Article -1: Six Sigma Basics:

by G.K.K. Singh

Six Sigma is a management system developed by Motorola in 1986-87. It focuses on improving the way of doing a process rather than concentrating on the output, which is only an outcome of how things are done.

Six Sigma is uniquely driven by parameters like:

a) Developing a close understanding of customer needs,

b) Working in cross-functional teams,

c) Relying more on prevention than inspection as a methodology for reducing defects,

d) Using facts, data, and statistical analysis for a better understanding of the processes,

e) Careful attention to managing, improving, and reinventing business processes.

The methodology relies on a number of tools and techniques like flow-charts, process-maps, pareto analysis, root-cause analysis, risk-assessment, risk reduction, hypothesis-testing, and establishing co-relation of the process output with the inputs. This helps the improvement teams to understand the way the organization's processes are happening and then find ways to improve the processes.

Six Sigma methodology uses **DMAIC as a proven-framework** for problem-solving and process-improvement:

Define:

• The problem statement,

• The goal statement,

• The scope of the process-improvement project,

• Form the project team,

• Finalize date-wise plan for the process-improvement project.

Measure:

You cannot improve anything that you cannot measure. To know where we want to go, we must know where we are today. So, this phase involves:

• Decide how you will measure current performance,

• Calibrate the measurement system,

• Measure current performance.

Analyze:

In this phase, we analyze the data related to current performance of the process, such as:

• Root causes that lead to occurrence of defects / mistakes,

• Causes of variation in the process – why we are not being able to achieve consistency,

• Causes that lead to waste and re-work in the process,

• Likely solutions that would help us to remove the above causes.

Improve:

This phase involves:

• Brainstorming, to arrive at the best solution,

• Risk-assessment & risk-reduction in respect of the chosen solution, before implementation,

• Implementing the chosen solution on a trial basis – verification,

• Fine-tuning the solution after verification,

• Fully implementing the fine-tuned solution – validation.

Control:

Greatest challenge after an improvement is to sustain the improvement. Control phase is to ensure sustenance of the improvement achieved. It involves aspects like:

• Documenting the changes made in the process,

• Training people on the changes,

• Using Control Charts to monitor the process performance on an on-going basis.

Most six sigma projects end in profit improvement and this is one of the measurements of process-improvement because whenever we reduce defects / re-work or wastage, it should result in savings / contribution to profit-improvement.

In recent years, adoption of Six Sigma Management System has increased phenomenally. **Today 53 % of Fortune-500 companies are using Six Sigma --and that figure rises to 82 % when you look at just the Fortune-100.**

It is seen that if an organization invests time and money on six sigma training and implementation, it usually ends up in achieving savings which would be 20 to 50 times of the investment made. Moreover, with reduction of defects the frustration of internal stakeholders drops and satisfaction of external customers improves substantially.

Article-2: Six Sigma Implementation - Role of Training

by G.K.K. Singh

The **traditional way** of looking at quality has been that “quality cannot be measured”, and “error in work is inevitable”.

At the end of the second world war, the quality of products manufactured in Japan was atrocious. At this juncture, the Japanese decided to change this scenario. They visited many industries in USA to study their approach to quality. They also invited experts like Dr. Deming and Dr. Juran to help them. These experts focused on enlightening the top management about their responsibility in respect of quality and training engineers on tools like statistical process control and design of experiments. Their efforts resulted in spectacular improvements and **by 1980 even the Americans preferred to buy Japanese products** due to better quality offered by them at a more competitive price.

By 1985, survival became a major issue for many American organizations against the onslaught of Japanese competition. One such organization which was at great risk was Motorola. **In an effort for survival, Motorola evolved and implemented the six sigma management system for the first time in the world.**

This system of management included lessons learnt from the successes achieved by Dr. Deming and Dr. Juran in Japan as also a **methodology of quantifying quality**. Till such time, quality was considered as “unmeasureable” and only talked of in terms of “excellent”, “world-class”, etc.

The six sigma management system made a major difference to the future of Motorola

Key Themes in Six Sigma:

Every functional area (department) is viewed as a supplier to another department whose requirements must be satisfied. So, the starting point is the “customer” – to find the critical requirements of every internal and external customer and finding ways to satisfy him.

For example, one of the internal customers for an HR Manager is the Production Manager or the Operations Manager. A critical requirement of this internal customer is that vacancies must be filled within, say, 30 days from time of placing the request. Another requirement would be that induction-training of new employees results in their settling fast on the job. If the HR Manager has identified these requirements of his internal customers, then he is more likely to fulfill them.

