It should be noted that procedures are not required for all elements. Many organizations combine the policy and procedures into one document. A procedure is needed if its absence would adversely affect the activity.

Work Instructions

Work instructions are usually department, machine, task or product oriented and spell out how a job will be done. These instructions are the most detailed of the documentation hierarchy. A work instruction may be in the form of a detailed drawing, recipe, routing sheet, specific job function (for example, turn nut four turns clockwise), photograph, video or simply a sample for comparison of conformity. The writing of a work instruction is best carried out by the employee who performs the task. This person knows the process and the problems encountered in that process best. However, a documentation specialist may be needed to do the actual writing. This method also creates a pride of ownership in the document, making it more likely to be carried out. Additionally, employee participation helps to ensure that future improvements will be suggested. Not every task requires a work instruction. For example, you do not need to tell a computer specialist to turn on the PC.

Records

Records are a way of documenting that the policies, procedures and work instructions have been followed. Records may be forms that are filled out, a stamp of approval on a product, or a signature and date on some type of document, such as a routing sheet. Records are used to provide tractability of actions taken on a specific product or batch of products. They provide data for corrective action and a way of recalling products, if necessary.

Document Development

Although documentation is required by the system yet its most important purpose is to provide guidelines for internal quality management. In this respect, it can be considered one approach to the road of continuing quality improvement and business success. Where does this road start? The answer is with the quality system that is already in place. If an organization has been in business for any length of time, with some degree of success, it has already established procedures for supplying its products or services to customers. This pre-existing documentation is the starting point for developing the documents necessary for registration.

To begin creating the documentation system, the implementation team should gather all the existing policies, procedures, work instructions and forms that are presently in use. Each

document should be reviewed and an attempt should be made to fit it into one of the elements. If a document does not appear to pertain to any element, it should be set aside. Where it belongs may become evident at a later time. In addition, the team should decide if the document is currently accurate and up to date. If it is not, it should be updated or discarded.

Now it is time to involve as many employees as possible. Remember, writing the documents will probably be the easiest part of the implementation process. And putting the policies and procedures to work will be the most difficult one. The more is the number of people involved in the creation of the system, the greater is the likelihood that the system will perform satisfactorily. People involved in the process are more likely to implement the procedures and ensure that they remain current than people who have had no input. If the organization is large enough, a team of three or more members should be appointed for each element. The team members should come from all areas of the organization and not just from the management or quality areas. Each team is assigned an owner and charged with the responsibility of writing the policy and procedures for the element. They can also be given the responsibility of interviewing personnel and writing the necessary work instructions and applicable documentation forms. A consultant may be needed during this phase to facilitate the team's activities.

As the documents are produced, the implementation team becomes the review committee. If changes appear necessary, suggestions are made and reviewed with the team. The initiating team then either clarifies what has been written or revises the documents as required. When the documents have been completed, they should be formatted in a manner that will allow for simple and effective document control.

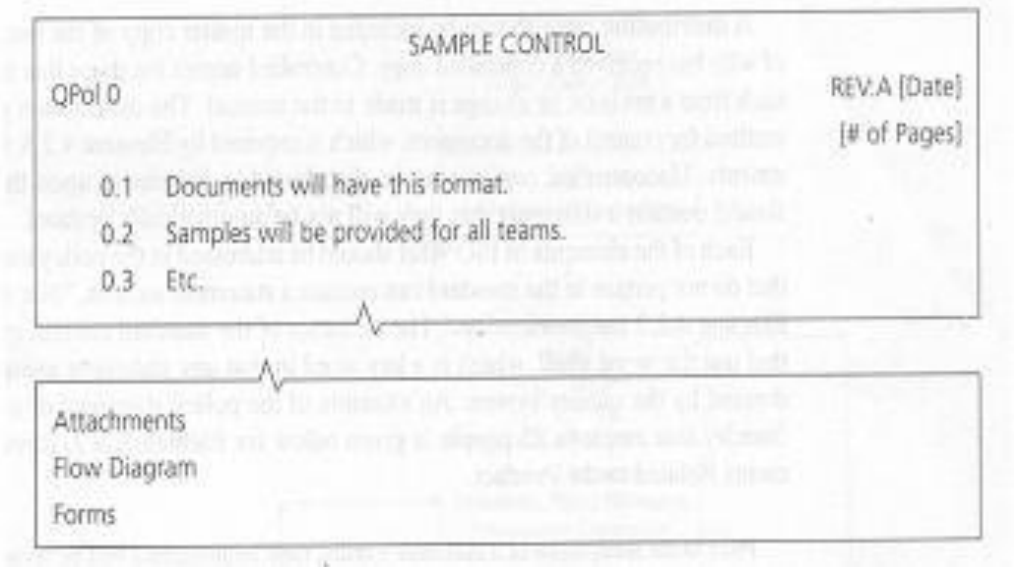


Figure 27.4-- Format example

Writing the Documents

The basic thought to be kept in mind when writing the documents is to create simplicity out of complexity. To accomplish this objective, the documents should be simple and concise.

Simplicity can be obtained by having one idea addressed per paragraph, short subject-verb-object type sentences and a simple paragraph-numbering system, as shown in figure 27.4. Write to an eighth grade reading level (most newspapers write to the sixth or seventh grade level). In addition, use 13- or 14-point type because it is easier to read and have plenty of white space. Unfortunately, a simple document is not easy to develop-- it takes time and a commitment to excellence.

Being concise requires that you write only what is needed. Remove all irrelevant material and avoid the use of special jargon that is common to only an industry or organization. Consider who, what, when, where, why and how of the concept being addressed. Write what you are doing. If you need to write, “what you ought to be doing” for compliance to an element, underline it and take the necessary action to achieve compliance. Avoid writing procedures on how to fill out forms. They become records and should be designed to be self-explanatory. Use flow diagrams and checks sheets wherever possible rather than lengthy verbiage. The revision process should be as painless as possible. In fact, employees should be encouraged to initiate changes and improvements in procedures and work instructions.

The first step in writing the documents is to create a format that can be used throughout the documentation hierarchy. Although it is not required by ISO yet it is helpful to auditors if documents follow the numbering system “QPol” in ISO 9001. Justification for the exclusion of any elements should be stated in Quality Manual. Each document should have a title, a number that is unique to only one document, a date, revision number or letter for control purposes and the number of pages it contains. In the case of policy and procedure manuals, the title can be the same as the ISO element they have reference to. Work instructions and records should have titles that identify their purpose. All policy documents may start with "QPol" to denote a quality policy and be followed by their element number. Procedures can follow the same system by changing "QPol" to "QPro," followed by the title and element number and so on through work instructions, flow diagrams and records. Figure 27.4 shows a simple and effective method for the formatting of documents.

When designing the manuals, simplicity and ease of use should determine the structure to be used. A cover page will list the organization name and location as well as the title of the document. The table of contents can list the revision letter or number of each document within the manual, as well as the location. The policy manual, being the first tier of the hierarchy, should have a copy of the organization's quality policy and statement of the purpose of the quality system. These statements are usually signed by the CEO of the organization. Some examples of purpose statements are mentioned below:

> This quality policy manual has been prepared to provide assistance to all employees in understanding and implementing the quality assurance activities associated with their jobs.

> In recognizing the responsibilities as a manufacturer (service organization) to comply fully with all contractual provisions and statutory requirements of society, we have developed this comprehensive quality system to assure customers that products (services) supplied will be in conformance to requirements and without nonconformities. The program described is in conformance to the requirements of ISO 9001.

A distribution page should be included in the master copy of the manual as a record of who has received a controlled copy. Controlled copies are those that should be updated each time a revision or change is made to the manual. The distribution page provides a method for control of the document which is required by the element "control of documents." Uncontrolled copies may be distributed to customers upon their request and should contain a statement that they will not be automatically updated.

Each of the elements of ISO 9001 should be addressed in the policy manual. Elements that do not pertain to the standard can contain a statement such as, "Not applicable-- see Element … for justification." The elements of the standard contain many statements that use the word "shall" which is a key word and any statement using it should be addressed by the quality system. An example of the policy statement of a small cast iron foundry that employs 85 people is given below for the element "review of requirements related to the product."

Prior to the acceptance of a customer's order, their requirements will be reviewed to determine the following:

> They are clearly defined and do not differ from the original proposal or sales offer.
> Any differences are resolved and any changes are appropriately recorded and affected people notified.
> Wirco Castings Inc. has the ability to meet them.

Where the customer does not provide requirements, Wirco Castings' standard requirements will be used and the customer so notified.

Record of the review will be recorded in the "part history file."

Analysis of the policy shows that all the information in the standard has been included. The policy is simply a rewording of the standard. It should be noted that the statement does not include the scope or the purpose because they are obvious.

The second tier of documentation is the procedures manual. Unless the procedure contains proprietary information, it can be included with the policy. Otherwise, the procedures manual, like the policy manual, should use a cover sheet, distribution page and table of contents that reflects a current revision letter or number. Procedures are the methods used to carry out the requirements of the policy and are more detailed. Procedure writing can be simplified by using a flow diagram of the required actions. Figure 37.5 is an example of a flow diagram.

The flow diagram shows who does the work, what they do and where it is in the organization's office. It is short and to the point, simple to audit, contains no unnecessary information and illustrates the process very effectively. Examples of documents used to show compliance of a

procedure can be attached to the procedure or referenced and placed in an appendix. In this case, the policy and the procedure can be on the same page.

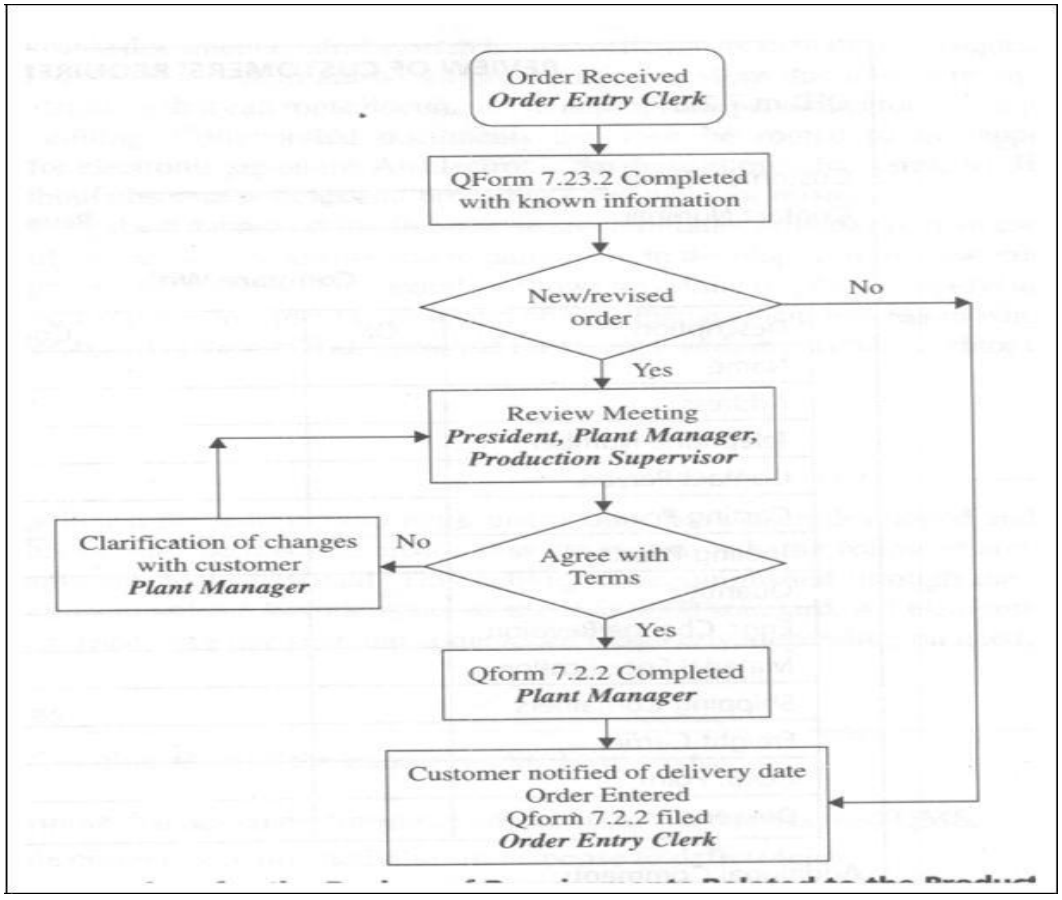


Figure 27.5-- Procedure for the review of requirements related to the product

Quality Systems-II

The third tier of the document pyramid is for work instructions that are specialized and used only as required for quality considerations. They should fit the organization's requirements. As much as possible, however, they should follow the same type of format and numbering system as the policy and procedure manual in order to maintain consistency. Work instructions come in many forms, such as drawings, recipes, routing sheets, operation sheets, samples, photographs and videos.

