1.1 WHAT IS QUALITY?

Quality has been universally acclaimed as fitness for use, signifying the supremacy of the user in judging its adequacy. For instance it is for the user to decide how good a product is. Only the wearer knows where the shoe pinches. Likewise the user can tell how good is a pencil, a mixer grinder or a gear. Further, whether he is satisfied with the electric supply, its voltage including its stability and continuity.

- It refers to all types and sizes of products and services and in fact any activity. Product hence forth shall include service also.
- It is a composite result of a satisfactory design and its conformance.
- Conformance to specification(s) of product parameter(s) is (are) indirect approximate means of forecasting adequacy of product to satisfy the intended use. Product parameters include chemical, durability, mechanical, physical and allied properties. Like appearance, availability, brightness, colour (shade), composition, cost, diameter, ease of maintenance and replacement, fastness of colour, hardness, odour, purity, safety, timely delivery at desired place. This list is not exhaustive.
- Quality therefore encompasses all features like:
  Appearance : that influences first sale.
  Functional : that causes repeat sales and
  Reliability : including availability and maintainability that sustains the market to ensure growth for survival. Lack of it is fatal sooner than later. Availability implies that the gadget works when operated or switched on while maintainability implies that repair, as and when it becomes necessary, is easy, economical and quick.

- Formal definition by International Organisation for Standardisation (ISO) read as:

  Totality of features and characteristics of a product or service that bear on its ability to satisfy stated and implied needs.

  It now reads as

  Degree to which a set of inherent characteristics fulfils requirements.

The preceding discussions only vindicate the above statement.
1.2 WHY QUALITY?

Consider mixer/grinder, for instance. A housewife shall be tempted to buy it, if it looks nice. She buys one, takes it home and operates it. It may not function as expected. She tells others about her experience. This message spreads like a wild fire and puts brake on its further sale. On the contrary, if she is satisfied, sharing her experience with others, will promote repeat sales. Further, as and when the service becomes necessary, it is reliable and effective life cycle cost is competitive, the organization not only sustains the market but is also able to ensure healthy growth rate. This generates more employment opportunities and hence prosperity for the society.

Quality indeed makes a difference between success and failure. Thus quality is necessary for survival, though survival is not mandatory.

1.3 WHAT ARE THE MEASURES OF QUALITY?

Some of the key indices of quality achievement are:

- Degree of satisfaction as reported by the user, Market complaints and Returns.
- Productivity Indices, namely Ratio of Conforming Output to each Input.
  
  Inputs include both direct and indirect. For example, energy, equipment, human resource, raw materials, and the invisible yet instantly perishable time. Each index needs to be monitored appropriately.
- Ratio of Ideal versus Actual costs of production.
  
  The Ideal cost of production is estimated under the assumption of Zero Wastage of inputs from conception of product to its fruition by doing every thing Right First Time.
- Measurement of Quality is the Price of Non-conformance.
  
  Account for every thing that need not have been done or would have been avoided if every thing were done the right way in the first instance and consider that as the Price of Non-conformance.
  
  Therefore, negatively, it is measured by the people with vision, as the loss that is caused to the society by the lack of quality or imperfection in the product delivered or service rendered.
  
  Imagine a Power House generating power lower than the designed capacity. The social loss is not just the loss of revenue to the producer of power, it also includes the loss of opportunity to provide better service to the existing users, and possibly meeting extra demand domestic or industrial. The latter adds to more employment potential providing necessary thrust to enhance Gross National Product and welfare of the society.
- Quality may also be simply expressed in terms of percent non-conforming units or nonconformities. Further if the criticality of various types of non-conformities is not uniform viz; the likely potential loss or damage caused is not equal or vary considerably, then an appropriate weighted demerit score is used as an index to signify the level of quality achieved. Inspection error, classifying conforming as non-conforming and vice versa, should not exceed one tenth of Acceptable Quality Level. Ideally the quality is zero non-conformity.
- Quality of an item with respect to any one measurable parameter may be assessed by its proximity to standard or target namely specified mean (middle value of the maximum and minimum specified acceptable limits called tolerance limits).
Quality of a lot is best defined by the *pattern of proximity of deviations* of the observations *from the target* designated as zero. It should conform to the normal pattern or any other expected pattern depending upon the parameter being assessed and not violate the specified tolerance band. The process mean and standard deviation (root mean square deviation) together describe the quality. The smaller the variance (square of standard deviation) the better the quality. Ideally it ought to be zero. Instead Dr. G Taguchi’s loss function, quantified as proportional to square of deviation, expresses quality in terms of monetary loss. This successfully highlights quality imperfections even though the product may be conforming to the specified norms. This might have been the single most important factor in focusing the attention of the top management on quality as hitting the target rather than satisfying the specification. This itch probably made Japan the world leader. It is obvious that loss arrived at through *loss function* is under estimate in comparison to the visualized *social loss*.

Consider the game of hitting the bull’s eye among four players A, B, C, and D. Compare the following four emerging situations. See Figure F1.1.

(A) is hitting away from the target and the hits are spread over a wide area.
(B) is hitting the target but the hits are spread over wide area like that in (A).
(C) is off the mark like (A) but the spread is over narrower area. He has better capability than (A). His failures are due to being off the mark. His performance will be better than that of (B) if only he can correct his bias, which is considered easier than improving one’s intrinsic capability.
(D) is hitting the target and simultaneously in closer range too like (C). The performance Quality of hitting the target is best in this case.

In *defence* parlance, if one *fails* to hit the target, it survives to blow the *fatal* hit in return.

Thus quality is measured positively by the value, the user attaches to what in his perception he is receiving in return for the rupee (s) spent by him or negatively by the loss that lack of quality is likely to impart to the society.
4 THE SEVEN MAGNIFICENT SIMPLE, QUICK AND COST EFFECTIVE...

It may also be expressed by percent non-conforming units or non-conformities or by appropriate demerit score or by the proximity of the value of the parameter of interest to the target together with its spread around it.

1.4 DOES BETTER QUALITY COST MORE?

It is often believed that superior quality of design costs more because of necessary costlier inputs. This is not necessarily true. Let us consider a practical example of two well known brands of scooters in India, Vespa (Bajaj) and Lambretta (Vijay super). Both these are designed to cater to the specific travel needs of particular economic group or market segment. Yet, one of these decisively established its overall superiority in design at lower cost. More examples are possible from housing designs to satisfy the needs of the customer in all respects at lower cost. