Model Question Paper - II

Quality Control & Quality Assurance (ETME – 402)

Prepared by- Mrs. Alka Sharma

Dr. Mohit Singh

**Note: Attempt any five questions including Q.No. 1 which is compulsory.**

Q.1 (a**) Explain TQM. (5x5)**

**(b) What is QMS?**

**(c What is meant by LTPD?**

**(d) ) What is a Sampling Plan?**

**(e Differentiate between Inspection & Quality Control?**

Ans(a) **Total quality management** (**TQM**) consists of organization-wide efforts to install and make permanent a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers. While there is no widely agreed-upon approach, TQM efforts typically draw heavily on the previously developed tools and techniques of [quality control](http://en.wikipedia.org/wiki/Quality_control). TQM enjoyed widespread attention during the late 1980s and early 1990s before being overshadowed by [ISO 9000](http://en.wikipedia.org/wiki/ISO_9000), [Lean manufacturing](http://en.wikipedia.org/wiki/Lean_manufacturing), and [Six Sigma](http://en.wikipedia.org/wiki/Six_Sigma).

There is no widespread agreement as to what TQM is and what actions it requires of organizations, however a review of the original United States Navy effort gives a rough understanding of what is involved in TQM.

The key concepts in the TQM effort undertaken by the Navy in the 1980s include:

* "Quality is defined by customers' requirements."
* "Top management has direct responsibility for quality improvement."
* "Increased quality comes from systematic analysis and improvement of work processes."
* "Quality improvement is a continuous effort and conducted throughout the organization."

The Navy used the following tools and techniques:

* The [PDCA](http://en.wikipedia.org/wiki/PDCA) cycle to drive issues to resolution
* *Ad hoc* cross-functional teams (similar to [quality circles](http://en.wikipedia.org/wiki/Quality_circle)) responsible for addressing immediate process issues
* Standing cross-functional teams responsible for the improvement of processes over the long term
* Active management participation through steering committees
* Use of the [Seven Basic Tools of Quality](http://en.wikipedia.org/wiki/Seven_Basic_Tools_of_Quality) to analyze quality-related issues

(b) A **quality management system** (QMS) is a collection of business processes focused on achieving your [quality policy](http://en.wikipedia.org/wiki/Quality_policy) and quality objectives — i.e. what your customer wants and needs.[[1]](http://en.wikipedia.org/wiki/Quality_management_system) It is expressed as the organizational structure, policies, procedures, processes and resources needed to implement [quality management](http://en.wikipedia.org/wiki/Quality_management). Early systems emphasized predictable outcomes of an industrial product production line, using simple statistics and random sampling. By the 20th century, labour inputs were typically the most costly inputs in most industrialized societies, so focus shifted to team cooperation and dynamics, especially the early signalling of problems via a [continuous improvement](http://en.wikipedia.org/wiki/Continuous_improvement) cycle. In the 21st century, QMS has tended to converge with [sustainability](http://en.wikipedia.org/wiki/Sustainability) and [transparency](http://en.wikipedia.org/wiki/Transparency_%28behavior%29) initiatives, as both investor and customer satisfaction and perceived quality is increasingly tied to these factors. Of all QMS regimes, the [ISO 9000](http://en.wikipedia.org/wiki/ISO_9000) family of standards is probably the most widely implemented worldwide - the [ISO 19011](http://en.wikipedia.org/wiki/ISO_19011) [audit](http://en.wikipedia.org/wiki/Audit) regime applies to both, and deals with quality and sustainability and their integration.

Other QMS, e.g. [Natural Step](http://en.wikipedia.org/wiki/Natural_Step), focus on sustainability issues and assume that other quality problems will be reduced as result of the systematic thinking, transparency, documentation and diagnostic discipline that sustainability focus implies. *See* [*sustainability*](http://en.wikipedia.org/wiki/Sustainability) *for more on this approach to quality management.*

**Elements of a Quality Management System**

* Quality Policy
* Quality Objectives
* Quality Manual
* [Organizational structure](http://en.wikipedia.org/wiki/Organizational_structure) and Responsibilities
* [Data Management](http://en.wikipedia.org/wiki/Data_Management)
* Processes - including purchasing
* Resources - including [natural resources](http://en.wikipedia.org/wiki/Natural_resources) and [human capital](http://en.wikipedia.org/wiki/Human_capital)
* Product Quality leading to [Customer satisfaction](http://en.wikipedia.org/wiki/Customer_satisfaction)
* [Continuous Improvement](http://en.wikipedia.org/wiki/Continuous_Improvement) including [Corrective and preventive action](http://en.wikipedia.org/wiki/Corrective_and_preventive_action)
* [Maintenance](http://en.wikipedia.org/wiki/Maintenance)
* [Sustainability](http://en.wikipedia.org/wiki/Sustainability) - including efficient resource use and responsible environmental operations
* Transparency and independence [audit](http://en.wikipedia.org/wiki/Audit)
* [Engineering Change Control](http://en.wikipedia.org/wiki/Change_management_%28engineering%29)

**(c)** The LTPD of a sampling plan is the level of quality routinely rejected by the sampling plan. It is generally defined as the percent defective (number of defectives per hundred units X 100%) that the sampling plan will reject 90% of the time. In other words, this is also the percent defective that will be accepted by the sampling plan at most 10% of the time. This means that lots at or worse than the LTPD are rejected at least 90% of the time and accepted at most 10% of the time.