The last tier of the pyramid is for records or proof that the policies and procedures have been followed. Most of the records will be readily available and no writing will be necessary. Like work instructions, records use many types of media, such as forms that are filled out, stamp of approval on a product, or a signature and date on a routing sheet. Figure 28.1 shows a check sheet that was used in the procedure for element 7.2.2. It was filed as evidence and a set procedure was followed. The check sheet was designed so that it not only aided the process but so that it also served as the record.

An electronic document control system is an excellent way to manage change and ease collaboration. Such a system allows an organization to store documents in access -controlled database that can route documents to appropriate personnel for developing, revising, or editing. Collaborated documents can then be routed to the appropriate personnel for electronic signature. All electronic databases allow the system to always be current without obsolete policies and procedures available for misuse.

Establishing the database on the Internet or on an intranet provides remote users with the capability to access documents and to participate in development, review, collaboration and approval processes. This capability allows traveling or offsite employees to stay involved and keep the document control and change management process moving effectively. A Web-based system will also provide for external auditing without auditor travel.

Review of Customer's Requirements

QFD m 7.2.2 REV: A [01 Jan 99]

[1 page]

Customer Name _____ Date _____

Contact Number _____ Reviewed By:

Compare with

Description	Ok	Comments
Name		
Address		
Telephone Number		
Contact person		
Casting Price		
Tooling Price		
Quantity		
Engr. Change/Revision		
Material Specification		
Shipping Containers		
Fright Carrier		
F.O.B. Point		
Delivery Date		

Additional Comments _____

Figure 28.1-- Review form of customer's requirements

Internal Audits

After the policies, procedures and work instructions have been developed and implemented, checks should be made to ensure that the system is being followed and the expected results are being obtained. This activity is accomplished through the internal audit which is one of the key elements of the ISO 9000 standard. All elements should be audited at least once per year and some more frequently, depending on need.

Objectives

Following are the five objectives of internal audit:

Determine that actual performance conforms to the documented QMS
Initiate corrective action activities in response to deficiencies
Follow up on noncompliance items from previous audits
Provide continued improvement in the system through feedback to management
Cause the auditee to think about the process, thereby encouraging possible improvements

Auditor

Qualified individuals who have received training in auditing principles and procedures should perform audits. Training programs are available from ASQ and RAB. Training should include classroom information as well as practical demonstration by the Trainer and a critiqued audit by the trainee. To be able to audit efficiently, an individual should possess good written ad oral communication skills, be a good listener and be good at taking notes. Other skills should include the ability to concentrate on the task at hand and not be distracted by other activities that are taking place at the same time, be observant and questioning and be able to separate relevant facts from other information.

The auditor should be objective, honest and impartial. Of course, an auditor should be prepared by being knowledgeable about the standards.

Techniques

During the actual audit, three are a number of techniques that the auditor should employ. The objective is to collect evidence, examination of documents, observation of activities and interviews. There are three methods to collect evidence.

The easiest method is to examine the documents. An auditor should start with the quality manual to determine that the policies cover the QMS standards and that they are controlled and assessable.

Next, the documents are examined in a systematic manner. For example, an auditor would check the purchase orders to determine whether they were accurate and followed the procedures.

He/she also checks his/her all appropriate attachments were present, all orders were numbered, signed and dated, only approved suppliers were used and so forth.

Document control ensures the following things:

Document is identified with a title, revision date and responsible owner.
Documents are readily available to users.
A master list by department or function for procedures, work instructions and records is appropriately located.
There are no obsolete documents at workstations.
Changes follow prescribed procedures.

Observation of activities is also an easy method that requires an aptitude for detail. For example, to evaluate the reservation of product element the auditor would observe the identification, handling, packaging, storage and protection of the product.

The most difficult method of collecting evidence is by interviewing the employee or auditee. However, there are ways to make the process easier. First, place the auditee in a non-threatening environment by starting with introductions and an explanation of the purpose of the audit. This initial conversation can be followed by easy questions such as," How long have you been working for the organization?" Humor is also very effective in placing one at ease. In addition, use basic human behavior techniques such as giving compliments, using a person's first name, encouraging suggestions and so forth.

Second, spend as much time listening and as little time as possible talking. Encourages employees to talk about the process. Then paraphrase your interpretations of their statements so there are no misunderstandings.

Third, if and when you find deficiencies in processes and systems, separate the significant from the trivial. Reserve the major issues for your report and the minor ones for the auditee. Focus on the system and not on the auditee.

Fourth, discuss the major issues informally with the auditee first. The auditor's job is to identify problems and allow the organization to determine solutions. Be sure that the auditee understands the problem, agrees that it is a problem and agrees that corrective action is necessary. If the auditee does not agree, there will be little or no cooperation. Sometimes the auditor, based on his experience, will have an idea that might solve the problem. It should be discussed in such a manner that the auditee believes it is his/her idea.

Fifth, use the appropriate type of question. There are open questions, closed questions, clarifying questions, leading questions and aggressive questions. Each type is discussed in the paragraphs that follow.

Examples of open questions are as follows:

When are supplier reviews performed?
How is the inspection status identified on this item?
Where does this document come from?

This type of question is designed to get a wide range of answers rather than a simple "yes" or "no." They are used to obtain an opinion, an explanation of a process, a person's attitudes, or the reasoning behind an action. The disadvantage of open questions is that the auditor can receive more information than desired.

The examples of closed questions are as follows:

Do you have a work instruction for this operation?
Does this instrument require calibration?
Is this dye supplied by the customer?

This type of question can be answered with yes or no and provides evidence or fat quickly. Closed questions are used to gather specific evidence and reduce any misunderstanding. The disadvantage of closed questions is that the interview can appear to be an interrogation.

Examples of clarifying questions are as follows:

Tell me more about this operation.
Please give me some examples.
What do you mean by parting line mismatch?

This type of question is used to obtain further information. It helps to prevent misunderstanding and encourages the auditee to relax and be more open. The disadvantages are that these questions can give the impression that the auditor is not listening or that the auditor is stupid. Also, when used too often, they are time consuming.

An example of a leading question is as follows:

Don't you agree that the non-conformity was caused by not understanding the purchase order?

This type of question should be avoided, because it encourages the auditee to provide a particular answer and will bias the audit findings.

An example of an aggressive question is as follows:

You don't mean to tell me that this test is the only one you perform?

This type of question should be avoided because it is offensive and argumentative.

The auditor should primarily use open questions with an occasional closed and clarifying question, as the interview may necessitate. For effective communication, there should be mutual trust between auditor and auditee.

Procedure

Before the audit takes place, the lead auditor should prepare an audit plan and checklist. As much time is spent planning as doing. The contents of an audit plan should identify the activity or department to be audited, list the procedures, documents and regulatory requirements involved. It should name the audit team and list who is to be notified of the audit and who will receive audit reports. The plan should also contain a schedule similar to figure 28.2. This schedule includes audit notification, audit conducted, corrective action required, if any, and follow-up, if any.

In addition, an audit matrix as illustrated in figure 28.3 can be very helpful. It determines the most-affected areas and elements.

Checklists ensure that the audit is efficient and give the auditor control of the process. It can take the form of questions to ask, the sequence in which they should be asked and space for writing the results. Checklist questions should be based on the procedures, records and work instructions to be audited, referencing the specific paragraphs being addressed.

The audit itself has three parts-- the pre-audit meeting, the audit and a closing meeting. During the pre-audit meeting, the audit process and timetable are discussed and prior audits are reviewed. Minutes of the meeting should be recorded and included with the audit documentation. A list of those attending the meeting is recorded in the minutes.

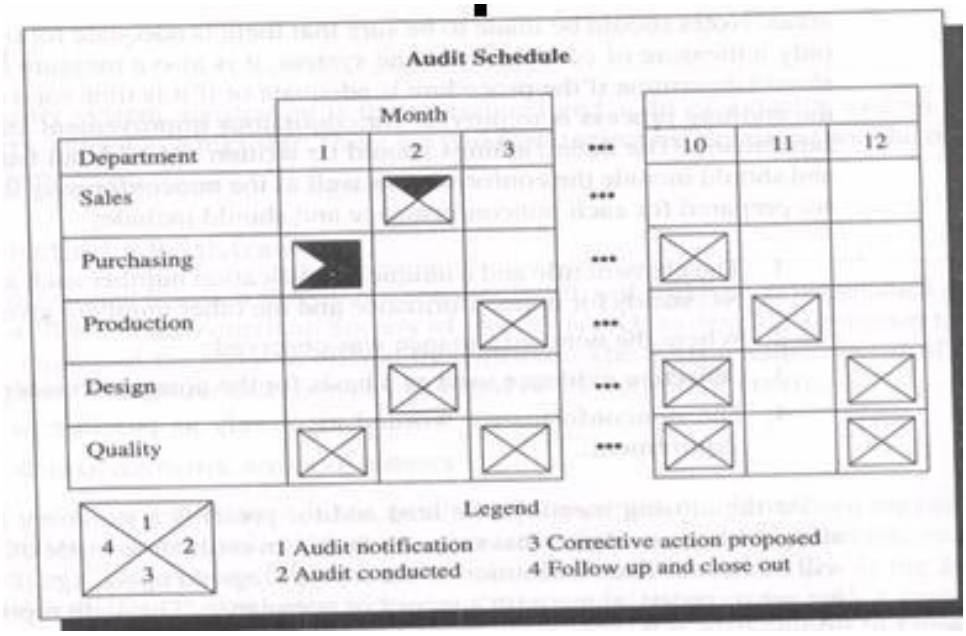
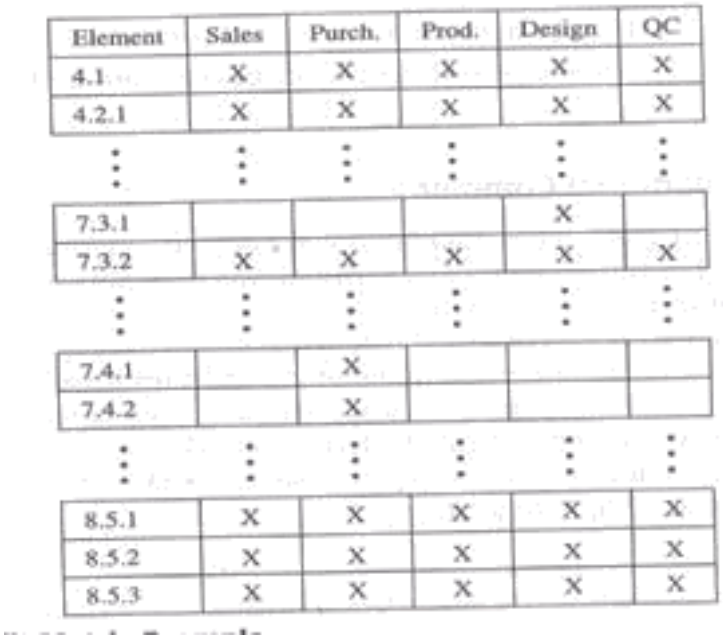


Figure 28.2-- Audit schedule example



Element	Sales	Purch.	Prod.	Design	QC
4.1	X	X	X	X	X
4.2.1	X	X	X	X	X
⋮	⋮	⋮	⋮	⋮	⋮
7.3.1				X	
7.3.2	X	X	X	X	X
⋮	⋮	⋮	⋮	⋮	⋮
7.4.1		X			
7.4.2		X			
⋮	⋮	⋮	⋮	⋮	⋮
8.5.1	X	X	X	X	X
8.5.2	X	X	X	X	X
8.5.3	X	X	X	X	X

Figure 28.3-- Audit matrix example

The purpose of the audit is to determine how well the quality system has been implemented and maintained. In large organizations, the area being audited should provide an escort. Escorts become witnesses who can provide backup to an event should a finding be challenged at a later time. The escort is usually a supervisor or key person of the audited area. The audit includes interviewing people working in the area and checking various records that back up the interviews. Often what surfaces from records of one area will lead to further questions that will have to be answered in other areas. Notes should be made to be sure that there is adequate follow-up.

The audit is not only a measure of conformity to the system; it is also a measure of the system itself. It should determine if the procedure is adequate or if it is time for a change. The object of the auditing process is to provide for continuous improvement and increased customer satisfaction. The audit findings should be written out in detail from the auditors' notes and should include the conforming as well as the nonconforming items. Separate reports are prepared for each non-conformance and should include the following:

The element title and unique identification number such as NC 7.2.3, where the NC stands for non-conformance and the other numbers give the element number
Where the non-conformance was observed
Objective evidence used as a basis for the non-conformance
The non-conformance worded as closely as possible to the language of the requirements

At the closing meeting, the lead auditor presents a summary of the audit findings along with the evidence that supports them. An estimate is made of when the final report will be issued. The distribution of the report is agreed upon. Again, minutes of the meeting are recorded, along with a record of attendance. The audit report will have the following:

Have a cover sheet that includes the audit date, names of the audit team, areas audited, distribution list, a statement that the audit is only a sample and a unique reference number and will be signed by the lead auditor.
List the non-conformances and copies of all non-conformance reports.
Outline procedures for corrective action and subsequent follow-up.