Each and **every activity in the organization is viewed as a process** represented by the function Y = f(X1, X2, X3,……Xn), where Y is the output (result) to be achieved from that activity. The X1, X2, X3 ……Xn are viewed as inputs to the process. In six sigma, we use statistical methods to find out what would be the optimum values of the inputs X1, X2, X3, ……. Xn which would help us to achieve the most effective result. By repeating these values for the inputs, we can be assured of the same (consistent) output from the process. In the above example, building a data bank would be an important X1 as input to the recruitment process.

In today’s environment of fierce competition, an external customer needs to be satisfied on various counts which include: providing the required specifications, giving prompt support before and after the sale, pricing the product competitively and meeting the timelines specified by the customer. All these outputs are possible only if a **boundary-less**

cooperation exists between the different departments. Thus, six sigma lays very heavy emphasis on cross-functional cooperation.

Six sigma requires employees to question existing practices and ways of doing tasks, with the idea of reducing the idle-time and other wastes in the processes and making them far more efficient. Instead of people reactively bouncing from crisis to crisis (and looking busy), **six sigma talks of creative thinking to achieve prevention and continual improvement** in the organization's processes.

Six sigma has adopted the **balanced scorecard model** of Robert Kaplan and David Norton whereby the organization focuses not only on parameters of financial- performance but also on learning & development of people, strengthening of internal business processes and maximizing customer satisfaction.

Six sigma implementation is **always carried out in teams** who work on projects with unknown solutions. Typically, the senior management selects areas of pain for the organization and these are taken up as projects by teams consisting of a Champion, a Black Belt and a number of Green Belts. (Reportedly, these titles were coined by a Motorola improvement expert with a passion for karate). Every project must result in reduction of errors / defects, or elimination of waste, or increase of customer satisfaction **ultimately ending in profit-improvement for the organization.**

Organizations like Asian Paints, Birlasoft, Citibank, GE Capital, IBM, ICICI Bank, LG Electronics, Marico, Patni Computers, Samtel, SKF, TCS, Tracmail, and Wipro are among the many who have embraced six sigma management system in recent years and improved their profitability tremendously.

Role of Training in Six Sigma Implementation:

From the above it is clear that implementation of six sigma requires training of employees as Black belts, Green Belts and Yellow Belts.

While the Black Belts and Green Belts may account for about 10 % of the total employee strength, **priming a large mass of the remaining personnel** through Yellow Belt (Foundation Level) training will help in creating widespread support for implementing six sigma.

Another important aspect is to bring about **major cultural changes** in the organization whereby people learn to make decisions based on analysis of data, think pro-actively and question existing practices without fear.

For these reasons, the major investment in implementing six sigma is in training the personnel. Once this is achieved effectively, the organization can **look forward to progressively execute successful six sigma projects and improve profitability on an on-going basis.**

BASIC STATISTICS

✓ ***(Participant is required to study this section on his own and practice the exercises at the end of the Section. The same will later be discussed during the training)***

1. Understanding Variation:

Consider the **situation-1** below:

- You went grocery shopping only to select the slowest cash counter in the store,
- You received a haircut that was shorter or longer than usual, and definitely not what you asked for,
- You decided to go shoe shopping, but got stuck with the most ignorant salesperson available.

Consider the **situation-2** below:

- You went grocery shopping and reached the fastest cash counter in the store,
- You received a haircut that was exactly as you wanted,
- You decided to go shoe shopping, and met the best salesperson in the shop .

Sure, are you happy about being in situation – 2, but what about the times when you are in situation – 1? Often we wonder why this variation?

Let's examine a few ways to help us evaluate **variation in processes**:

Lets say that on your way home you stop at your local pizza shop to order a pizza that you (and your family) are waiting for. We will consider the general concept of variation by examining the preparation time (in minutes) of 10 pizzas being prepared by the two local shops. The times are listed below.

ABC Pizza	6.5	6.6	6.7	6.8	6.8	6.9	7.0	7.1	7.2	7.3
XYZ Pizza	4.2	5.4	5.8	6.2	6.7	7.2	7.2	8.5	9.3	10.0

If we use common statistical tools, such as mean, median, and mode we get the following results.

1.1 Mean:

The mean is the **average data point** value within a data set.

To calculate the mean, add all of the individual data points then divide that figure by the total number of data points.