The LTPD can be determined using the operating characteristic (OC) curve by finding that quality level on the bottom axis that corresponds to a probability of acceptance of 0.10 (10%) on the left axis.   
     
Associated with the LTPD is a confidence statement one can make. If the lot fails the sampling plan, one can state with 90% confidence that the quality level of the lot is worse than the LTPD (i.e., the defective rate of the lot > LTPD). On the other hand, if a lot passes the sampling plan, then one can state with 90% confidence that its quality level is equal to or better than the LTPD.  
     
The LTPD of the sampling plan describes what the sampling plan will reject, but it is also important to know what the sampling plan will accept. Information on what the sampling plan will accept is provided by the [AQL](http://www.siliconfareast.com/ltpd_aql2.htm) of the sampling plan.

(d) A sampling plan is a detailed outline of which measurements will be taken at what times, on which material, in what manner, and by whom. Sampling plans should be designed in such a way that the resulting data will contain a representative sample of the parameters of interest and allow for all questions, as stated in the goals, to be answered.

The steps involved in developing a sampling plan are:

* [identify the parameters to be measured, the range of possible values, and the required resolution](http://www.itl.nist.gov/div898/handbook/ppc/section3/ppc331.htm)
* [design a sampling scheme that details how and when samples will be taken](http://www.itl.nist.gov/div898/handbook/ppc/section3/ppc332.htm)
* [select sample sizes](http://www.itl.nist.gov/div898/handbook/ppc/section3/ppc333.htm)
* [design data storage formats](http://www.itl.nist.gov/div898/handbook/ppc/section3/ppc334.htm)
* [assign roles and responsibilities](http://www.itl.nist.gov/div898/handbook/ppc/section3/ppc335.htm)

Once the sampling plan has been developed, it can be verified and then passed on to the responsible parties for execution.

(e) Usually there is no difference. But both terms have slightly different meaning in different circles.

Inspection means checking the characteristics of a product to ensure that conformity to a set of specifications is met. Sometimes it means checking 100% of a batch of product; sometimes it means checking only some samples (in that latter case, it is exactly the same as "statistical quality control".

Quality control usually means only checking the conformity of products already made. It comprises inspection and other tests such as labtests. Some people use quality control to designate some more upstream activities that aim at preventing quality issues (usually these activities are called "quality assurance").

**Q2(a). Difference between quality control & quality Assurance. 6.5**

Ans. **Quality Assurance Quality Control**

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| Definition | QA is a set of activities for ensuring quality in the processes by which products are developed. | QC is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced. |
| Focus on | QA aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process. | QC aims to identify (and correct) defects in the finished product. Quality control, therefore, is a reactive process. |
| Goal | The goal of QA is to improve development and test processes so that defects do not arise when the product is being developed. | The goal of QC is to identify defects after a product is developed and before it's released. |
| How | Establish a good quality management system and the assessment of its adequacy. Periodic conformance audits of the operations of the system. | Finding & eliminating sources of quality problems through tools & equipment so that customer's requirements are continually met. |
| What | Prevention of quality problems through planned and systematic activities including documentation. | The activities or techniques used to achieve and maintain the product quality, process and service. |
| Responsibility | Everyone on the team involved in developing the product is responsible for quality assurance. | Quality control is usually the responsibility of a specific team that tests the product for defects. |
| Example | Verification is an example of QA | Validation/Software Testing is an example of QC |

**Q(b). What is an Attribute? Compare the Attribute Control Charts with Variable Control Charts? 6**

Ans. The Shewhart control chart plots quality characteristics that can be measured and expressed numerically. We measure weight, height, position, thickness, etc. If we cannot represent a particular quality characteristic numerically, or if it is impractical to do so, we then often resort to using a quality characteristic to sort or classify an item that is inspected into one of two "buckets".

An example of a common quality characteristic classification would be designating units as "conforming units" or "nonconforming units". Another quality characteristic criteria would be sorting units into "non defective" and "defective" categories. Quality characteristics of that type are called *attributes.*

Note that there is a difference between "nonconforming to an engineering specification" and "defective" -- a nonconforming unit may function just fine and be, in fact, not defective at all, while a part can be "in spec" and not fucntion as desired (i.e., be defective).

Examples of quality characteristics that are attributes are the number of failures in a production run, the proportion of malfunctioning wafers in a lot, the number of people eating in the cafeteria on a given day, etc.

Types of Attribute Control Charts

Control charts dealing with the number of *defects* or *nonconformities* are called [*c* HYPERLINK "http://www.itl.nist.gov/div898/handbook/pmc/section3/pmc331.htm" charts (for count)](http://www.itl.nist.gov/div898/handbook/pmc/section3/pmc331.htm).