Additional Comments

Until1987, when ISO 9000 was adopted, internal auditing was confined to the control of financial processes. In addition to quality and financial auditing, there are now other assurance functions, such as security, safety and environment that need to be audited as part of a total risk management package. Top management and other stakeholders are interested in obtaining audit information that is current, reliable and accurate. They want to know that processes are stable and safe and risks are identified and mitigated. It is expected that all of the different audits will be integrated into a generic, value-added model of partnering, assessment and business process improvement.

Registration

Quality system registration is the assessment and audit of a quality system by a party, known as a registrar. There are two parts-- selecting a registrar and the register as process.

In the United States, a Registrar Accreditation Board (RAB) was established in 1981 an affiliate of the American Society of Quality (ASQ) to develop a program to evaluate the quality of the services offered by registrars. The RAB maintains a list of approved registrars. Registrar selection can be based on the following criteria.

Qualifications and Experience

Of particular importance is the number of companies that have been registered, their experience in particular industry sectors and their customers' structure, such as location. Quality Digest's annual customer satisfaction survey in the July is issue, rates registrars in five categories- interpersonal relations, value added, consistent interpretations, administration and communication. It is also helpful to know the registrar’s financial condition to be assured that it will stay in business. The register should remain current by participating in the Independent Association of Accredited Registrars.

Certificate Recognition

The registrar should be approved by a regulatory agency such as RAB. Existing and potential customers should recognize it. For example, an organization might sell particular country or a

specific industry such as the medical industry. Are there intentional cooperative agreements? The registrar should provide references and prior customer feedback. It may be helpful to interview prior customers. A database of registered organizations in North America is maintained at www.qualitydigest.com.

The Registration Process

The registrar should have a structured registration procedure that is tailored to the organization's needs. They should be responsive to requests. A significant factor in the registration process is the objective of improving quality and productivity. The register should not only evaluate the system but also identify opportunities for more efficient practices. Of future importance is the ability of the registrar to perform multiple types of audits: environmental, quality, security and workplace safety.

Time and Cost Constraints

The evaluation should include the lead-time necessary prior to the audit. In addition, the evaluation should include the time and cost required for the initial audit and the surveillance audits. Be wary of additional fees such as the use of a subcontractor that has expert knowledge or language skills.

Auditor Qualifications

Of particular importance is the auditor's qualification. The ISO 19011 auditing standard requires that auditors:

Know the standard
Know the types of processes, the organization and the customers
Have the knowledge, temperament and experience to be credible

Because the auditor and registrar are exposed to sensitive information about the organization, it is vital that a non-disclosure policy be maintained. It is also vital that the auditor has no conflict of interest with the organization. The registrar should provide proof of qualifications, knowledge and experience. The organization should be able to refuse a particular auditor and have a suitable replacement found.

It is wise to take time to select the best registrar for an organization's needs in order to avoid dissatisfaction. The vice president of Engineered Systems Inc. in Delaware, OH comments about his direct experience with registrar: "I was frustrated with their level of responsiveness. We were never given a 'point person' as a contact, and they did not return phone calls." Other areas of dissatisfaction by other organizations are like constantly rescheduling audits, billing undisclosed expenses, arrogant and argumentative auditors and reporting findings in an untimely fashion.

Questions

What is ISO? Briefly explain the objectives of each of the five ISO 9000 standards.

Discuss the benefits of ISO 9000 series.

What is the difference between ISO 9000 and ISO 9001?

Explain the steps in obtaining ISO 9000 registration.

Describe how a two party audit system works. What can be accomplished by the addition of a third party registering a quality system?

What is the difference between being certified and being accredited?

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MODULE 5

Benchmarking-I

Introduction

Benchmarking is a systematic method by which organizations can measure themselves against the best industry practices. It promotes superior performance by providing an organized framework through which organizations learn how the "best in class" do things, understand how these best practices differ from their own and implement change to close the gap. The essence of benchmarking is the process of borrowing ideas and adapting them to gain competitive advantage. It is a tool for continuous improvement.

Benchmarking is an increasingly popular tool. It is used extensively by both manufacturing and service organizations, including Xerox, AT&T, Motorola, Ford and Toyota. Benchmarking is a common element of quality standards, such as Chrysler, Ford and General Motors Quality Systems Requirements. These standards stipulate that quality goals an objectives be based on competitive products and Baldrige National Quality Award similarly requires that applicants benchmark external organizations.

Benchmarking

Benchmarking is the systematic search for best practice, innovative ideas and highly effective operating procedures. Benchmarking considers the experience of others and uses it. Indeed, it is the common-sense proposition to learn form others what they do right and then imitate it to avoid reinventing the wheel. Benchmarking is not new and indeed has been around or a long time. In fact, in the 1800s, Francis Lowell, a New England colonist, studied British textile mills and imported many ideas along with improvements he made for the burgeoning American textile mills.

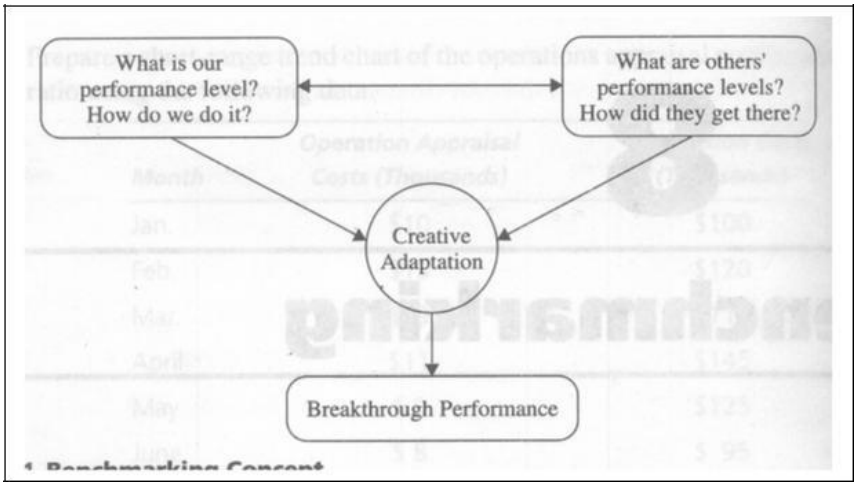


Figure 29.1-- Concept of benchmarking

As shown in figure 29.1, benchmarking measures performance against that of best-in-class organizations, determines how the best in class achieve those performance levels and uses the information as the basis for adaptive creativity and breakthrough performance.

Implicit in the definition of benchmarking are two key elements. First, measuring performance requires some sort of units of measure. These are called metrics and are usually expressed numerically. The numbers achieved by the best-in-class benchmark are the targets. An organization seeking improvement then plots its own performance against the target. Second, benchmarking requires that managers understanding why their performance differ. Benchmarkers should develop a thorough and in-depth knowledge of both their processes. The processes of the best-in-depth knowledge of standing of the differences allow managers to organize their improved efforts to meet the goal. Benchmarking is about meeting them by improving processes.

Reasons to Benchmark

Benchmarking is a tool to achieve business and competitive objectives. It is powerful and extremely effective when used for the right reasons and aligned with organization strategy. It is not a panacea that can replace all other quality efforts or management processes. Organizations should still decide which markets to serve and determine the strengths that will enable them to gain competitive advantage. Benchmarking is a tool to help organizations develop those strengths and reduce weaknesses.

By definition, benchmarking requires an external orientation, which is critical in a world where the competitor can easily be on the other side of the globe. An external outlook greatly reduces the chance of being caught unaware by competition. Benchmarking can notify the organization if it has fallen behind the competition or failed to take advantage of important operating improvements developed elsewhere. In short, benchmarking can inspire managers (and organizations) to compete.

In contrast to the traditional method of extrapolating next year's goal from last year's performance, benchmarking allows goals to be set objectively, based on external information. When personnel are aware of the external information, they are usually much more motivated to attain the goals and objectives. Also, it is hard to argue that an objective is impossible when it can be shown that another organization has already achieved it.

Benchmarking is time and cost efficient because the process involves imitation and adaptation rather than pure invention. Benchmarking partners provide a working model of an improved process which reduces some of the planning, testing and prototyping effort. As the old saying goes, “why reinvent the wheel?”

The primary weakness of benchmarking, however, is the fact that best-in-class performance is a moving target. For example, new technology can create quantum leap performance improvements such as the use of Electronic Data Interchange (EDI). Auto- mobile makers no longer use paper to purchase parts from suppliers. A computer tracks inventory and transmits orders directly to a supplier's computers. The supplier delivers the goods and payment is

electronically transmitted to the supplier's bank. Wal-Mart uses bar-code scanners and satellite data transmission to restock its stores, often in a matter of hours. These applications of EDI save tens of thousands of worker hours and whole forests of trees, as well as helping to meet customer requirements.

For functions that are critical to the business mission, organizations should continue to innovate as well as imitate. Benchmarking enhances innovation by requiring organizations to constantly scan the external environment and to use the information obtained to improve the process. Potentially useful technological breakthroughs can be located and adopted early.

Process

Organizations that benchmark, adapt the process to best fit their own needs and culture. Although the number of steps in the process may vary from organization to organization yet the following six steps contain the core techniques.

Decide what to benchmark
Understand current performance
Plan
Study others
Learn from the data
Use the findings

Table 29.1 illustrates how AT&T and Xerox have adapted benchmarking to their won needs. AT&T, in its first six steps, explicitly incorporates training and makes sure that personnel using benchmarking results to improve their processes buy into the program. The assumption is that if the process owners are not committed, they will ignore the results and the effort will have been wasted. Step seven represents the core benchmarking process.

Xerox, in steps 5 through 8 devotes extra effort to integrating benchmarking results into its formal planning process. This involves justification to senior management and gaining agreement from senior management. Again, steps are added to fit the process to the organizational need, but the core activities are consistent

AT & T's 12-step Process		Xerox's 10-Step Process	
1.	Determine who the clients are—who will use the information to improve their processes.	1.	Identify what is to be benchmarked.
2.	Advance the clients form the literacy	2.	Identify comparative organizations.
3.	Test the environment. Make sure the clients can and will follow through with benchmarking findings.	3.	Determine current performance gap.
4.	Determine urgency. Panic or disinterest indicates little chance for success.	4.	Determine current performance gap.
5.	Determine scope and type of benchmarking needed	5.	Project future performance levels.
6.	Select and prepare the team.	6.	Communicate benchmark findings and gain acceptance.
7.	Overlay the benchmarking process onto the business planning process.	7.	Establish functional goals.
8.	Develop the benchmarking plan.	8.	Develop action plans.
9.	Analyze the data.	9.	Implement specific actions and monitor progress
10.	Integrate the recommended actions.	10	Recalibrate benchmarks.
11.	Take action		
12.	Continue improvement.		

Table 29.1-- Approaches to benchmarking

Deciding what to Benchmark

Benchmarking can be applied to virtually any business or production process. Improvement to best-in-class levels in some areas will contribute greatly to market and financial success whereas improvement in other areas will have no significant impact. Most of the organizations have a strategy that defines how the firm wants to position itself and compete in the marketplace. This strategy is usually expressed in terms of mission and vision statements. Supporting these statements is a set of critical activities which the organization should do successfully to realize its vision. They are often referred to as critical success factors. Critical processes are usually made of a number of sub-processes. In general, when deciding what to benchmark, it is best to begin by thinking about the mission and critical success factors.

For example, take the case of two insurance organizations. The chairperson of the first expresses the organization's vision as becoming the "easiest in the industry to do business with." He wants to sell customers all their insurance needs by emphasizing speed of writing policies and an outstanding level of customer service. Critical success factors in this case could include a 24-hour, 800-number service, fast payment of claims, database systems that can relate information on all policies held by each customer and reduced cycle time.

Benchmarking customer service processes would have a substantial impact on the vision. The chairperson of the second organization admits that his organization is only an average performer in terms of customer service but intends to reduce the cost of insurance through excellent investment performance. Because today's premiums are invested to pay tomorrow's claims, higher earnings from investments would allow the organization to charge less. The critical success factors for this firm could include hiring and training good financial managers, using telecommunication to track and act on developments in global money markets, development of on-line, real-time information systems and expert forecasting. Benchmarking investment processes would be appropriate in this case.

Some other questions that can be raised to decide high impact areas to benchmark are as follows:

- Which processes are causing most of the trouble?
- Which processes contribute the most to customer satisfaction and which are not performing up to expectations?
- What are the competitive pressures impacting the organization the most?
- What processes or functions have the most potential for differentiating our organization from the competition?