Calculating the mean (x-bar) in both cases, we get

- Mean for ABC Pizza = 6.89
- Mean for XYZ Pizza = 7.05.

1.2 Median:

Relating to or constituting the **middle value** in a distribution.

The median is the middle point of a data set; 50% of the values are below this point, and 50% are above this point. Median is the middle value, when all possible values are listed in an ascending order.

(If number of **data points (n) is even**, then median is the average of the n/2 th and (n/2 +1) th
reading. If number of **data points (n) is odd**, then median is the (n + 1)/2 th reading).

In this example, median will be average of the 5^{th} and 6^{th} reading.

Calculating the median in both cases, we get

- Median for ABC Pizza = 6.85
- Median for XYZ Pizza = 6.95.

1.3 Mode:

The value or item occurring most frequently in a series of observations or statistical data.

The most often occurring value in the data set. So, the mode in both cases will be:

- Mode for ABC Pizza = 6.8
- Mode for XYZ Pizza = 7.2

	ABC Pizza	XYZ Pizza
Mean	6.89	7.05
Median	6.85	6.95
Mode	6.8	7.2

You can see from these results that the two pizza shops have the same measures of central tendency. So, on an average, customers wait for the same amount of time for pizzas at the two shops.

Based on these measurements, can we see any distinguishable difference between the two processes? NO, NOT MUCH!!

In the above example, however, we can see a very distinguishable difference: ABC Pizza has preparation times with much less variation than the times for XYZ Pizza.

(If all the other characteristics of the pizza like taste, temperature, size and topping quality are equal, a customer is likely to prefer ABC Pizza where he will not become annoyed by being the one person whose pizza preparation time is much slower than the others).

In other words, variation is what customers do not like. Therefore, in six sigma the most important goal is to reduce variation.

1.4 Range:

The easiest way to measure variation in a process is the **range**. It is simply the difference between the highest value and the lowest value among the data points.

By inspecting and comparing the differences in variation between the preparation times of the two pizza companies, we can get an idea of the variation. But in business, we need more than an idea - we need to measure and quantify the process - variation.

Range and standard – deviation are typical measures of variation in a process.

Range in these 2 cases will be:

- Range for ABC Pizza = 0.8
- Range for XYZ Pizza = 5.8

ABC Pizza	6.5	6.6	6.7	6.8	6.8	6.9	7.0	7.1	7.2	7.3
XYZ Pizza	4.2	5.4	5.8	6.2	6.7	7.2	7.2	8.5	9.3	10.0

For the ABC Pizza data, the range is the difference between 7.3 minutes and 6.5 minutes,
which is **0.8 minutes**.

The range for XYZ Pizza preparation time is 10.0 - 4.2 = **5.8 minutes**.

The much larger range in case of XYZ Pizza shows that their process has a much larger variation than the ABC Pizza.

1.5 Standard Deviation as a measure of Process Variation:

The standard deviation (*s*) of a set of sample data is a measure of variation of the data as compared to the mean, and is defined by the following formula:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

Using this formula we can now compare the variation of the two pizza companies and note that

Standard Deviation in these 2 cases will be:

- Standard Deviation for ABC Pizza **= <u>0.26</u>**
- Standard Deviation for XYZ Pizza **= <u>1.8</u>**

Thus the standard deviation for ABC Pizza (**0.26 minutes**) is much lower than the standard deviation for XYZ Pizza (**1.8 minutes**). In other words, the variation in ABC Pizza process is much less than the variation in the XYZ Pizza process.

In our definition of standard deviation, we have referred to the **standard deviation of sample data as *s*.**

If we want to calculate the **standard deviation (σ) of a population**, we would divide by the population size *N*, instead of *n*-1.

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{N}}$$

Exercises:

Calculate the Mean, Median, Mode, Range and Standard Deviation in respect of the following data:

(Hint: First arrange the data in ascending order)

1. Heights of 20 persons in a room (in cms):

   165, 165, 165, 158, 158, 158, 160, 160, 155, 157,
   163, 163,163, 163, 169, 169, 160, 160, 175, 160.

2. Weights of 21 persons in a room (in Kgs):

   67, 67, 67, 60, 60, 60, 62, 62, 57, 59, 65,
   65, 65, 65, 71, 71, 62, 62, 77, 62, 78

3. Time taken by a call center executive to resolve problems of 15 customers: (in minutes)

   3.1, 3.1, 3.7, 3.7, 3.7, 4.2, 2.1, 2.3, 2.3, 2.7, 2.7, 2.7, 3.1, 3.1, 3.1

Article -3: A History of Managing for Quality in the United States by Dr. J.M.Juran

Until the voyage of discovery by Christopher Columbus in 1492, the North American continent was populated by numerous native American tribes. These tribes mostly lived off the land as food gatherers, farmers, fishermen, and hunters.