Control charts dealing with the *proportion* or *fraction* of defective product are called  [*p* HYPERLINK "http://www.itl.nist.gov/div898/handbook/pmc/section3/pmc332.htm" charts (for proportion)](http://www.itl.nist.gov/div898/handbook/pmc/section3/pmc332.htm).

There is another chart which handles *defects per unit*, called the *u* chart (for unit). This applies when we wish to work with the average number of nonconformities per unit of product.

For additional references, see [Woodall (1997)](http://www.itl.nist.gov/div898/handbook/pmc/section7/pmc7.htm) which reviews papers showing examples of attribute control charting, including examples from semiconductor manufacturing such as those examining the spatial dependence of defects.

**Q3(a). Explain about quality system auditing? 8.5**

Ans. Quality system auditing can be as follows:

1.Internal audits

2.External audits

In external audits system auditing is carried out by people not belonging to the same organization and when it is conducted by customers it is called second party audits and when it conducted by certification agencies or independent registrars it is called Third party audits. The system auditing is either done for qualifying a supplier or is done for improvement of the existing system. Normally, the Quality system auditing is done as per the international standard ISO 9001 but it is possible to do the auditing as per a customer’ requirements also. For example in the automotive industry the standard TS 16949 requires the system auditing to take note of the requirements of the customers.There is an international standard for system auditing and it is called ISO 19001:2002 . It covers audit planning, competences of auditors, audit management and the communication of results.Unlike product audits, system auditing does not have any fixed sample size to audit. The auditorshave knowledge of the quality systems and they pick up trails of a particular order or a requirementand find whether the system is complied with by all the prople. If the requires are not found to becomplied, eg a wrong machine is used or a test is missed out then th auditors raise Nonconformance note called NCR .This is not a note telling the auditee what to do or complaining against any one but it is an objectiverecord of an event being found that a particular requirement is not followed.. it has three parts,1.Evidence2.Attribution of the finding to a requirement3.Explanation about the need to comply.The NCRs are signed both by the auditor and the auditee and given to management also for followup. Many companies have affixed time period within which the NCRs are to be closed and actionstaken verified by the auditor.It is usual to upgrade the competences of auditors periodically as the job calls for high degree of knowledge and familiarity with the Quality systems being audited. Many take the feedback form the auditee to monitor the fairness of the audit process

**(b) Explain about NCR?**

**Ans.** In an internal/external audit, when the auditor finds certain requirements are not followed adequately or the effectiveness lacking then he records the finding in a report called the NONCONFORMANCEREPORT. It is signed by the auditor and auditee. It has three parts.

1. The objective evidence found in the location.

2. The requirement to which it was non conforming.

3. The explanation or conclusion by the auditor with respect to the criticality of the non conformance Sometimes the NCR is categorized as minor or major by the auditor to enable the auditee to take the corrective action quickly.

**Q4 (a) Explain quality circles? What are the requirements of quality circles? 6.5**

Ans. A quality circle is a participatory management technique that enlists the help of employees in solving problems related to their own jobs. In their volume *Japanese Quality Circles and Productivity,* Joel E. Ross and William C. Ross define a quality circle as "a small group of employees doing similar or related work who meet regularly to identify, analyze, and solve product-quality and production problems and to improve general operations. The circle is a relatively autonomous unit (ideally about ten workers), usually led by a supervisor or a senior worker and organized as a work unit." Employees who participate in quality circles usually receive training in formal problem-solving methods—such as brainstorming, pareto analysis, and cause-and-effect diagrams—and then are encouraged to apply these methods to either specific or general company problems. After completing an analysis, they often present their findings to management and then handle implementation of approved solutions.

Although most commonly found in manufacturing environments, quality circles are applicable to a wide variety of business situations and problems. They are based on two ideas: that employees can often make better suggestions for improving work processes than management; and that employees are motivated by their participation in making such improvements. Thus, implemented correctly, quality circles can help a small business reduce costs, increase productivity, and improve employee morale. Other potential benefits that may be realized by a small business include greater operational efficiency, reduced absenteeisms, improved employee health and safety, and an overall better working climate. In their book *Production and Operations Management,* Howard J. Weiss and Mark E. Gershon called quality circles "the best means today for meeting the goal of designing quality into a product."

United States, the quality circle movement evolved to encompass the broader goals of cost reduction, productivity improvement, employee involvement, and problem-solving activities.

Requirements for Successful Quality Circles

First, the small business owner should be comfortable with a participative management approach. It is also important that the small business have good, cooperative labor-management relations, as well as the support of middle managers for the quality circle program. The small business owner must be willing and able to commit the time and resources needed to train the employees who will participate in the program, particularly the quality circle leaders and facilitators. It may even be necessary to hire outside facilitators if the time and expertise does not exist in-house. Some small businesses may find it helpful to establish a steering committee to provide direction and guidance for quality circle activities. Even if all these requirements are met, the small business will only benefit from quality circles if employee participation is voluntary, and if employees are allowed some input into the selection of problems to be addressed. Finally, the small business owner must allow time for the quality circles to begin achieving desired results; in some cases, it can take more than a year for expectations to be met.