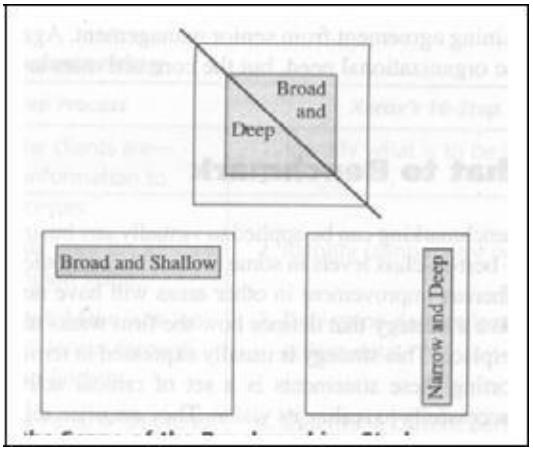


Figure 29.2-- Choosing the scope of the benchmarking study

In deciding what to benchmark, it is best not to choose too large a scope. A benchmarking study should be done quickly, to it may not get done at all. Teams can get very bogged down in the technicalities of benchmarking and take a year or longer to complete a study. Many circumstances can change in an organization over a year. Team members or management may change in a year’s time and may compromise the study or even force a study to be abandoned. In

order to limit the scope of a study and thereby limit the time it takes to conduct the study, it is best to choose a broad and shallow scope or a narrow and deep scope as shown in figure 29.2. Broad and shallow studies ask, “What is done?” and span many functions and people and do not go into detail in any one area. Broad and shallow studies are useful in developing strategies, setting goals and reorganizing functions to be more effective. Narrow and deep studies ask, “How is it done?” and delve into a few aspects of a process or function. Narrow and deep studies are useful in changing how people perform their jobs. Some benchmarking teams start with a broad-and-shallow scope and identify a few area of particular interest to do a narrow and deep study. Other benchmarking teams identify the narrow and deep target immediately, based on existing data or experience.

Pareto analysis can be a helpful technique for deciding what processes to investigate. It is often effective to start with the process output and trace back to the inputs, asking what, how, where, when and why questions along the way. Cause -and -effect diagrams and flow diagrams are excellent tools for tracing outputs back to inputs and for examining factors that influence the process. The bottlenecks identified become benchmarking candidates.

At this point, it is appropriate to begin thinking about metrics (measurements). Numerical measures illustrate the effect of improvement and thereby aid in deciding where to direct benchmarking activities. One quick and meaningful metric is the value added per employee. Measuring labor productivity is a fundamental indicator of efficiency that strongly correlates with profitability.

MODULE 5

Benchmarking-II

Types of Benchmarking

Industry Group Measurements

Industry group measurements are the measurement of various facets of operation and comparing these to similar measurements. Often the measures have little to do with productivity, customer satisfaction, or "best practice." Many industry groups publish comparative data either privately (for members of the group or service only) or publicly or both. The Institute of Internal Auditors' GAIN, i.e. Global Audit Information Network provides this kind of data privately to subscribers. The Institute also publishes biannual salary surveys and occasionally special studies of external audit fees and research on effective audit departments. These are considered as the "best practices."

Best Practice Studies

These are studies and lists of what works best. These are useful to benchmarking research, but they are not useful as metrics. What works best for an entity in its specific environment may not work the same way in another environment. These studies can be useful stimulators, but they are not "benchmarks" per se. There are books, consultants and public accounting firms that report internal audit "best practices" gathered from research and consulting practice. The IIA published a book for audit committees that were a study of best practices.

Cooperative Benchmarking

Cooperative benchmarking is the measurement of key production functions of inputs, outputs and outcomes with the aim of improving them. In internal audit, we would study, for example, comparisons of costs per audit hour, time elapsed to distribute final report, percentage of recommendations accepted. Cooperative benchmarking is done with the assistance of the entity being studied (the benchmark "partner"). Often the entity chosen as a benchmark is one that has "best practices" in the area of interest or has won a major national or international quality award. Internal audit departments are increasingly interested in this method.

A version of cooperative benchmarking is collaborative benchmarking. In the collaborative method, both entities study each other and work together to improve. Some audit departments are now doing this.

Competitive Benchmarking

Competitive benchmarking is the study and measurement of a competitor without their cooperation for the purposes of process or product quality improvement. The latter is called reverse engineering.

A version of competitive benchmarking is a commission granted to a third party to study a group of competitors and share the results with all. The third party consultant is the only one who knows what data belongs to which entity.

There are other benchmarking terms that refer to or describe versions of these basic types. This lesson will focus on Cooperative Benchmarking the internal audit process.

Benchmarking is usually done within the same industry. However, benchmarking is often done between organizations that have a similar process, but they are in different industries. By benchmarking the process across industries, the organization sometimes achieve greater results than by sticking to their own industry. Benchmarking a process across industries causes people to challenge some of the assumptions that are part of the problem.

Benchmarking as a tactical planning tool originated with Xerox Business Systems in the late 1970s. Japanese affiliates were selling better quality copiers for less than the manufacturing costs of similar products in the USA. One of the first experiments in benchmarking was in the production logistics area (warehousing, picking, packing and shipping). Xerox Business Services benchmarked with L.L. Bean, a clothing manufacturer who had one of the best logistics operations in the world.

Change Management

The process of benchmarking should fit into a change management framework. The management of change includes project management skills as well as understanding the behavioral aspects of change. The overall process usually requires three different teams (different charters, not necessarily different people):

A needs assessment team to identify key customer needs and their status:

Needs that are not being met (cost, quality, timeliness etc.)
Needs that are met better by the competition (hiring consultants)
Needs that are being met but can be improved

The benchmarking team takes the needs assessment results to design the required benchmarking project.

A problem solving team to take the action required in changing the audit process identified by the benchmark team. The problem solving team also helps to identify new customer issues for a continuous change management loop.

Benchmarking Steps

There are many versions of Benchmarking Steps used by very successful organizations. AT&T has 12, Xerox uses 10, Alcoa has 6 and others recommend 7 or 8 steps. The software program benchmarking, based on the work of James Harrington in business process improvement, uses an 18-step process. All current models use the same steps. The differences between them are that some of the steps are divided into multiple steps.

The simplest framework is recommended by GOAL/QPC. It has six steps (keyed to the Deming Cycle of continuous improvement):

1. Plan (Plan)
Research (Plan)
Observe (Do)
Analyze (Do)
5. Adapt (Check)
6. Improve (Act)

Benchmarking is not a one-time project. It is a continuous improvement strategy and a change management process. Once begun, the entity should continue to benchmark against "best practices" in order to continuously improve. Benchmarking is a part of the total quality management system and it relates well to other TQM initiatives.

Benchmarking Steps

Step 1: Plan

The first step in the benchmarking process is to plan. The needs assessment team provides insight into key customer needs and the processes in the organization that address those needs. When a customer need is identified, the processes that directly fulfill that need become critical processes. We only benchmark critical processes. Typically, we try to identify weak critical processes that can give us the most leverage if they are fixed.

The benchmarking team needs to perform the following:

Understand the critical processes and how they are measured
Decide what kind of data is needed and how data will be collected
Identify all team members and find a sponsor

A key step in the planning process is using flow charts so that the team first understands their own critical processes. The team needs to understand the process and how it is measured, both in their own terms and in the customer's terms. The kinds of measurements (or metrics) chosen have to be useful to compare performance with a benchmark partner. If the metric chosen uses information that could be sensitive to either partner, it is not a good measure. There is a golden rule of benchmarking which is as follows:

Do not ask your benchmarking partner to tell you things you are not willing to reveal about your own operation.

The planning stage is where the benchmarking team begins the process of linking their study to the organization's strategic goals. The benchmarking effort should focus its energies on those customers and customer needs that are most important. One way to determine relative importance is to develop a list using this selection methodology:

State the mission, purpose or goal of the function or department.
List the outputs and customers for each.
Identify major customers by value or volume.
List the major customers' needs and complaints.
Identify which processes affect these needs or complaints.
Identify which processes add the most value and which add the most cost.
(For competitive benchmarking) Identify which areas are subject to competition.

The needs assessment team may have already done some of the above. Clearly defining the processes will help to define the data required in the next step.

A sponsor, someone with authority and stature in the organization, is necessary for effective benchmarking. As we find in internal auditing, we need to report our findings to someone with enough clout to take action and implement the improvements. Due care should also be focused on assembling a team with the right mix of skills. Especially look for those with experience in the process being studied.

Following should be the output of planning process:

An identified customer class
Identified customers' needs
A targeted critical process related to fulfilling customers' needs
A linkage between the purpose of the benchmarking study and organizational objectives
A sponsor and a benchmarking team
A data collection plan

Step 2: Research

Following are the purposes of research:

To establish the metrics to be used
To identify the benchmark candidate
To collect public data

Before collecting a lot of data about others, a benchmarking team needs to collect baseline data about its own processes. Collecting this data will refine the measurement process and help develop the final set of metrics to be used in the benchmarking effort. Use TQM tools or other analytical tools to observe and analyze your own process. The benchmarking team can use this internal review as benchmarking practice prior to the site visit with the benchmarking partner.

Identifying potential benchmarking partners is another step in the research phase. It is always best to develop a list of three to five potential benchmarking partners for cooperative benchmarking. Some potential partners may not be interested, not have the time, or not wish to share information. Although benchmarking practice stresses using the "best in class" for our benchmark yet often that has to be tempered with other factors such as cooperation, costs, time, location and already established relationships.

To find a likely benchmark partner, there are a number of methods to discover who is best at satisfying customers and best at the process you want to measure. The most obvious search would be in your own industry and among direct competitors. In addition, the Benchmarking Team should be open to "generic" processes that are done outside of your industry. The classic example is Xerox choosing L.L. Bean as a benchmark for logistics and shipping.

Some of the sources to identify benchmarking partners are as follows:

Quality award winners (e.g., Malcolm Baldrige Award)
Business newspaper and magazine articles
Trade journal articles
Conference speakers
Industry and professional associations
Books on well-run companies
Consultants and Big six accounting firms who work in your industry

When likely candidates are found, some preliminary research should be done to help narrow the list. Using only public information, the benchmarking team compiles as much relevant data as possible. The data collection plan developed earlier keeps the data gathering process relevant and under control.

The sources of public information include all those used to select possible candidates as well as the following:

Internal resources (other departments in your organization)-- Your own market research, strategic planning, legal and others may have already compiled data on the potential partner, especially if the organization is in your industry.

Benchmarking services-- Some industries have data available through subscription to their benchmarking service, or the industry association knows who provides this service. The American Productivity and Quality Center maintains an office of the Director, International Benchmarking Clearinghouse.

Data base services-- Literature search data bases, Dunn and Bradstreet, Dow Jones and the like can be good sources of information.

Investor Relations departments at the potential benchmarks-- These people often have copies of annual reports, 10K, 10Q and other public financial data. Most of this data is available on one or the other of the financial databases.

Some potential partners may not have much information available. In these cases, they are normally dropped from the list. The ones remaining will have sufficient public data so that the benchmarking team can make a final decision of which organization we want to approach to be their cooperative benchmarking partner.

Step 3: Observe

Eventually the benchmarking team should go to the source of the data and visit the benchmarking partner. The team will have already prepared itself by:

Establishing a benchmarking agreement with a partner organization
Establishing a data collection plan and method
Becoming experts in the measurement of their own system
Preparing themselves by absorbing and cataloging all relevant public information

To save embarrassment, it would be helpful if the benchmarking team reviewed the common sense principles found in the “Benchmarking Code of Conduct” or similar document. This list of "correct behavior" will ensure that benchmarking efforts are not derailed over a breach of etiquette.

Benchmarking Code of Conduct

Keep it legal.
Be willing to give what you get.
Respect confidentiality.
Keep information internal.
Don't refer without permission.
Be prepared from the start.
Understand expectations.
Act in accordance with expectations.
Follow through with commitments.

There are measurement pitfalls to avoid as well. The team needs to have uniform collection methods (same forms seeking same data the same way). Be sure to specify the data at the proper aggregation level. Specify the data in terms of units and intervals (pounds of scrap per month) to make comparison easier in the analysis phase. It is good practice to mail any questionnaires in advance of the visit to provide time the benchmarking partner to prepare the data in the format requested.

Remember that the purpose of benchmarking is to improve operations. The same purpose also applies to the benchmarking project itself. Use the site visits as a way of improving the data collection design and method. Also realize that the world is not standing still during this exercise. Build in robustness to the metrics and the benchmarking plan because things will change before the project is complete.

Step 4: Analyze

Analysis of the collected data usually takes several steps:

Summarize and interpret the data.
Analyze the gap between your process and your partner's process.
Project where future gaps will be.
Analyze things that were not on the agenda.
Develop key findings into new operational goals.

Analyzing the benchmark performance "Gap" can be done as a snapshot or as a trend over a period of time. Either method (or both) may be appropriate for the process being studied. When cost, productivity or quality is the metric under study, sometimes it is useful to look at the historical trend as well as the current gap. Projecting future performance levels of your productivity and the benchmark partner's, given the current rate of improvement for each, creates what we call the "Z Chart" of productivity improvement required to attain parity with your benchmark partner.