What is now the United States was colonized mainly by Great Britain, Spain and France. These European countries subdued the natives through superior weaponry and took possession of the continent. In due course, the colonists revolted against foreign rule, declared their independence in 1776 and formed the United States of America.

Following independence, the United States became a haven for large numbers of immigrants, at first mainly from Great Britain and northern Europe, and later from southern and eastern Europe. It also expanded its territory, by purchase and conquest, to reach its present boundaries.

Early systems of managing for quality:

The origins of managing for quality in the United States are to be found in Europe rather than in North America. At first, the principal industries in the colonies were agriculture plus production for self-use. The British government favored retaining for the British Isles the roles of manufacture and sale of finished goods while using the colonies as a source of materials and as a captive market for manufactured goods. The colonists resisted these restricted roles and sought to create their own manufacturing capabilities.

The early colonists and immigrants also faced the problems and opportunities associated with exploiting the immense natural resources of their new world. An innovative spirit emerged and became a driving force when the new nation undertook to industrialize. Self-reliance and risk taking became major and respected traditions. These traditions in turn raised individualism and entrepreneurship to a state of respect.

Craftsmanship:

In their approach to manufacture, the colonists and immigrants tended to follow the craftsmanship concept prevailing in their respective European countries of origin. A boy learned a skilled trade as an apprentice to a master. The master trained the apprentice in how to produce the product. The master also maintained a form of quality control by inspecting the goods before sale.

Once the apprentice had learned his trade, he became self-employed or employed by the master of a small shop. Quality under craftsmanship was usually in good hands -- the hands of the craftsmen. Achievement of quality was one of the essential skills learned by the apprentice. Most goods were sold locally, so the craftsman had a large personal stake in meeting his customers' needs for quality.

The Industrial Revolution:

The Industrial Revolution, which originated in Europe, created the factory system. The factory system usually subdivided former trades into multiple, specialized tasks. It soon out-produced the craftsmen and the small independent shops, and made them obsolete. It forced many craftsmen to become factory workers, and many shop owners to become production supervisors. (The factories employed many semiskilled and unskilled workers as well).

Managing for quality remained a production function:

Large production departments employed full-time inspectors, who reported to the respective production supervisors. Quality was assured through the skills of the workers, supplemented by supervisory audit or by departmental inspectors. When the Industrial Revolution was exported from Europe to North America, the United States again followed European practice, with further damage to craftsmanship.

The Taylor system and its impact:

Late in the 19th century, the United States broke sharply with European tradition by adopting Frederick W. Taylor's system of scientific management. Taylor's goal was to increase production and productivity without increasing the number of skilled craftsmen. His concept was to separate planning from execution.

In those days, planning of factory work was done largely by factory supervisors and workers who, in Taylor's view, lacked the necessary technological literacy. Taylor's solution was to assign the planning to engineers and to limit the supervisors and workers to executing the plans. This approach became the basis for a remarkable rise in productivity. In fact, the Taylor system was a major contributor to making the United States the world leader in productivity.

The emergence of independent inspection departments:

The Taylor system also had negative consequences. The new emphasis on productivity had a negative effect on quality. To restore the balance, factory managers created central inspection departments, headed by a chief inspector.

The various departmental inspectors were then transferred to the new inspection departments. This was done with the bitter opposition of the production supervisors.

The major job of the new inspection departments was to keep defective products from reaching the customers. This was done by inspection in various forms. Raw materials and goods in process were commonly sampled. The results of the sampling determined the disposition of the lot. Finished goods were usually detail-inspected to separate the good from the bad.

In many companies, the assignment of responsibility for quality took a curious turn. If defective goods did get out to clients, it was common for the upper managers to ask the chief inspector, "Why did you let this get out?" It was less common to ask the production manager, "Why did you make it this way?"

In due course, there evolved a widely held belief that quality was the responsibility of the inspection department.

Quality during World War II:

U.S. involvement in World War II began as a supplier to the Allies during the late 1930s. The Japanese attack on Pearl Harbour in December 1941 then brought the United States into the war as a combatant. Legislation was enacted to put the country on a war footing. A War Production Board was created to gear the civilian economy to the war machine and to produce enormous quantities of military products, many of which used new, sophisticated technology.

Regulations were established to give the war effort priority in allocation of facilities, materials, skilled personnel and services of all sorts. Production of a wide range of civilian products came to a halt. These included automobiles, household appliances, entertainment products and many others. A massive shortage of civilian goods developed while defence factory employees were working overtime and building up a great hoard of purchasing power.

The effect on quality of military products:

The traditional approach had been to award military contracts based on competitive bidding, the contract usually going to the lowest bidder. Upon delivery, the products were inspected and tested for conformance to specifications. **Often this involved inspecting and testing every single unit of product.**

This same basic approach was retained during World War II. It required a huge expansion of the inspection forces, with massive problems in recruitment, training, employee turnover and so on. The armed forces tried to reduce these problems by greater use of sampling inspection. In doing so, they decided to replace their empirical ways of sampling with methods based on the laws of probability.

Despite this progress in improving the inspection process, the top priority was on meeting the delivery schedules. This was underscored by the system of awarding the coveted Army-Navy "E" to government contractors. **The award was for meeting delivery schedules.**

The effect on quality of civilian products:

World War II ended in 1945, but meanwhile a massive shortage of goods had built up. It then took the rest of that decade to refill the pipelines and for supply to catch up with demand. During those years, the quality of products declined severely (quality always goes down during shortages.) The traditional, experienced manufacturers gave top priority to volume of production in order to secure maximum share of market. The shortage also attracted new competitors, and their inexperience contributed further to the decline in quality.

The most subtle effect of the shortages was to create a habit of giving top priority to meeting schedules. As the years went on, this priority found its way into company policies and procedures. This resulted in the formation of a habit of giving top priority to delivery dates, which persisted long after the shortages were gone. The role of the Quality –Control inspectors became unimportant in this scenario and quality suffered for many years.

Managing for quality at mid-20th century:

By the middle of the 20th century, managing for quality in the United States was carried out largely as follows:

* Each functional department in the company carried out its assigned function and then handed off the result to the next function in the sequence. This was often called "throwing it over the wall."

* At the end of the sequence, the quality department separated the good products from the bad.

* For defective products that escaped to the customer, redress was to be provided through customer service based on warranties.

This approach contained numerous deficiencies, such as:

* Training in how to manage for quality was limited to members of the quality department.

* Quality had top priority in the quality department, but not in other departments.

* The over-the-wall concept permitted departments unilaterally to create quality problems for their customers, internal and external.

* This kind of reliance on inspection and testing fostered the belief that quality was the responsibility of the quality department.

* The upper managers were detached from the quality function. In their mind, they had delegated quality to the quality managers.

*** There was no organized approach for quality improvement -- for improving the processes so as to reduce the incidence of defects and field failures. The responsibility for prevention was vague.**

Despite the deficiencies inherent in this concept, many U.S. goods came to be well-regarded as to quality. In some product lines, U.S. companies became the quality leaders.

In addition, the U.S. economy grew to super-power size. The domestic economy was unified by the laws governing movement of goods in interstate commerce; these laws avoided the obstacles inherent in the national boundaries then prevailing in Western Europe. The American belief in a market-based economy and the spirit of entrepreneurship stimulated investment to bring new and improved products to market. Additionally, managers were willing to invest in facilities to improve productivity. Some of those investments (for example, in machines, tools and instruments) improved quality as well.

The emerging forces

During the second half of the 20th century, some massive forces emerged to challenge the adequacy of quality in the United States. The chief forces included:

* The growth of consumerism. Consumerism is a popular name for the movement to help consumers solve their problems through collective action.

* The growth of legislation in respect of unfair or deceptive practices in commerce.

* The growth of government regulation of quality such as the right to investigate product failures, user complaints, inspect the companies' processes and systems, test products in all stages of distribution and inform users of deficiencies.

* The Japanese quality revolution.

The Japanese quality revolution and its impact:

The major manufacturers in Japan, who had been extensively involved in military production, converted to civilian products after the second world war. They then found that **a major obstacle to selling these products in international markets was Japan's reputation as an exporter of shoddy goods.**

This major obstacle convinced the Japanese of the need to improve their quality reputation. The shock of losing the war made them willing to explore new ways of thinking about quality, including learning from other countries. They sent teams abroad to visit foreign companies and study their approaches to managing for quality. They translated selected foreign literature into Japanese. They invited foreign lecturers to come to Japan and conduct training courses.

These lecturers, Dr. Edwards Deming on statistical methods and Dr. J.M. Juran on managing for quality, provided courses that became influential inputs to the quality revolution in Japan.

Building on these and other inputs, the Japanese adopted some unprecedented strategies for creating their revolution in quality:

The **senior managers personally took charge of leading the quality revolution**. The companies trained their engineers and the work force in how to use statistical methods as an aid to control of quality.

They trained the entire managerial hierarchy in how to manage for quality and undertook quality improvement at a revolutionary rate, year after year. They evolved the **QC circle concept** to enable the work force to participate in quality improvement. They enlarged their business plans to include quality goals.

During the 1960s and 1970s, many Japanese manufacturers greatly increased their share of the U.S. market. A major reason was superior quality. Numerous industries were impacted: consumer electronics, automobiles, steel, machine tools and so on.

The impact of the Japanese exports on the United States was considerable. Consumers benefited greatly by access to goods of superior quality at competitive and even lower prices. However, great damage was done to other areas of the U.S. economy: The impacted manufacturing companies were damaged by the resulting loss of market share. The work force and the unions were damaged by the resulting

export of jobs. The national economy was damaged by the resulting unfavorable trade balances. Collectively, these impacts called for responsive action.

In due course, U.S. managers evolved responses to those massive forces, but not before much damage had been done to the economy.

Responses to the Japanese quality revolution-Price competition:

In the early post-war period, the impacted U.S. companies logically considered Japanese competition to be in price rather than in quality. (Japanese wages were far below those in the United States.) So one major response was to move the production of labor-intensive products to low-wage areas, often off-shore.

Block the imports:

Some of the impacted companies tried to solve their problem by blocking the imports. They urged legislation that would establish restrictive import quotas and tariffs. They filed civil lawsuits on the grounds of unfair trade practices. They appealed to the public to "Buy American."

These efforts yielded some relief but did nothing to improve U.S. capability in terms of quality.

Lack of early warning:

As the years unfolded, price competition declined while quality competition increased. At the outset, Western companies were clearly the quality leaders. Moreover, they continually improved their products, but at a gradual rate.

In contrast, Japanese automotive quality was at the outset well below that of the West. However, the Japanese undertook to improve their quality at a revolutionary rate, enabling them to overtake the West during the mid-1970s.

The U.S. senior managers were generally unaware of these trends. The reports available to them consisted mainly of financial information. In those days, the executive instrument panels lacked information on customer satisfaction, competitive quality, cost of poor quality and the like. **So the managers continued to believe that Japanese competition was primarily price competition rather than quality competition.**

The major initiatives of the 1980s:

By the end of the 1970s, the U.S. quality crisis had reached major proportions. It attracted the attention of national legislators and administrators. It was featured prominently in the media- it was regularly on the front page. It increasingly forced company CEO's to provide personal leadership in managing for quality.

During the 1980s, a great many U.S. companies undertook initiatives to deal with the quality crisis. These initiatives focused largely on three strategies: exhortation, project-by-project quality improvement and statistical process control.

Exhortation:

Some consultants proposed a sweeping solution by exhorting the work force to make no mistakes, "Do it right the first time." This simplistic approach was persuasive to those managers who, at the time, believed that the primary cause of their company's quality problems was the carelessness and indifference of the work force. Actually, the bulk of the quality problems had their origin in the

managerial and technological processes. In due course, this approach was abandoned, as an ineffective one.

Quality improvement, project by project:

One of the consulting companies, Juran Institute Inc., created and published a series of videos titled Juran on Quality Improvement. These were tested by many companies. Some achieved notable quality improvements; others did not. **The decisive variable was the extent of personal leadership provided by the senior managers**.

Wave of Statistical Process Control:

The 1980s also witnessed a broad movement to train company personnel in application of statistical methods to quality problems. The stimulus came from a widely viewed video titled “If Japan Can, Why Can't We?”

It implied strongly that Japanese success in quality had resulted solely from use of statistical methods. The video helped persuade many companies to train numerous employees in basic statistical methods. Such training had merit - it provided trainees with a useful set of tools. Yet it was premature. It was done before the companies had defined their quality goals and the strategies needed to reach those goals. In a sense, the personnel were trained in remedies when the diseases were not yet known.

During the 1980s, many US companies limited their quality initiative to SPC, assuming it to be “the solution”. **These companies lost precious years before learning that quality leadership comes from a mixture of strategies, no single methodology is the magic.**

Results of the initiatives of the 1980s:

In retrospect, the results of the quality initiatives of the 1980s were deeply disappointing. Most of the initiatives fell well short of their goals. The disappointing results were due mainly to poor choice of strategies and poor execution of valid strategies. In turn, these were largely traceable to the limitations of leadership by senior managers, who lacked training and experience in managing for quality.

The role models:

However, during the same disappointing decade, **a few companies’ initiatives achieved stunning results.** Such companies attained quality leadership i.e. "world-class quality" and became the role models for the rest of the U.S. economy.

The role models were few in number. They included the Balridge Award winners plus other companies that had achieved similar results. Together they made up only a tiny part of the U.S. economy. **Yet there were enough of these companies to prove that world-class quality is attainable within the U.S. culture.**

The **successes achieved by the role-model companies stimulated great interest among senior managers and others who sought to learn how such stunning results had been achi**eved. The role models were quite willing to share information about the strategies they had used to achieve those results. In addition, they took steps to share the lessons learned through company visits, conferences, publications and so on.

Lessons learned:

Each role model is different. In groping for ways to attain world-class quality, each serves as a laboratory, testing out various strategies, adopting some, modifying others, rejecting still others.

Nevertheless, **analyzing these collections shows that they include considerable commonality**. There is a core list of strategies that achieved adoption by most of the role model companies. These core strategies deserve careful study. They form the central body of lessons learned.

Customer focus:

All role models adopted the concept that the customer has the last word on quality. Adoption of this concept then led to intensified action to identify: who are the customers, internal as well as external; what are the customers' needs; what product features are required to meet those needs; how do customers decide which of the competing products to buy; and so on.

For example, it is now widely recognized that many past quality problems can be traced to failure to meet the needs of internal customers. The customer focus concept led to broader acceptance of the participation concept i.e. “internal customers should participate in those planning activities that will impact the quality of their operations.”

Senior managers in charge:

One element present in all successes and absent in most failures was the personal involvement of the top management.

In effect, the senior managers took charge of quality **by accepting responsibility for certain roles** like:

* Establishing the quality goals,

* Providing the needed resources,

* Providing the quality-oriented training,

* Stimulating quality improvement,

* Reviewing progress,

* Give recognition to performers.

The lessons learned from the role models are that the above roles cannot be delegated. They must be carried out by the senior managers personally.

Strategic quality planning:

The role models recognized that the new priority given to quality **required that the business plan included quality-related goals.**

These goals are then deployed to identify the actions and resources needed, to establish responsibility for taking the actions, and so on. The resulting plans are similar to those used for meeting goals for sales and profits. A common name for this concept is strategic quality planning.

The concept of "Big Q":

The role models grasped the concept that managing for quality should not be limited to manufacturing companies and manufacturing processes. **It should also include service companies and business processes.**

This concept broadens the area under the quality umbrella. It bears the name **"Big Q,"** to distinguish it from the traditional "little Q."

Quality improvement:

Without exception, the role models went extensively into quality improvement and most of the stunning results came from the projects to improve quality.

These projects extended to all activities under the Big Q umbrella. They reduced costs, raised productivity, shortened cycle times, improved customer service and so on.

The role models also adopted the concept that quality improvement must go on year after year - it must be woven into the company culture. To this end, **they mandated that goals for quality improvement be included in the annual business plans.**

They also redesigned the systems of recognition and reward to give added weight to performance on quality improvement.

Business process quality management (reengineering):

A major extension of quality improvement was to the area of business processes. This extension resulted from fresh thinking relative to the multifunctional processes prevalent in functional organizations.

Each horizontal macro-process consists of numerous steps or micro-processes that thread their way through multiple functions.

Every micro-process has an owner, but **there is no clear ownership of the macro-process.**

The role models concluded that **each key macro-process should have an owner, and they took action to create such owners (individuals or teams).** They also defined the responsibilities of an owner, involving responsibility for improving the macro-process. An important part of the stunning

results achieved by the role models came from improvements made in the business processes.

Measurement of quality:

Measurement of quality at the technological level has been used for many centuries.

What is new is the need for measuring quality at the business level such as, measures of customer satisfaction, competitors' quality, performance of key business processes and so on. To meet such needs often requires inventing new measures as well as creating related methods of analysis and presentation.