But successful quality circles offer a wide variety of benefits for small businesses. For example, they serve to increase management's awareness of employee ideas, as well as employee awareness of the need for innovation within the company. Quality circles also serve to facilitate communication and increase commitment among both labor and management. In enhancing employee [satisfaction](http://www.answers.com/topic/satisfaction) through participation in decision-making, such initiatives may also improve a small business's ability to recruit and retain qualified employees. In addition, many companies find that quality circles further [teamwork](http://www.answers.com/topic/teamwork) and reduce employee resistance to change. Finally, quality circles can improve a small business's overall competitiveness by reducing costs, improving quality, and promoting innovation.

**(b) What are seven basic tools of quality? 6**

Ans. The **Seven Basic Tools of Quality** is a designation given to a fixed set of graphical techniques identified as being most helpful in [troubleshooting](http://en.wikipedia.org/wiki/Troubleshooting) issues related to [quality](http://en.wikipedia.org/wiki/Quality_%28business%29).[[1]](http://en.wikipedia.org/wiki/Seven_Basic_Tools_of_Quality) They are called *basic* because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues.[[2]](http://en.wikipedia.org/wiki/Seven_Basic_Tools_of_Quality)

The seven tools are:[[3] HYPERLINK "http://en.wikipedia.org/wiki/Seven\_Basic\_Tools\_of\_Quality"[4] HYPERLINK "http://en.wikipedia.org/wiki/Seven\_Basic\_Tools\_of\_Quality"[5]](http://en.wikipedia.org/wiki/Seven_Basic_Tools_of_Quality)

* [Cause-and-effect](http://en.wikipedia.org/wiki/Ishikawa_diagram) diagram (also known as the "fishbone" or Ishikawa diagram)
* [Check sheet](http://en.wikipedia.org/wiki/Check_sheet)
* [Control chart](http://en.wikipedia.org/wiki/Control_chart)
* [Histogram](http://en.wikipedia.org/wiki/Histogram)
* [Pareto chart](http://en.wikipedia.org/wiki/Pareto_chart)
* [Scatter diagram](http://en.wikipedia.org/wiki/Scatter_plot)
* [Stratification](http://en.wikipedia.org/wiki/Stratified_sampling) (alternately, [flow chart](http://en.wikipedia.org/wiki/Flow_chart) or [run chart](http://en.wikipedia.org/wiki/Run_chart))

The designation arose in [postwar Japan](http://en.wikipedia.org/wiki/Postwar_Japan), inspired by the seven famous weapons of [Benkei](http://en.wikipedia.org/wiki/Sait%C5%8D_Musashib%C5%8D_Benkei). It was possibly introduced by [Kaoru Ishikawa](http://en.wikipedia.org/wiki/Kaoru_Ishikawa) who in turn was influenced by a series of lectures [W. Edwards Deming](http://en.wikipedia.org/wiki/W._Edwards_Deming) had given to Japanese engineers and scientists in 1950. At that time, companies that had set about training their workforces in [statistical quality control](http://en.wikipedia.org/wiki/Quality_control) found that the complexity of the subject intimidated the vast majority of their workers and scaled back training to focus primarily on simpler methods which suffice for most quality-related issues.

The Seven Basic Tools stand in contrast to more advanced statistical methods such as [survey sampling](http://en.wikipedia.org/wiki/Survey_sampling), [acceptance sampling](http://en.wikipedia.org/wiki/Acceptance_sampling), [statistical hypothesis testing](http://en.wikipedia.org/wiki/Statistical_hypothesis_testing), [design of experiments](http://en.wikipedia.org/wiki/Design_of_experiments), [multivariate analysis](http://en.wikipedia.org/wiki/Multivariate_analysis), and various methods developed in the field of [operations research](http://en.wikipedia.org/wiki/Operations_research).

The [Project Management Institute](http://en.wikipedia.org/wiki/Project_Management_Institute) references the Seven Basic Tools in [A Guide to the Project Management Body of Knowledge](http://en.wikipedia.org/wiki/A_Guide_to_the_Project_Management_Body_of_Knowledge) as an example of a set of general tools useful for planning or controlling project quality.

**Examples**



**Q5(a) How to improve productivity? 6.5**

**Ans.**  When supervisors and other managers look for ways to boost productivity, they often start by looking at their costs per unit of output. Productivity improves when the department or organization can do as much work at a lower cost and when output rises without a cost increase. Another way to improve productivity is to improve process quality so that employees work more efficiently and do not have to spend time correcting mistakes or defects. Mistakes, errors, and rework are a drag on productivity. Poor quality can slow the output of both individuals and the firm as a whole. For that reason, one of the supervisor’s most important tasks is to think of and implement ways to get the job done right the first time.   
       Many of the quality-control strategies introduced in this chapter, such as Six Sigma, zero defects, and employee involvement, apply to productivity improvement. For example, 3M Corporation uses Six Sigma as its primary method for improving process and product quality. Beginning with processes in its factories and then turning to the efficiency of other processes, such as finance and customer service, 3M has been using Six Sigma and other programs to cut about $300 million from its costs each year.  
       Because of their direct contact with employees, supervisors play an important part in most of these initiatives. Supervisors can increase their own and their team’s or group’s productivity by understanding the goals of quality programs and their own role in achieving those goals. Through leadership and motivation, they can help employees contribute to quality goals. Finally, they can use their specific knowledge of the tasks and processes their teams perform to find unique ways to contribute to productivity.   
       To lower costs, supervisors can use a number of strategies. in These strategies are not mutually exclusive. Supervisors can get the greatest productivity by using as many of these strategies as will work. In deciding which strategies to use, supervisors should consider which will appeal to higher-level management, which will be acceptable to employees, and which involve areas within their control.   
       An important part of many of these strategies is encouraging and using employees’ ideas for saving money. Operating the machines, preparing the reports, and serving clients or customers gives employees a close-up view of how things are done, enabling them to see the shortcomings of the organization’s way of doing things. For instance, Philips Lighting charged employees with finding ways to operate more efficiently and reaped the rewards of ideas generated throughout the company. A team of packaging workers figured out how to reduce the time a lamp spends waiting to be packed from one or two days to just 15 minutes. At the same time, they determined they could pack them as well with less cardboard, and the reduction in packaging volume means the company can ship the same amount of product in 44 percent fewer trucks. Maintenance workers at the Philips plant in Salina, Kansas, improved maintenance manuals and procedures, making the workplace safer even as they increased the amount of time machinery is running properly.

**Use Budgets**   
Not surprisingly, before a supervisor can make intelligent decisions about how to trim costs, he or she has to know where the money is going. The most important source of such information is budget reports. By reviewing budget reports regularly, a supervisor can see which categories of expenses are largest and identify where the department is spending more than it budgeted. Then a supervisor should spend time with workers, observing how they use the department’s resources, including their time. The process of gathering information about costs and working with employees to identify needed improvements is part of a supervisor’s control function.

**Increase Output**   
Remember that the numerator in the productivity equation (output/input) represents what the department or organization is producing. The greater the output at a given cost, the greater the productivity. Thus, a logical way to increase productivity is to increase output without boosting costs.   
     Sometimes, by applying themselves, people can work faster or harder. Servers in a restaurant may find they can cover more tables, and factory production workers may find they can assemble more components. Of course, it is not always possible to increase output without sacrificing quality. Also, this method of improving productivity often makes employees unhappy. A supervisor who wants to boost productivity by increasing output must first ensure that the new output goals are reasonable, perhaps by including employees in the decision-making process. A supervisor must also communicate the new goals carefully, emphasizing any positive aspects of the change. For example, a supervisor might mention that if employees are more productive, the organization has a chance to remain competitive without layoffs. In the end, improving productivity by increasing output works only when employees are motivated to do more.   
      Some companies use technology to ensure productivity. Software programs that monitor e-mail and Internet usage have many uses, including applications that identify computer use that is not work related or that violates company rules. Electronic monitoring can also provide basic productivity measures such as how long order takers spend processing each customer order. The American Management Association reports that 76 percent of employers use some form of electronic monitoring, and one-fourth of companies have fired an employee for misuse of the Internet.

**Improve Methods**   
There are only limited ways of doing the same thing better or faster. Reviewing and revamping the way things are done is the basic principle of *reengineering*. Process control techniques for improving quality also can improve productivity. Kato Engineering, located in Mankato, Minnesota, used a process called *kaizen*, in which teams map the details of each work process, looking for ways to eliminate waste. The manufacturing company improved productivity in office procedures as well as factory operations. Now Kato answers requests for quotes in one-sixth the original time and processes order changes in 2 hours instead of 24.  
     A potentially powerful approach to improving methods is to give employees more control over the way they work. Much of the growth in productivity in the 1990s came from efforts such as getting production ideas from nonmanagement employees and linking rewards to high performance. Similarly, designing jobs to include variety and responsibility makes the jobs more interesting, which should motivate employees to deliver higher quality as well as work harder.   
     Like managers at all levels, supervisors should be constantly on the lookout for ways to improve methods. Some ideas will come from supervisors themselves. Employees often have excellent ideas for doing the work better because they see the problems and pitfalls of their jobs. Supervisors should keep communication channels open and actively ask for ideas.