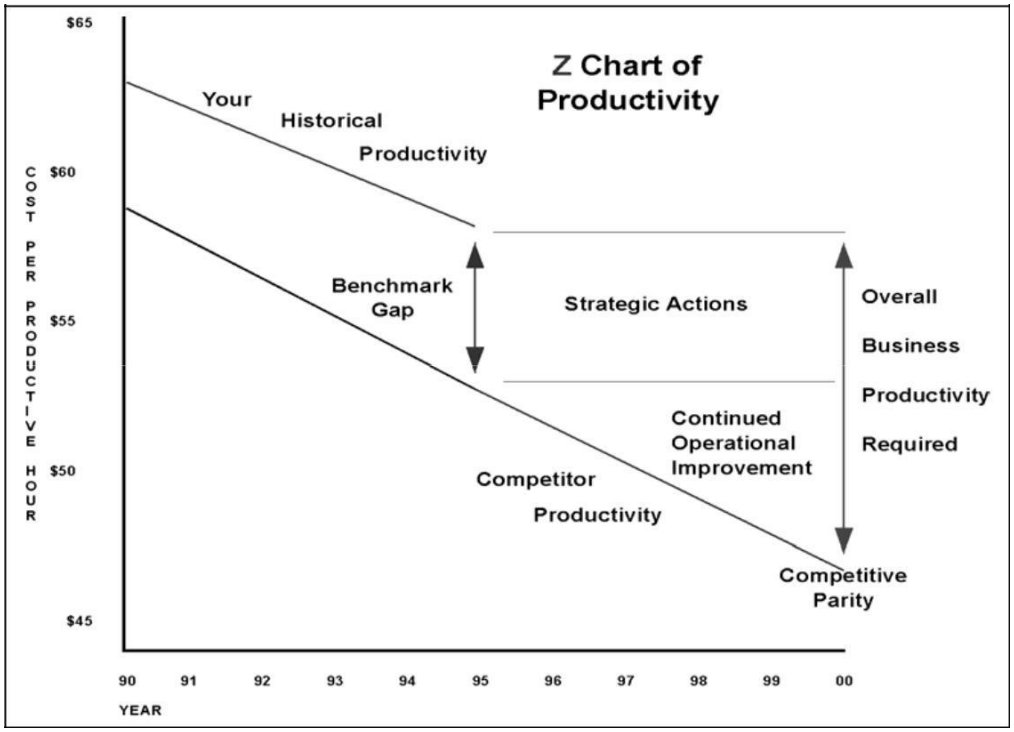


Figure 30.1-- Z chart of productivity

Useful formulas for calculating differences in performance levels are:

Your performance [When smaller numbers are more

desirable] Benchmark performance

Your performance - 1 [When larger numbers are more desirable]

Benchmark performance

By reducing the problem to metrics through analysis, it is easy to get lost in the numbers. Part of our analysis is to step back and look for things the numbers are not telling us. We also should be alert to qualitative data and observations.

To close the benchmark gap, the laggard should take strategic actions in addition to operational process improvements. Sometimes these strategic actions include restructuring, downsizing or

reengineering. The Z-chart provides a quantified target to aid in that task. The qualitative observations may provide the breakthrough thinking that will be required in order to leapfrog the current process and develop an improved process.

Step 5: Adapt

As a process improvement technique, benchmarking requires the same change management framework that all improvements need. The key change management techniques used are as follows:

Communicate the benchmark findings widely
Involve a broad cross-functional team of employees
Translate the findings to a few core principles
Work down from principles to strategies to action plans

Benchmarking is about improving processes. Each process has a process "owner," and process owners and other stakeholders need to have a voice in the changes recommended. Before developing strategies, it is important to communicate with all who might be involved in the change. Communication needs to follow the change management pattern:

Identifying the need for change
Getting stakeholders to voice their feelings about the change
Providing a forum for all to discuss the methodology, the facts and the findings from the benchmarking effort
Communicating the expectations about the changes
Building commitment for the change
Getting closure; celebrating the change

The best results from benchmarking have come from organizations that extrapolate and generalize the findings into a few core principles. Doing this before you create strategies gives a reference point for building a cohesive and continuous change process. Acceptance of broad principles is usually easier to win than specific strategies.

Various methods are used to generate the strategies required:

The "end-state vision" method-- According to the "end-state vision" method, the desired state or condition when the process is working as intended is defined and compared with the current condition. A strategy is developed to migrate from the current state to that desired end state.

A "force field" diagram-- The force field diagram is used to explain where we are and how we got there by identifying helping factors and hindering factors. Our strategy becomes to boost the helping factors and reduce or eliminate the hindering factors. (Refer to figure 30.2)



Figure 30.2-- Force field diagram

A matrix can be used to target the highest priority changes by looking at importance of the process to the organization and the leverages from various options.

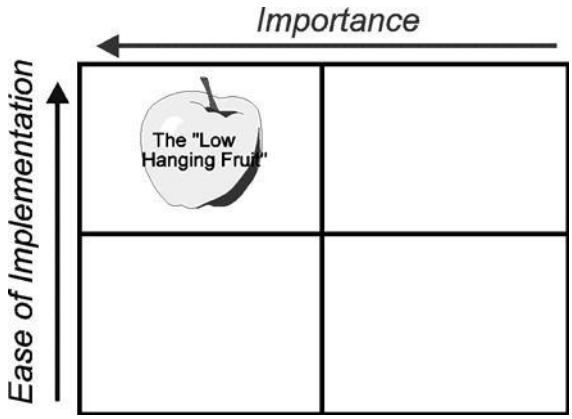


Figure 30.3

Adapting the results of benchmarking can be the most difficult step. No two organizations are alike, so what works for you benchmark partner may not work for you in the same way or with the same results. Choose the strategies that allow for feedback to be certain the recommendations are effective. Whatever is chosen, there should be strong linkages between the original purpose in the benchmarking plan and the strategies selected. Once strategies have been chosen, they can be broken down to a set of action items. These action items will be measured and monitored as part of the next phase.

Step 6: Improve

The key implementation strategy is to choose solutions to benchmark findings that also contain an element of continuous improvement. Another implementation strategy is to move the benchmarking out from specialized work groups to include all employees and all processes that may need it. Finally, there should be an improvement to the benchmarking process itself -- to establish "best practices" in benchmarking.

Continuous improvement is brought to bear in a process by ensuring that the process is subjected to an ongoing benchmarking activity. Benchmarking links each process in the organization with an improvement strategy and organizational goals that are in turn linked to customer needs. This linkage strengthens the bond between the customer and the organization.

A part of the organization’s environment includes technology and competition. It is not enough to continuously improve if competitors are improving at a faster rate. Benchmarking imbues the organization with a sense of continuous improvement. It also acts a practical monitor on the environment to ensure long-term organizational survival.

To accomplish the goal of bringing benchmarking activities to all critical processes of the organization means that all employees may eventually need benchmark training. Process owners are key people to train in benchmarking principles so that they can also own the benchmarking process. Once they feel ownership and control, benchmarking becomes another quality management tool.

The final step in any benchmarking activity is to complete the Deming cycle of continuous improvement; that is, to plan for the next benchmarking project. Lessons learned in the benchmarking activity become the source for continuous improvement of the benchmarking process. These lessons should be documented and used as the basis for the new planning cycle.

Case Study-1 Changing Company Culture

Changing Company Culture

Creating a total quality company culture is one of the biggest challenges of a total quality management program. A firm's very survival may depend on how it adapts its culture to a rapidly changing business environment and to the new demands of its customers. Of corporations in the Fortune 500 rankings five years ago, 143 are missing today.

In this lesson, we will first look at the elements of company culture and how it should change to accommodate TQM. After that, we will look at five companies which have made the change and are still making it. These five brief case studies include two-information technology service and manufacturing companies, IBM and Xerox, two service companies, British Airways and the Royal Mail, and Paul Revere Insurance Group.

But what is company culture? What are the different kinds of company culture? What is meant by a total quality management culture?

What is company culture?

Part of the fascination of foreign travel is observing the differences in national cultures. The British culture is very different from the French, Malaysian, Japanese or American cultures. And they are all different from the Eastern European national cultures. Yet there are multinational companies that operate in strikingly similar ways across many national cultures. Oil companies such as Shell and Esso, car firms such as Ford and Nissan, computer giants such as IBM, Xerox and Hewlett Packard, and telecommunications consortiums such as British Telecom or Cable and Wireless or IIT, all have distinctive company cultures. In fact, these companies have ways of doing things which often override national culture. Their managers, in many different countries, often behave more like each other than like their fellow citizens. These companies have created their own cultures.

In 1972 Roger Harrison described organizational culture as, “The ideologies, beliefs and deep-set values which occur in all firms and are the prescriptions for the way in which people should work in those organizations.”

More recently, in 1986, Charles Handy echoed Harrison's definition, but went further in clarifying culture as, “Deep-set beliefs about the way work should be organized, the way authority should be exercised, people rewarded, people controlled.” What are the degrees of formalization required? How much planning and how far ahead? What combination of obedience and initiative is looked for in subordinates? Do work hours matter, or dress, or personal eccentricities? Do committees control an individual? Are there rules and procedures or only results? These are all parts of the culture of an organization.

Recognizing Culture

Culture is deeply rooted in organizations. It manifests itself in a number of obvious ways. Six expressions of a company's culture are the following:

1. **Regular Ways of doing Things**

Often there are observable patterns of behavior among people of the same company. In one electronics company, the managing director called employees by surnames and expected everyone to be addressed formally. In a well-known bank it was frowned upon if the male members of management did not come to work in a suit.

2. **Work Group Norms**

Standards of performance are formally/ informally set by work groups. “We make our decisions together and stand by them. No rate busting allowed. A fair day's work for a fair day's pay.”

3. **Main Values Espoused by a Company**

A value is a deeply held assumption, which influences attitudes and behavior. The US Marine Corps has its central value enshrined in the motto Semper Fidelis (always faithful). One of the key values of IBM is “excellence in everything we do.”

4. **Philosophy that Shapes a Company's Policies towards its Employees or Customers**

John Lewis expresses its philosophy in the phrase “never knowingly undersold.” Tesco's was built on the barrow boy philosophy “pile them high and sell them cheap.”

5. **Rules of the Game for getting along well in a Company**

Not attending a company's social events, in many companies is seen as a lack of involvement and commitment to the company. Leaving the office before the boss in the evening can be viewed as having a lack of serious commitment to one's work in certain firms.

Feeling or Atmosphere Created by the Physical Layout and Decoration in a Company

The opulence of the Cartier watch company's retail outlet in London creates an aura of high sophistication associated with its expensive products. The VIP lounge of British Airways, with a special section filled with personal computers, fax machines and photocopiers, reflects its attention to detail in customer service for the business traveler.

All of these evidences of company culture Schein would argue are not, in themselves, the company culture, but they simply reflect the deeper level of basic assumptions and beliefs that are shared by people in a business. These assumptions and beliefs about how a company gets organized internally and deals with threats and opportunities in its business environment are deeply rooted and operate unconsciously and in a taken-for-granted fashion. Company culture can be defined in Schein’s words as follows:

“A pattern of basic assumptions - invented, discovered, or developed by a given group as it

learns to cope with its problems of external adaptation and internal integration - that has worked well enough to be considered valid and, therefore to be taught to new members as the correct way to perceive, think and feel in relation to those problems." Peters and Waterman provided a list of seven basic values that are found in the best American companies. These two management writers present corporate culture as a recipe for success in which quality is one of the seven essential beliefs. These basic values are defined as follows:

A belief in being the best.
A belief in the importance of the details of execution, the nuts and bolts of doing the job well.
A belief in. the importance of people as individuals.
A belief in superior quality and service.
A belief that most members of the organization should be innovators, and its corollary, the willingness to support failure.
A belief in the importance of informality to enhance communication.
Explicit belief in, and recognition of, the importance of economic growth and profits.

Peters and Waterman wrote In Search of Excellence while they were working as management consultants for McKinsey. It was there they learned the centrality of values in a company which is graphically portrayed in figure 46.1, developed by Tom Peters, Robert Waterman, Richard Pascale and others. When quality becomes the central shared value as in a TQM program, everything else flows from it - systems, strategy, structure, style, skills and staff or choice of people.

SAS, the airline, underwent a radical cultural change by redefining its mission to meet its customers' 50 million moments of truth. Since frontline employees managed most of the moments of truth, they had to be empowered and educated to deal directly with them. Frontline management backed them. The role of middle and top managers was changed simply to support the frontline people in dealing with the 50 million "moments of truth." SAS created a huge internal realignment to face up to the external adaptation of a new approach to customer service.

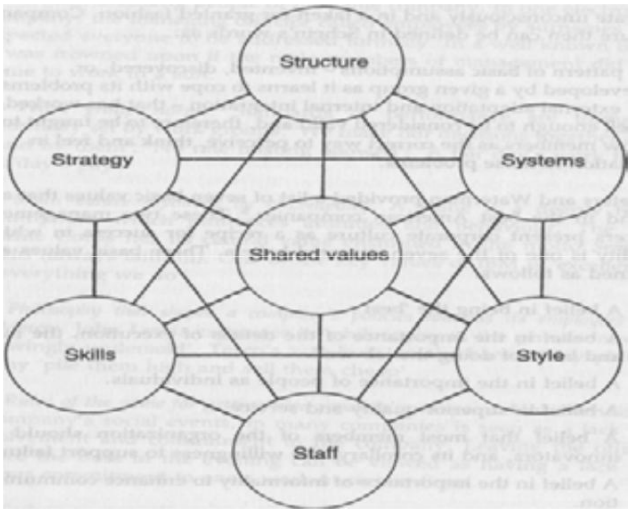


Figure 31.1-- The McKinsey 7-5 framework.

As a quality process which makes the quality central to the business, total quality management recognizes a change in many of the basic assumptions and beliefs from former practices to future performance. Xerox made this cultural change explicit in its "Leadership Through Quality" programs. Examples of cultural changes which could be required are shown in table 31.1.

To	From
Incomplete or ambiguous understanding of customer requirements.	Use of systematic approach to understand and satisfy both internal and external customer requirements.
An orientation to short-term objectives and actions with limited long-term perspective.	The deliberate balance of long-term goals with successive short-term objectives
Acceptance of a certain margin of error and subsequent corrective action as the norm.	Striving for continuous improvement in error-free output in meeting customer - requirements and doing things right the first time.
Unstructured, individualistic problem solving and decision-making.	Predominantly participative and disciplined problem solving and decision making using a common approach
A management style with uncertain objectives that installs fear of failure.	An open style with clear and consistent objectives which encourages problem solving and group-derived solutions

Table 31.1-- Examples of cultural changes which could be required

Case Study-II Xerox Corporation-- Using TQM as a Competitive Strategy

In launching its total quality management program, called “Leadership Through Quality,” David T. Kearns, the chairman and chief executive officer of the Xerox Corporation, cited the fierce global competition in the office machine business as the motivator for making the fundamental changes at Xerox to total quality in a $400 billion business. His company had enjoyed a near monopoly status for the sale and rental of photocopy machines until 1975. Five years later Xerox's market share of photocopy machines had fallen to below 50 per cent and the firm had over a hundred direct competitors for that core part of their business.

Japanese photocopy machine companies, led by Canon and Ricoh, began to match Xerox on copy quality, reliability and service and to beat them on price. Xerox watched its position in the Fortune 500 (in terms of company revenue) fall from the upper 10 percent to the bottom third of the ranking. Xerox responded to the serious threat to its business by taking the following steps:

Trimming its costs by about $600 million a year. Worldwide, Xerox employees were reduced through redundancy from 120,000 in 1980 to 104,000 three years later.
Restructuring, led from corporate headquarters in Stamford, Connecticut, each part of Xerox reorganized itself for greater efficiency.
Competitive benchmarking its new rivals in terms of products, service and practices.
Launching a total quality program in February 1983 based on massive training in the teachings of Deming and Juran.

The policy statement was simple and direct—“Xerox is a quality company.” Quality is the basic business principle for Xerox. Quality means providing our external and internal customers with innovative products and services that fully satisfy their requirements. Quality is the job of every Xerox employee.

The news from Japan was not all bad. Fuji Xerox had won the Deming prize for quality in 1980 and had provided the Corporation with a role model for managing total quality. A change in both company culture and management style was required. It all began with quality training, starting with the top twenty- five Xerox executives and cascading down through the Xerox world. David T. Kearns published the top-down commitment to total quality in a video which had him talking to the camera like an anchorman on television news. The message was equally straightforward:

> “Customers have come to expect and demand quality from Xerox. They no longer merely use our products and services they depend upon them. As the office becomes more and more sophisticated and automated, that dependency on Xerox products and services will grow. As a result, our customers will make ever -increasing demands on us. Faulty design, billing errors and. defects that might have been understood just a few years ago, will no longer be acceptable. Our customers won't tolerate it and our competition won't allow us to get away with it.”

“We were faced with a challenge to bring ever-increasing levels of quality to our products, services and practices and we responded. We introduced competitive benchmarking and employee involvement to our management processes. We reorganized our development activities so that we can bring out higher quality products faster and at less cost. We began to measure customer satisfaction and to take appropriate action to enhance our service to our customers.”

Despite these, and other moves in the right direction, we have a long way to go. Xerox is clearly in a period of transition. We are no longer the company that we once were and not yet the company that we must be. If we are to successfully complete the transition and continue our record of success, every individual in this corporation will have to work toward our common goals. That is where you come in. Leadership Through Quality is neither a panacea nor a magic formula for success. It is a vehicle for change and an umbrella under which all Xerox people can work to improve quality. As I view it, there are three objectives for Leadership Through Quality:

To install quality as the basic business principle in Xerox and to ensure that quality improvement becomes the job of every Xerox person.
To ensure that Xerox people provide customers with innovative products and services that fully satisfy their requirements. When we speak of customers we mean customers in the broadest sense of the word.
To firmly establish in the Xerox culture new management and work processes. We must unleash the creative talents and energies of all Xerox people so that they can continually pursue quality improvement.

There are 8,000 UK Xerox employees who belong to the 30,000 strong subsidiary Rank Xerox. As part of the cost cutting exercise Rank Xerox moved its own international headquarters from central London to Marlow. A unique approach, to shedding executive management took the form of “networking” in which the company set up former employees in private business, giving them the computers they needed and contract assignments.

Rank Xerox was one of the Xerox Corporation's ten major sectors represented on an international “quality implementation team” through its own Vice-president of quality who reported to the managing director at Rank Xerox and who, with the other vice presidents of quality, had two tasks. First, to advice the board on quality issues. Second, to put the corporation's quality policy into effect in his or her own territory. The Xerox Corporation assisted the “quality implementation team” in every way possible - from providing its own training material beautifully packaged under the “Leadership Through Quality” label which would cascade from director level to the office and factory floor of Xerox worldwide, to the publication of the policy and plan and, most importantly, through the high level of senior management commitment to the cultural change the TQM process would set in motion.

In its early planning sessions at top level Xerox identified the cultural changes demanded by the new quality policy, The specially designed “Leadership Through Quality” training material identified five change levels, interacting with each other, which are essential to achieving the desired change. These were as follows:

1. Standards and measurements will provide all Xerox people with new ways of assessing

and performing their work, solving problems and improving quality. Tools to do this include the following:

A six-step problem solving process (refer to figure 32.1)
A nine-step quality improvement process
A figure of competitive bench marking
An emphasis on error prevention and doing things right first time
Techniques for determining the cost of quality

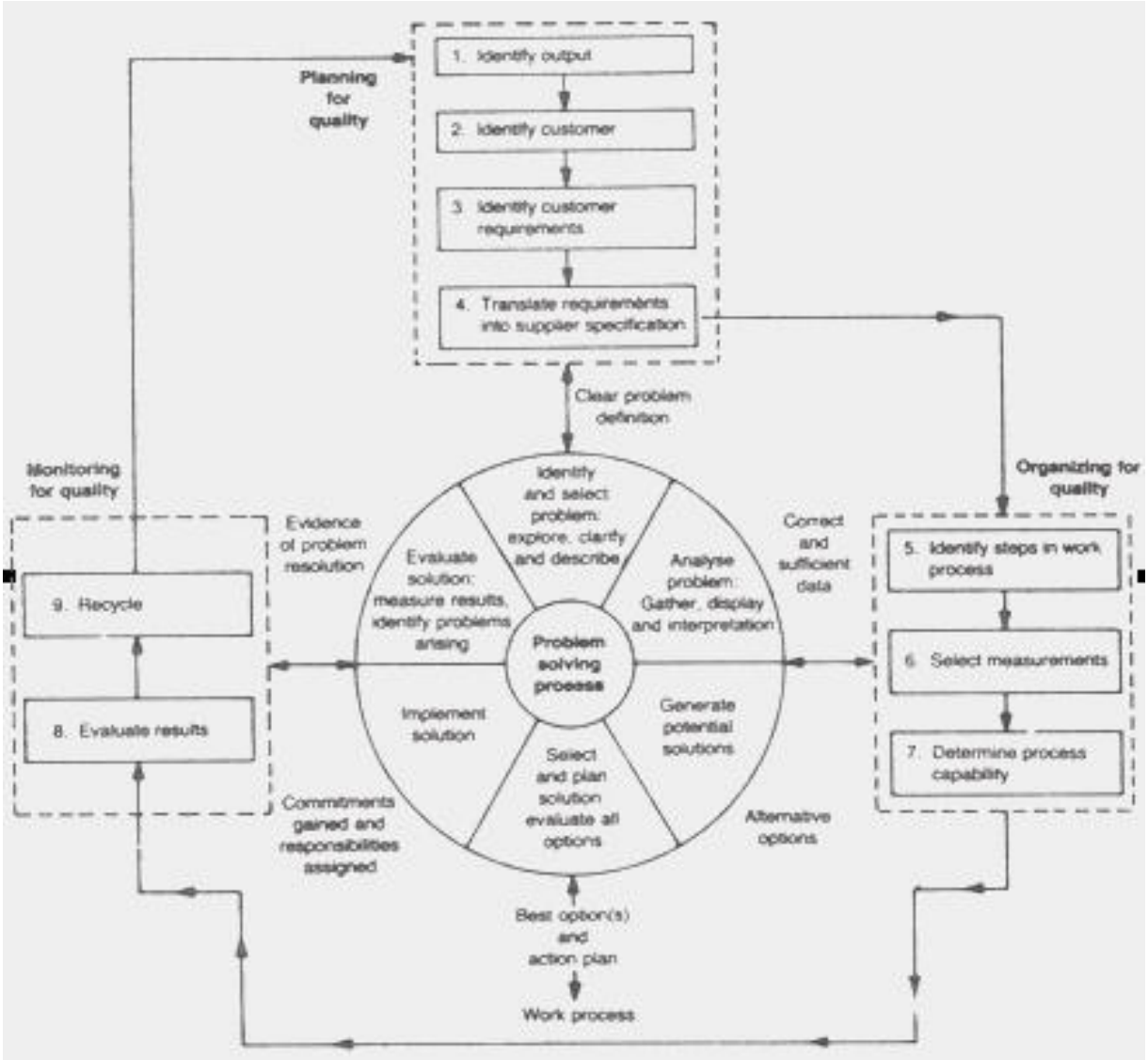


Figure 32.1-- Xerox Corporation's problem-solving process

Recognition and reward will ensure that Xerox people are encouraged and motivated to practice the behaviors of leadership through quality. Both individuals and groups are recognized for their quality improvements-- whether that takes the form of a simple thank you (recognition), or merit pay increase (reward).

Communications will ensure that all Zero people are kept informed of the objectives and priorities of the corporation in general and their work group in particular and how they are doing in meeting these priorities. Communications includes both formal media such as magazines and films as well as informal media such as staff meetings.

Training will provide every Xerox person worldwide with an understanding of leadership through quality and a working "knowledge" of the tools and techniques for quality improvement. This quality training is delivered in "family groups" consisting of a manager and his or her direct reports. The manager, assisted by a professional trainer, conducts the weeklong problem solving and quality improvement training. During the course of the week, the group selects a problem or project for application of the quality processes and tools. After training, the manager guides the family group in the use of the quality process. Once the project is under way, member of the family group work with a professional trainer (consultant) to deliver the weeklong training to their own subordinates, who then choose their own application project. This method of training top managers first and having them participate in the training of their subordinates is called training "cascade." It is designed to ensure that managers are trained in and understand the quality process and to involve them actively in the training of their family groups.

Management behavior and actions will ensure that the management team at all levels of the corporation provides the necessary leadership, sets the right tone and acts as examples for the successful implementation of leadership through quality. Managers must not only espouse the principles of leadership through quality, but also practice them day-in and day-out. In other words, managers must walk like they talk.

Table 32.1 shows the time frame of the Xerox total quality program. Cultural change takes years to effect.

Feb 1984	First training group at top of Xerox Corporation.
April 1984	MD of Rank Xerox takes part in training group (along with MDs of nine other main Xerox companies).
May1984	Rank Xerox senior executive group take part in first 'leadership through quality' sessions to be held in UK.
Late1984	Top managers of Rank Xerox operating companies meet in training groups.
Late1984	Orientation video shown to all Rank Xerox employees.
During1985	Training starts to cascade down management layers of all Rank Xerox operating companies.
Late1986	Final sessions completed within English-speaking companies.
Late1987	Final stages of training (at workgroup level) in European, African and Eastern areas.

Table 32.1-- Time frame of the Xerox total quality program

There have been many pain barriers to such sweeping cultural changes in Xerox. These have included staff reductions on an unprecedented scale to such an extent that to many employees the "new flexibility" simply meant job losses. "Downsizing" operations mean redundancies which

are difficult to square with employee involvement and personal commitment to change. Another major barrier had to do with Xerox emphasis on reducing the cost of quality. It is difficult to control cost of quality when over 80 per cent of Xerox's production costs are attributed to buying in materials from their outside suppliers. To deal with the problem in 1986 Xerox set up a full-time consultancy group to carry its “Leadership Through Quality” message to one hundred key suppliers. The plan was initially for three years and has been extended.