Benchmarking:

The benchmarking concept grew out of the need to establish quality goals based on factual analysis rather than empirical judgment. For example, in one company the warehouse takes an average of five working days to fill customers' orders. The leading competitor takes an average of three days. A company in a totally different industry takes only two days. Then the benchmarked goal becomes two days. There may well be a reaction that "It can't be done," and this may be valid as applied to the present process. However, the fact is that the goal is already being met. So the problem is then to create (or recreate) a process that can meet the benchmark.

Human resources and quality: Empowerment

As of the early 1990s, many U.S. companies still retained the separation of planning from execution inherent in the Taylor system of scientific management. As a result, those companies failed to make use of a huge underemployed asset, i.e. the education, experience and creativity of the work force. It is generally agreed that the Taylor system is obsolete and should be replaced, but there was no consensus on what should replace it.

Replacing the Taylor system required transfer of tasks from specialists and supervisors to non-supervisory workers. The word **empowerment** has become a label for such transfer, i.e. establish worker self-control. This requires providing workers with all the essentials for doing good work; means of knowing what are the quality goals; means of knowing what is the actual process performance; and means for adjusting the process in the event that quality does not conform to goals.

A state of self-control makes it possible to empower workers to make decisions on the process such as, "Is the process in conformance?" and "Should the process continue to run or should it stop?" **Ideally, the work force should make such decisions. There is no shorter feedback loop i.e. establish worker self-inspection.** This empowers workers to make decisions on whether the product conforms to the quality goals.

The concept of self-directing teams has been widely tested. The published results indicate that quality and productivity improve significantly. The ratio of workers to

managers rises sharply. Jobs cross functional lines and become team jobs. Workers become team members.

Because empowerment involves extensive transfer of work from supervisors and specialists to the work force, it can meet much cultural resistance. .

The ISO 9000 series of standards:

During the 1980s, the countries of Western Europe began to use the International Organization for Standardization's ISO 9000 series of standards as the basis for judging the adequacy of the quality assurance systems of companies.

The ISO 9000 standards define a comprehensive quality assurance system. The certification process may well get rid of the plague of multiple assessments that have burdened suppliers in the past.

Total quality management:

As the quality crisis deepened during the last half of the 20th century, more and more prerequisites were identified as essential to achieving world-class quality. A need then arose for a short label for this list of pre-requisites. As of the 1990s, the most popular label was the term total quality management, or TQM.

Although TQM became a popular label, there was no agreement on what the essential elements of TQM are.

Six Sigma Methodologies

Six Sigma involves achieving a goal of very few defects, down to 3.4 defects per million. In the past, we used to think in terms of percent defects.

For example 1 % defects is 10,000 defects per million units, a far cry from 3.4. It originally started with Bob Galvin, the former CEO of Motorola and a very ardent follower of excellence in quality. In 1987, he gave his organization the job of improving quality and reducing the defect level by an order of magnitude - to reduce it from a few percent defective to three per million.

The name Six Sigma comes from a measure of what we call process capability, measuring the inherent uniformity of the process. **One of the things that is inherent in tools used to achieve improvement under the label of Six Sigma is the concept of process capability.**

Like Motorola, GE went into quality improvement, encouraged by what Bob Galvin had done at Motorola. Jack Welch personally went into this and achieved huge savings running into the billions of dollars.

Prognosis for the 21st century:

Until the 1980s, the prognosis for the United States was gloomy. Japanese companies had successfully invaded the U.S. market with products that offered superior quality and value. The resulting public perception then became a force in its

own right, continuing to damage those U.S. companies that had been slow to respond.

During the 1980s, the quality crisis deepened despite initiatives taken by many companies. However, a small number of companies distinguished themselves by raising their quality to world-class levels.

The results they achieved have been publicized. The methods they used to get those results have also been publicized. **The fact that such results were achieved proved that world-class quality is achievable within the U.S. culture. (If those companies did it, it is "do-able".)**

More recently, some U.S. companies have narrowed or eliminated the gap between Japanese and U.S. quality. That action enabled those companies to regain some of the market share they had lost.

Of course, quality is a moving target, and competitors do not stand still. But the trend remains clear. **The revolution in quality will persist into the next century. The 20th century has been the Century of Productivity, but the 21st century will be the Century of Quality.**

:Questions:

Q1. In due course, there evolved a widely held belief that quality was the responsibility of the inspection department. What are the drawbacks of such a belief?

Q2. What was the initial response of American companies to the success of Japan in 1970's?

Q3. What lessons did the Americans learn from the "role models"?

Q4. What would be your views on the author's comment: "The 20th century has been the Century of Productivity, but the 21st century will be the Century of Quality". Why?