**Reduce Overhead**   
Many departments spend more than is necessary for **overhead**, which includes rent, utilities, staff support, company cafeteria, janitorial services, and other expenses not related directly to producing goods and services. Typically, an organization allocates a share of the total overhead to each department based on the department’s overhead expenses. However, a supervisor can periodically look for sources of needless expenses, such as lights left on in unoccupied areas or messy work areas that mean extra work for the janitorial staff. By reducing these costs to the company, a supervisor ultimately reduces the amount of overhead charged to his or her department.   
     Staff departments in particular can be guilty of contributing too much to the cost of overhead by generating unnecessary paperwork. Supervisors and their employees who produce or handle reports and forms should evaluate this paperwork, whether hard copy or electronic, to make sure it is needed. Another way to reduce the amount of paper is to make sure that when a procedure calls for a form with several parts, all the parts are actually used.

**Minimize Waste**   
Waste occurs in all kinds of operations. Amedical office may order too many supplies and wind up throwing some away or taking up unnecessary storage space. Afactory may handle materials in a way that produces a lot of scrap. Asales office may make unnecessary photocopies of needlessly long proposals, contributing more to landfills than to the company’s profits.   
A costly form of waste is **idle time**, or **downtime**—time during which employees or machines are not producing goods or services. This term is used most often in manufacturing operations, but it applies to other situations as well. In a factory, idle time occurs while a machine is shut down for repairs or workers are waiting for parts. In an office, idle time occurs when employees are waiting for instructions, supplies, a computer printout, or a response to a question they asked the supervisor. In both settings, idle time may occur because jobs and work processes are poorly designed. Productivity consultant Edgar Burnett visited a factory that assigned six operators to six machines. Their work involved periodically monitoring the machine’s output and feeding in materials about every 40 minutes. Burnett quickly determined that one operator could run two machines without difficulty. Similarly, Burnett observed a receptionist who spent less than three hours a day on tasks related to receiving visitors. The company solved the problem of the receptionist’s idle time by training her to perform clerical tasks as well. In service businesses, an important way to minimize idle time is to schedule just enough employees to perform the service at any given time. To learn more about the challenges of scheduling employees fairly, see the “Supervision and Ethics” box.   
      Another form of wasted time results from **detour behavior**, which is a tactic for postponing or avoiding work. Employees and their supervisors use a wide variety of detour behavior: A supervisor enjoys a cup of coffee and the newspaper before turning to the day’s responsibilities or an employee stops by a colleague’s desk to chat. Detour behavior may be especially tempting when a person’s energy is low or a person is facing a particularly challenging or unpleasant assignment. (The opposite of detour behavior is effective time management.)   
       Wasted time may be an even more important measure of lost productivity than wasted costs. For office employees, a major cause of wasted time is spam— messages that are unrelated to work, unwanted, and often distasteful or fraudulent. Organizations are countering the problem with filtering software that searches messages and attachments for viruses and worms, inappropriate content, and other signals that a message is likely to be spam. They also are training employees to be more wary about opening e-mail attachments from unknown senders.   
      Supervisors should be on the alert for wasted time and other resources in their department. They can set a good example for effective time management and make detecting waste part of the control process. Often, employees are good sources of information on how to minimize waste. The supervisor might consider holding a contest to find the best ideas.

**(b) ) Explain six sigma concept ? 6**

Ans. **Six Sigma** is a set of techniques and tools for process improvement. It was developed by [Motorola](http://en.wikipedia.org/wiki/Motorola) in 1986 coinciding with the [Japanese asset price bubble](http://en.wikipedia.org/wiki/Japanese_asset_price_bubble) which is reflected in its terminology. [Jack Welch](http://en.wikipedia.org/wiki/Jack_Welch) made it central to his business strategy at [General Electric](http://en.wikipedia.org/wiki/General_Electric) in 1995. Today, it is used in many industrial sectors.

Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing [variability](http://en.wikipedia.org/wiki/Statistical_dispersion) in [manufacturing](http://en.wikipedia.org/wiki/Manufacturing) and [business processes](http://en.wikipedia.org/wiki/Business_process). It uses a set of [quality management](http://en.wikipedia.org/wiki/Quality_management) methods, including [statistical methods](http://en.wikipedia.org/wiki/Statistics), and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Yellow Belts", etc.) who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits. These are also core to principles of Total Quality Management (TQM) as described by [Peter Drucker](http://en.wikipedia.org/wiki/Peter_Drucker) and [Tom Peters](http://en.wikipedia.org/wiki/Tom_Peters) (particularly in his book "[In Search of Excellence](http://en.wikipedia.org/wiki/In_Search_of_Excellence)" in which he refers to the Motorola six sigma principles).

The term *Six Sigma* originated from terminology associated with **manufacturing**, specifically terms associated with statistical modeling of manufacturing [processes](http://en.wikipedia.org/wiki/Process_capability). The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defective parts/million), although, [as discussed below](http://en.wikipedia.org/wiki/Six_Sigma), this defect level corresponds to only a 4.5 sigma level. Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

**Methodologies**

Six Sigma projects follow two project methodologies inspired by [Deming](http://en.wikipedia.org/wiki/W._Edwards_Deming)'s [Plan-Do-Check-Act Cycle](http://en.wikipedia.org/wiki/PDCA). These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.