Any change as bold and comprehensive as Xerox's attracts public attention and running commentary from critical academic observers. Since total quality management at Xerox is a journey not a destination, there is no point at which its initiators will say they have arrived. Hence the verdict on how successful it has been will be an open one. The financial indicators, however, are very positive and indeed measurable. Production costs are down in places by as much as 40 per cent. Customer satisfaction-- the key principle is increasing by 35-40 per cent in various parts of the business. Market share once threatened is increasing. And the Xerox Corporation won the Malcolm Baldrige Quality Award in 1989 for Leadership Through Quality.

Xerox Corporation - Leadership Through Quality

Xerox Corporation is a global company that offers the widest array of document-prong products and consulting services in the industry. Xerox sells its publishing systems, copiers, printers, scanners, fax machines, and document management software, along with related products and services, in more than 130 countries. Xerox products and services are designed to help customers master the flow of information from paper to electronic one and back again. The Xerox customer is anyone who uses documents be it Fortune 500 corporations and small companies or public agencies and universities.

Xerox leads the way in digital imaging and what is called distributed publishing. Xerox technology enables the home office to copy, print, scan, and fax documents using a single device and far flung enterprises to transmit complicated, multi page documents across networks for copying or printing. Xerox started the office copying revolution with the introduction of its 914 copier in 1959. Today, Xerox stands poised for the continued expansion of the global document-processing market, already enormous at $ 200 billion a war and growing 10% a year. In 1995, 20% of revenues were in businesses that grew more than 20% personal copying and printing (29%), document outsourcing (50%); production publishing (24%) and color copying and printing (45%). Including Fuji Xerox about two-thirds of the $25 billion in revenues are generated outside the United States.

Xerox and Quality

Xerox practices total quality management and is committed to providing its customers with innovative products and services that fully meet their needs. Xerox products are consistently rated among the worlds best by independent testing organizations. Since 1980, Xerox has won numerous quality awards, including the world's three most prestigious-- the Malcolin Baldrige National Quality Award for Xerox Products and Systems in 1989, the first European Quality Award for Rank Xerox in 1992 and the Deming Prize, Japan’s highest quality award for Fuji Xerox in 1980.

Xerox is the first major US Corporation to regain market share after losing it to Japanese competitors. The company's decision to rededicate itself to quality explains that accomplishment. In the 1970s, Xerox nearly became a victim of its own success, lulled into complacency by the easy growth of its early years. Market share dropped to less than 50% by 1980, from nearly 100% a few years earlier. Fortunately, Xerox reacted to this challenge with a strategy called "Leadership Through Quality." Using Fuji Xerox in Japan as a model, Xerox created a participatory management style that stressed improving quality while reducing costs. Quality circles flourished and teamwork was fostered. Xerox also sought more customer feedback, changed its approach to product development to target key markets, reduced costs, encouraged great or employee involvement and began competitive benchmarking-- the now widely used process of measuring performance against the tough best competitors and against companies recognized as the beat in a particular area, such as L.L. Bean for distribution and Toyota for quality control.

Leadership Through Quality

The "Leadership Through Quality" thrust has made quality improvement and, ultimately customer satisfaction the job of every employee. All received at least 28 hours of training in problem solving and quality improvement techniques. The company has invested more than four million man-hours and $ 125 million in educating employees about quality principles. Workers are vested with authority over day-to-day work decisions. They are expected to take the initiative in identifying and correcting problems that affect the quality of products or services. Both salaried and hourly personnel have embraced these added responsibilities.

For example, the company's 1989 labor contract (the year they won the Baldrige Award) with the Amalgamated Clothing and Textile Workers Union pledged employee support to continuous quality improvement while reducing quality costs through teamwork and the tools and processes of "Leadership Through Quality." This partnership with the union is considered a model in the industry.

The phrase "Team Xerox" is not an empty slogan. It accurately reflects the firm's approach to tackling quality issues. Xerox Business Products and Services (BP&S) estimates that 75% of its workers are members of at least one more than 7000 quality improvement teams. In 1988, teams in manufacturing and development were credited with saving $16 million by reducing slogan, triggering production schedules, and devising other efficiency and quality enhancing measures.

Teamwork also characterizes the company's relationship with many of its 480 suppliers. Vendors are process qualified through a step-by-step procedure to analyze and quantify supplier's production and control processes. Vendors receive training and follow up in such areas as statistical process control arid total quality techniques; firms credit Xerox with improving their products and operations. For BP&S, increasing reliance on qualified when floors over the last five years has reduced the number of defective parts reaching the production line by 73 %.

Planning new products and services is based on detailed analyses of data organized in 375 information management systems, including 175 specific to planning, managing, and evaluating

quality improvement. Much of the wealth of data has been amassed through an extensive network of market surveillance and customer feedback, all designed to support systematic evaluation of customer requirements. Over half of the company's marketing-research budget is allocated for this purpose, and each year its Customer Service Measurement System tracks the behavior and preferences of about 200,000 owners of Xerox equipment.

Benchmarking System

In its quest to elevate its products and services to world-class status, Xerox BP&S devised a benchmark high system that has in itself, become a model. The company measures its performance in about 240 key areas of product, service, and business performance. Derived from international studies, the ultimate target for each attribute is the level of performance achieved by the world leader, regardless of industry.

Returns from the company's strategy for continuous quality improvement have materialized quickly. Gains in quality over the last five years inc1ude a 78% decrease in the number of defect per 100 machines. This greatly increased product reliability, as measured by a 40% decrease in unscheduled maintenance, increasing copy quality, which has strengthened the Company's position as held leader. A 27% drop (nearly two hours) in service response time and significant reductions in labor and material overhead. These improvements have enabled Xerox BP&S to take additional steps to distinguish itself from the competition; for instance, it was the first in the industry to offer a three-year product warranty.

The thrust of "Leadership Through Quality" is ongoing. The process of continuous quality improvement is directed toward greater customer satisfaction and enhanced business performance. Such goals illustrate the commitment contain to in the Xerox Quality Policy, Which states "quality is the basic business principle at Xerox."

Xerox and Diversity

Xerox viewed diversity in the workplace as more than a moral imperative or a business necessity. They see it as a business opportunity. They believe diversity makes them better. People of all ages and with different backgrounds bring fresh ideas, opinions, perspectives, and boundless creativity to the company. Under the company's balanced workforce strategy, senior managers are evaluated on their ability to hire, keep, and promote minorities and women. Even when the company must reduce its ranks, the smaller workforce is expected to mirror the workforce before the reduction, in the percentages of minorities and women. Caucus groups are another aspect of the diversity story at Xerox. These independent groups if Xerox employees date from the 1960s. The caucuses, not labor unions but something akin to self-help groups, help members negotiate the corporate world and work to ensure that their members, like all Xerox employees, have equal opportunities in hiring, promotion, and training.

Xerox and Social Responsibility

Xerox understands that corporations, like private citizens, have a responsibility to society at large Civic virtue and community involvement are among the most cherished corporate values. The

company carries out much of its philanthropic work through the Xerox Foundations, which in 1995 contributed $14 million in five areas:

Community affairs
Education and workforce preparedness
Science and technology
Cultural affairs
National affairs

Xerox also supports employee involvement through two innovative programs, Social Service Leave and the Xerox Community Involvement Program (XCIP).

Under Social Service Leave, employees are granted paid leaves of absence to work on community projects of their choice. More than 400 have taken leaves since 1971. The program is believed to be the oldest of its kind in American business. Through XCIP, groups of Xerox employees can get corporate seed money to work on meeting needs they identify in their communities. In 1995 alone, more than 20,000 Xerox employees took part in nearly 700 XCIP projects.

Xerox and Work/Family

Xerox is committed in helping employees balance the demands of professional and personal life, The Company believes that by relieving some of the pressures in people's personal lives, Xerox can help them be more focused and productive at work. Xerox offers childcare subsidies, salary redirection for dependent-care expenses, childcare sources and referrals, eldercare consultations and referrals, adoption assistance, leaves of absence and flexible work arrangements.
In 1993, Xerox introduced “Life Cycle Assistance” to address the changing needs of a diverse workforce. Money from this program of flexible benefits can be put toward the purchase of a first home, and toward the purchase of health insurance for household members not generally eligible for coverage under the Xerox health plans, such as a domestic partner. Life Cycle Assistance is another important step toward giving employees greater choice in how benefit dollars are spent. Xerox ranked No.1 on *Money* magazine's 1995 1ist of U.S. corporations with the best employee benefits.

Xerox and the Environment

Xerox is proving that what is good for the environment can also be good for business. Their environmental initiatives have already saved hundreds of millions of dollars while reducing pollution, waste and energy consumption. The motto "Reuse, Remanufacture and Recycle” reflects their goal-- To rate waste-free products in waste-free factories and offices’ using what is called “Design for the Environment.” Most copier, printers, and qualification devices are now designed to be remanufactured at the end of their initiate life cycles, approach made possible by the durability and quality of Xerox products and parts. Xerox uses only recyclable and recycled thermoplastics and metals. The company has adopted snap-together designs to facilitate assembly and disassembly, for the cleaning, testing, and reuse of parts. In 1995, Xerox received

the Environmental Achievement Award from the international Wildlife Federation which cited the company's design for the environment program.

Questions

What are some of the unique characteristics of the quality culture at Xerox?

Discuss the major strategic goals of Xerox. Compare and contrast this to another company of your choice. List some goals of a company other that profit P1ax-imizationand discuss the social responsibilities of an organization as promoted by Xerox.

Describe the benchmarking efforts of Xerox. Discuss what steps Xerox could have taken to avoid loss of market share prior to its turnaround in the 1980.

Discuss the role-played by the management at Xerox in adopting the quality policy.

What are some efforts undertaken by Xerox to ensure satisfaction of its employees? How would you monitor such a system to maintain employee commitment?

Case Study-III Motorola’s Secret to Total Quality Control

The Galvin Manufacturing Corporation later renamed Motorola, Inc, began operations on September 25, 1928, in a small section of a rented building at 847 Harrison Street in Chicago. At that time the company had five employees. Now in its sixty-second year, Motorola is ranked among America's 150 largest industrial corporations with close to 98,000 employees worldwide and sales approaching $8 billion.

In 1988, Motorola received one of the first Malcolm Baldrige National Quality Awards. No single article can address all the elements in Motorola's corporate quality system or explain in detail how to set up a quality system that will win the Baldrige Award. Instead, some of the elements of quality control of manufacturing operations within the semiconductor products sector will be examined. The secret to Motorola's success in quality control is a focused effort in three major areas-- material control, in process control and arid containment. Within each major area are several key items that should be addressed to achieve success.

Material Control

Motorola stresses to all vendors that percent AQL (acceptable quality losses) is unacceptable and that their defective units are measured in parts per million. Moreover, Motorola's goal is to reduce the number of its vendors by an average of about 50% each year. Only those vendors that meet its expectations for superior quality will be retained or added to its vendor base. Motorola has substantially improved as its vendors have improved their quality. Each vendor should indicate its Cpk performance (process capability index, which accounts for no centered process averages). Vendors should have an acceptable Cpk and a program to achieve a Cpk of 2.

The vendor rating system measures vendors on the quality of product delivered and the timeliness of those deliveries. Vendors with higher ratings get more business and poor vendors are dropped. Most vendors now receive a monthly or quarterly rating of their performance.

Special programs are provided to individual vendors as needed, including training for service vendors. For example, a seminar for a travel industry vendor demonstrated how the principles of Six-Sigma Quality could be applied to that business.

Certifying Vendors

The best way to address material control is through a vendor certification program. Motorola's program consists of five phases:

Agree on key parameter measurements and work on having supplies correlate with these measurements.

Demonstrate consistency on key parameters. Once products correlate with measurements then Motorola will continue to inspect incoming products and review measurements for

correlation for an indefinite period of time, depending on volume and how long it takes to have confidence in the quality of incoming products.

Institute Statistical Process Control (SPC) on critical processes to achieve preliminary certification. In this phase, agree to certain critical processes on which SPC is to be implemented. When review of SPC shows that the critical processes are under control, preliminary certification can be granted.

Develop and approve a never-ending improvement plan and grant full certification. In this phase, the vendor is expected to develop and share its plan for ongoing process cost and yield improvements. Once this plan is approved, the vendor is granted full certi-fication.

Maintain an ongoing partnership. Review common goals on a quarterly basis. Long-term contracts and preferred vendor status are granted in this phase.

Also integral to the ongoing evolution of each vendor is a yearly audit of the following areas:

Quality management
Quality control
Procurement
Material control
Record keeping
Methods documentation
Calibration

Process Control

Motorola uses two tools to establish in-process controls-- SPC and process audits. During the last four years, more than $170 million has been invested in training people and improving their skills. Virtually all U.S. personnel are being trained in quality. For example, from 1986 to 1988, more than 10,000 technical personnel were trained in SPC and design for manufacturing techniques More than 50.000 people are being trained in the concepts of Six Sigma (such as the use of SPC in all work, including no manufacturing tasks).

Motorola defines three phases of SBC implementation:

Phase I

Avoidance-- Characterize the process and establish control limits.

Phase II

Path to Six Sigma-- Identify and quantify critical circuit/device parameters that need tighter distributions to satisfy Six Sigma requirements.