* DMAIC is used for projects aimed at improving an existing business process. DMAIC is pronounced as "duh-may-ick" (<ˌdʌ ˈmeɪ ɪk>).
* DMADV is used for projects aimed at creating new product or process designs. DMADV is pronounced as "duh-mad-vee" (<ˌdʌ ˈmæd vi>).

**DMAIC**

Main article: [DMAIC](http://en.wikipedia.org/wiki/DMAIC)

The DMAIC project methodology has five phases:

* ***D****efine* the system, the voice of the customer and their requirements, and the project goals, specifically.
* ***M****easure* key aspects of the current process and collect relevant data.
* ***A****nalyze* the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
* ***I****mprove* or optimize the current process based upon data analysis using techniques such as [design of experiments](http://en.wikipedia.org/wiki/Design_of_experiments), [poka yoke](http://en.wikipedia.org/wiki/Poka_yoke) or mistake proofing, and standard work to create a new, future state process. Set up pilot runs to establish [process capability](http://en.wikipedia.org/wiki/Process_capability).
* ***C****ontrol* the future state process to ensure that any deviations from the target are corrected before they result in defects. Implement [control systems](http://en.wikipedia.org/wiki/Control_systems) such as [statistical process control](http://en.wikipedia.org/wiki/Statistical_process_control), production boards, visual workplaces, and continuously monitor the process.

Some organizations add a ***R****ecognize* step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

**DMADV or DFSS**

Main article: [DFSS](http://en.wikipedia.org/wiki/DFSS)

The DMADV project methodology, known as DFSS ("**D**esign **F**or **S**ix **S**igma"), features five phases:

* ***D****efine* design goals that are consistent with customer demands and the enterprise strategy.
* ***M****easure* and identify CTQs (characteristics that are **C**ritical **T**o **Q**uality), product capabilities, production process capability, and risks.
* ***A****nalyze* to develop and design alternatives
* ***D****esign* an improved alternative, best suited per analysis in the previous step
* ***V****erify* the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

**Q6(a) Draw an OC Curve. Show and explain the salient points and regions of this curve? 6.5** 

The Operating Characteristic Function (also known as OC Function) is one of the most useful tools in practical statistical applications. Unfortunately, it is also under utilized and often misunderstood mainly because of confusing information. Some theoreticians think of the OC Function as the result of elaborate calculus-based manipulations, while some practitioners reduce it to a table of values, whose origins are obscure, but whose results are very useful. Missing the strong connections between theory and applications affects the use of the OC Function as the excellent design and analysis working tool that it is.  
  
The objective of this START sheet is to enhance the links between OC Function theory and its practice, by providing an overview of the theoretical background and numerical examples and practical applications. With this, the practicing engineer will hopefully gain an increased awareness of the OC's great potential as a statistical tool, a better understanding of the theory, and be better able to use the OC Function.

First, recall that the OC Function is closely associated with Acceptance Sampling procedures. For it measures the efficiency of a statistical hypothesis test designed to accept or reject a product.

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**(b) Distinguish briefly between quality of design & quality of conformance? 6**

Ans Creation of any product involves two major stages – intellectual creation and physical creation. During intellectual creation a product is conceived in the mind and a design is created and after that it is physically produced.

The term quality involves two complementary aspects, quality of design and quality of conformance. So, good quality can be attained only when both of them are controlled satisfactorily. Quality is designed into a product as much as it is built in during its production or service processes.

Quality of conformance

**Quality of conformance** is the level of the quality of product actually produced and delivered through the production or service process of the organization as per the specifications or design. When the quality of a product entirely conforms to the specification (design), the quality of conformance is deemed excellent.

Specifications are targets and tolerances determined by the designer of a product. Targets are the ideal values for which production is expected to strive; tolerances are acceptable deviations from these ideal values recognizing that it is difficult to meet the exact targets all the time due to variability in material, machine, men and process.

For example, if an engineering component manufacturer specifies the diameter of a steel pin as 2.525 + 0.005 mm, the value 2.525 is the target value and + 0.005 is the tolerance. In a similar way, in case of an Airline service, if on time arrival of a flight is specified as within 15 minutes of scheduled time, the target is scheduled time and tolerance is + 15 minutes.

The measure most commonly used for expressing the quality of conformance is fraction defective. A fraction of defect of 0 % implies that the quality of a product wholly conforms to the quality of design. Even if the quality of a design is very good and quality of conformance is poor, the product cannot give the intended service and is classified as poor quality product.

For example, in case of a service product like maintenance of law and order by governmental agencies, the quality of design is reflected in the relevant acts and rules, whereas quality of conformance depends upon the extent to which these acts and rules are complied by the enforcement agencies. In spite of having excellent rules and regulations, the quality of law and order of society cannot be rated as good, if these rules and regulations are not adhered to properly.

Fitness for use (quality of design) and conformance to specification (quality of conformance) provide the fundamental basis for managing the processes to produce quality products. Good quality can be attained only when both, quality of design and quality of conformance are good.

Quality of design

**Quality of design** is the quality which the producer or supplier is intending to offer to the customer. When the producer is making the quality of design of the product, he should take into consideration the customer's requirements in order to satisfy them with **fitness for use** of the product.

If the quality of design does not reflect the customer's requirements, the product which the producer offers him would not probably satisfy the customer, even if it does sufficiently conform to the design. Quality of design is usually indicated by completeness and correctness of specifications, drawings, catalogues, etc. and is measured with fitness for use.

**Q7 Write short notes on following** 12.5

* Defect & Defectives
* JIT
* Zero defect

Ans. (a) A defect is any nonconformance of the unit of product with the specified requirements. A defective is a unit of product which contains one or more defects. Failure to meet requirements with respect to quality characteristics are usually described in terms of defects or defectives.

Critical - A critical defect is on that judgment and experience indicate is likely to:

* result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the products; or
* prevent performance of the tactical function of a major end item. A critical defective is a unit of product that contains one or more critical defects.

Major - A major defect is one, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit of product for its intended purpose. A major defective is a unit of product that contains one or more major defects.

Minor - A minor defect is one that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit of product. A Minor defective is a unit of product that contains one or more defects.

(b)J**ust in time** (**JIT**) is a production strategy that strives to improve a business' [return on investment](http://en.wikipedia.org/wiki/Return_on_investment) by reducing in-process [inventory](http://en.wikipedia.org/wiki/Inventory) and associated [carrying costs](http://en.wikipedia.org/wiki/Carrying_cost). To meet JIT objectives, the process relies on signals or [Kanban](http://en.wikipedia.org/wiki/Kanban) (看板[**?**](http://en.wikipedia.org/wiki/Help:Installing_Japanese_character_sets), Kanban) between different points, which are involved in the process, which tell production when to make the next part. Kanban are usually 'tickets' but can be simple visual signals, such as the presence or absence of a part on a shelf. Implemented correctly, JIT focuses on continuous improvement and can improve a manufacturing organization's [return on investment](http://en.wikipedia.org/wiki/Return_on_investment), quality, and efficiency. To achieve continuous improvement key areas of focus could be flow, employee involvement and quality.

JIT relies on other elements in the inventory chain as well. For instance, its effective application cannot be independent of other key components of a [lean manufacturing](http://en.wikipedia.org/wiki/Lean_manufacturing) system or it can "end up with the opposite of the desired result." In recent years manufacturers have continued to try to hone forecasting methods such as applying a trailing 13-week average as a better predictor for JIT planning; however, some research demonstrates that basing JIT on the presumption of stability is inherently flawed.

The philosophy of JIT is simple: the storage of unused inventory is a waste of resources. JIT inventory systems expose hidden cost of keeping inventory, and are therefore not a simple solution for a company to adopt it. The company must follow an array of new methods to manage the consequences of the change. The ideas in this way of working come from many different disciplines including statistics, industrial engineering, production management, and behavioral science. The JIT inventory philosophy defines how inventory is viewed and how it relates to management.

Inventory is seen as incurring costs, or waste, instead of adding and storing value, contrary to traditional accounting. This does not mean to say JIT is implemented without an awareness that removing inventory exposes pre-existing manufacturing issues. This way of working encourages businesses to eliminate inventory that does not compensate for manufacturing process issues, and to constantly improve those processes to require less inventory. Secondly, allowing any stock habituates management to stock keeping. Management may be tempted to keep stock to hide production problems. These problems include backups at work centers, machine reliability, process variability, lack of flexibility of employees and equipment, and inadequate capacity.

In short, the Just-in-Time inventory system focus is having “the right material, at the right time, at the right place, and in the exact amount”, without the safety net of inventory. The JIT system has broad implications for implementers.

© **Zero Defects** (or **ZD**) was a management-led program to eliminate defects in industrial production that enjoyed brief popularity in American industry in the late 1960s and early 1970s. Quality expert [Philip Crosby](http://en.wikipedia.org/wiki/Philip_B._Crosby) later incorporated it into his "Absolutes of Quality Management" and it enjoyed a renaissance in the American automobile industry—as a performance goal more than as a program—in the 1990s. Although applicable to any type of enterprise, it has been primarily adopted within [supply chains](http://en.wikipedia.org/wiki/Supply_chain) wherever large volumes of components are being purchased (common items such as nuts and bolts are good examples).

Zero Defects [is] a management tool aimed at the reduction of defects through prevention. It is directed at motivating people to prevent mistakes by developing a constant, conscious desire to do their job right the first time."— *Zero Defects: A New Dimension in Quality Assurance*

Zero Defects seeks to directly reverse the attitude that the amount of mistakes a worker makes doesn't matter since inspectors will catch them before they reach the customer. This stands in contrast to activities that affect the worker directly, such as receiving a paycheck in the correct amount. Zero Defects involves [reconditioning](http://en.wikipedia.org/wiki/Social_conditioning) the worker "to take a personal interest in everything he does by convincing him that his job is just as important as the task of the doctor or the dentist."[[1]](http://en.wikipedia.org/wiki/Zero_Defects):4