Phase III

Never-ending improvement-- Continue to lighten distributions and establish new control limits.

Once the final phase is reached, ongoing improvement continues. Work is under way to computerize control techniques.
Motorola uses two types of audits for process control-- engineering and monitor audit. The former is conducted by a QA engineer and entails an intense review of all process steps including equipment parameters, handling techniques and SPC.

A certified auditor conducts the monitor audit. It reviews a broad range of issues such as whether specifications and revisions are correct, whether logs are filled and maintained properly, etc. The system is set up so that any discrepancy-critical, major, or minor -is documented, and corrective action is required in writing. Critical defects should be corrected immediately; major and minor problems should be remedied within five working days. The proof of success is that results from customer audits for the past two years have been excellent.

Containment

Containment means inspecting out defects until permanent corrective actions can be implemented. Statistical sampling plans are used to-inspect each lot as it finishes each operation. The sampling plans are based on two items. The historical process capability in parts per million is determined and used with a sampling plan that has a high confidence level of rejecting lots that do-not meet requirements. Each operator then decides either to scrap or to- screen the product in question before sending it to the next operation.

Screening means that 100% inspection is performed, and all products that does not meet requirements is scrapped. Rework is not allowed. The result is that each operation receives only product that is known to the good and can therefore concentrate on process control and avoid defects. No sampling plan or even 100% inspection can guarantee that all defects will be eliminated, but the combination of these techniques makes near perfection possible.

The result-- focus on material control. The process control and containment is a total quality system that aims for never-ending improvement in product quality and that eventually will lead that ultimate goal of Six Sigma products.

Audit Checklist

Is the specification accessible to production staff?
Is the current revision on file?
Is the copy on file in good condition with all pages accounted for?
If referenced documents are posted on equipment, do they match the specification?
If the log sheet is referenced in specifications, is a sample included in the specification?
Is the operator completing the log sheet according to specification?
Are lots with out-of-specification readings authorized and takei1 care *of* in writing by the engineering department or the proper supervisor?
Arc corrections to paperwork made according to specification?
Are equipment time settings according to specification?
Are equipment temperature settings according to specification?

Is the calibration sticker on equipment current?
Do chemicals or gases listed in the specification match usage on line?
Do quantities listed in the specification match the line setup?
Are changes *of* chemicals or gases made according to specification?
Is the production operator certified? If not, does the supervisor authorize this person?
Is the production operating procedure according to specification?
Is the operator performing the written leaning procedure according to specification?
If safety requirements are listed in the specification, are they being followed?
If process control procedures are written in the specification, are the actions performed by process control verifiable?
If equipment maintenance procedures are written in the specification, are the actions performed verifiable?

Questions

What major effects led to Motorola being awarded the Malcolm Baldrige National Quality Award?
Prepare a form to rate vendors based on characteristics that you consider to be important. Suggest a scheme to select vendors.
Describe the role of auditing in maintaining an SPC system.
Discuss specific auditing tasks in operator and process control that could be beneficial to companies.
Describe how the philosophy of never-ending improvement is incorporated in the company.

Case Study-IV Motorola's Quest for Quality

The Total Customer Satisfaction (TCS) worldwide competition showcases the quality achievements of Motorola teams. All employees are given an equal opportunity to participate. Like many companies, Motorola uses teams to solve problems. In fact, almost half of Motorola's employees are on teams. But Motorola takes it one step further. It gives teams the opportunity to compete with one another and share firsthand what they have accomplished, allowing them to see how their achievements impact the organization through their TCS competition. Winning team members from all over the world are treated like royalty for a few days and are given the opportunity to make a presentation to top executives of the company.

The Need for TCS

Why develop such a competition? The Chairman of the Board says the first few years of Motorola's quality journey "were carved by the idea of the Malcolm Baldrige National Quality Award." But after winning the award in 1988, "the company needed something to carry the momentum." This led the company to develop the TCS team competition. Teams already existed within Motorola and the idea of a competition was met with enthusiasm. Since its inception eight years ago, Motorola estimates this quality program has resulted in savings of $2.4 billion a year--a savings that is essential for the company to remain competitive when its products have a price learning curve of 15% to 35% a year. In addition to the dollar savings, TCS has helped develop a company of empowered workers. "I'm not sure if maybe the whole empowerment aspects of what we did with the team process is not more important than the individual savings that we've generated," comments the Director of Corporate Quality for Business Systems. "Nothing has empowered the work force faster than the team process -- it makes the difference between a good company and a bad company." This opinion is echoed by the Chairman of the Board who says, "The numbers are impressive, but the numbers are not what counts."

The TCS competition is based on the following objectives:

Renew emphasis on the participative process at all levels of the organization, worldwide
Recognize and reward outstanding performance at the team level
Reaffirm the environment for continuous improvement
Demonstrate the power of focused team effort
Communicate the best team achievements throughout Motorola

How it works?

The competition starts with preliminary contests held for each of Motorola's business units. As many as 5,000 teams take part initially, incorporating roughly 65,000 of Motorola's 142,000 plus employees. The number of teams has grown from approximately 1,500 seven years ago and has increased every year. Depending on the size of each regional competition, one to five teams are selected to move forward to the worldwide finals.

This year's one -day competition featured 24 teams from countries that included the United States, Ireland, the Philippines, Israel, Taiwan, China, Malaysia and Japan. Teams took command of a large stage with four video screens and microphones at both ends. Each team had 12 minutes to present its accomplishments to a panel of judges that included the company's top executives. Teams that went over time lost points. The presentations were well rehearsed and proceeded like clockwork, with many teams having committed their entire presentations to memory. It was very impressive considering all the presentations were given in English, a language some of the team members did not even speak.

The TCS teams generally consist of 10 to 12 members, all of whom participate in the presentation. Teams are awarded points in the following seven categories:

Project selection-- The project should be tied to Motorola's key initiatives and should use specific customer input. Also, the projects should last from three to 12 months.

Teamwork-- The team should handle the project from selection through implementation. Participation of customers and/or suppliers is encouraged and all team members are expected to contribute to all phases of the project.

Analysis-- Analysis techniques used should support appropriate analytical processes for the project, lead to a root cause, identify alternative solutions and reflect innovative use of analytical tools.

Remedies-- The team should defend its choice of remedies from the alternatives, and remedies should be consistent with the analysis. Creative and innovative solutions are especially noted.

Results-- Results should be compared with the original goals and requirements. The degree of achievement of these goals is considered by the judges.

Institutionalization-- Teams should demonstrate that improvement is maintainable over time. They are encouraged to adapt solutions from other teams and spread their success throughout the company. Teams should emerge as leaders in their own right.

Presentation-- Presentations should be clear and concise, with overhead graphs and charts that are clear and easy to read. Listeners should be able to easily follow the team's thinking through the entire process.

Impressive Results

The accomplishments of these teams are truly impressive. A team from Motorola's Automotive Energy and Controls group in Sequin, Texas, achieved a savings of $1.8 million in 1996 by reducing polyamide delaminating for electronic circuits-- an 85 % improvement in six months.

Another cross-functional team from the company's General Systems Sector in Hong Kong set out to make the best cellular phone in the market in China and increase production capacity by 50% in just eight weeks. It also corrected a design problem that prevented users from ending their phone calls when closing the lower flap on the cellular phone.

Motorola's Land Mobile Product Sector in Schaumberg, Illinois, created a cartoon character named Eugene and a site on the World Wide Web to help improve its responsiveness to the Motorola service station community. The team's work resulted in 86% growth in new-account setups, 99% improvement in cycle-time reduction and 90% improvement in customer satisfaction.

The Real Reward

Even though team members are there to compete, the worldwide final is more than a competition-- it is actually a celebration. It is a way for Motorola to thank its employees and vice versa. It is no coincidence that the 1996 worldwide competition was held at the Phoenician in Scottsdale, Arizona, a five star resort. To the presenters, the real prize was just being there and being a part of something so grand.

At Motorola, all the teams are considered winners. "We do say, and mean it, that everybody wins because you're here," stated the CEO. Following the competition, an awards banquet was held to honor all the participants. Company executives were visible throughout, mingling in conversation with team members and other guests. After dinner, each team was called up on stage to be recognized and photographed with the President and CEO. These photos were just a few of some 2,000 pictures taken throughout the event that will be compiled in a TCS yearbook for all participants.

The excitement and enthusiasm of these Motorola employees was evident. "This is probably the grandest display of our efforts to be global and the way we manage and think about our business," said the CEO. He continued by saying that "This event reflects all of the important aspects of the corporation."

The winner of this year's customer satisfaction competition was a team from a manufacturing plant in Boynton Beach, Florida, with a history of noteworthy quality improvements. The team had members representing Motorola's messaging, information and media sector. Its goal was to develop and implement a low-cost, reliable packaging system that demonstrates environmental leadership and corrects problems identified by the team. Team members found $1.2 million in hidden packaging costs and identified three root causes-- lack of packaging standards, stock outages and inefficient reuse of materials. After tackling each problem individually, the team developed a standardized packaging tray that could be used to hold both finished pagers and in-coming housing. It also created a central database to track packaging requirements. The result of their efforts was a per unit total cost reduction, expected to save $6.1 million in 1997.

An Open Invitation

How do Motorola employees become a part of the contest? The TCS competition is open to all Motorola functional or cross-functional teams, 98% of which are self-forming. Since all team members are required to participate in all phases of the project, teams with representatives located around the world rely heavily on e-mail, telephone and other communications technology. Motorola also realizes the challenges of working with employees from different countries and offers cultural diversity classes to help employees prepare for these differences.

For every team that enters the competition, there are numerous others that have also made significant accomplishments, perhaps on a smaller scale. Roughly 40% of Motorola's teams are present in the competition. Many of the teams choose not to compete, but participate in what Motorola calls "showcase days" at their facilities, where teams set up booths and display their accomplishments to facility managers and co-workers.

To help them learn how to solve quality problems as a team, Motorola employees are trained in quality techniques and teamwork. Additionally, many teams, particularly those in Asia, have big sisters or brothers who act as sponsors for newly formed teams. These sisters and brothers are more experienced workers who help direct the teams and offer expertise. The company also has TCS process manuals that describe quality tools. One of Motorola's business units even developed a CDROM training tool that creates graphs and visual aids which can be used in the presentations. Finally, Motorola University offers quality training in areas such as quality processes and teamwork.

Never Good Enough

In keeping with Motorola's philosophy of continuous improvement, the competition has changed over the years. For instance, in past years, all teams that made it to the worldwide finals were presented either a gold or silver award. But the silver award winners went away feeling like losers, even though they were really winners. So in 1996, after recognizing each team for its work, the company gave away one diamond award to the overall winner.

To pinpoint areas for improvement, team members are usually surveyed at the worldwide competition for suggestions. Some of the regional competitions have been shifted to different countries to allow more employees to experience other cultures. While the events have been refined so that they are good for the employees, they have been designed to retain the travel and the excitement.

Sharing the Wealth

Motorola encourages other companies to learn from its success. This year, Motorola extended the TCS competition to its suppliers and for the first time held a formal supplier contest in conjunction with the Motorola competition. Fifty-one supplier teams competed in three regional competitions. The three winners participated in the worldwide supplier competition, which was held the day prior to the TCS competition. The winning team from Varitronix was presented at the Motorola competition as a showcase team. These supplier teams were eager to learn from

Motorola. Many of them had heard about quality processes, but did not know how to implement them until Motorola stepped forward. Representatives from other countries, educators, foreign government representatives and customers were also invited to attend the competition. Sun Microsystems started a similar competition few years ago based on TCS.

Additionally, to help others learn about the process, Motorola offers quality briefings to the public through Motorola University that address total customer satisfaction. Motorola University Consulting and Training Services offers quality briefings to the public that explain the six-sigma story, total cycle time reduction and total customer satisfaction teams.

Equally impressive as the competition is the company's ability to motivate its employees. It has much to do with Motorola's culture. The company stresses on the importance of trust before implementing something similar to TCS. Teams and empowerment will not work without trust. The employees have to trust management as well as each other. Without trust, it just would not work. A team from Dublin, Ireland, was motivated by the opportunity to show others in Motorola what they had accomplished. And the chance to win a trip did not hurt. For TCS team members, it is an opportunity not only to get away, meet new people and learn, but also to have fun. The day following the contest is usually set aside for recreation, which, in the latest edition, included hiking, rafting, mountain biking and golf.

Whether employees are executives or factory workers, Motorola works to show them that they are valued. The TCS competition only reinforces these feelings. The experience emphasizes even more the value of each individual in the company. Finalists say they treasure each one of their TCS memories. It is worth remembering time and again, even forever.

Questions

What is the most important asset of a company? How does Motorola ensure maintaining this asset?
Describe the role of cross-functional teams in the process of quality improvement. What are some of the actions taken by Motorola to promote such teams?
Discuss the advantages to be gained by companies conducting TCS-type competitions.
Discuss the importance of organizational culture and its adoption at all levels in striving for quality improvement.
Discuss how Motorola motivates its employees to strive for continuous improvement.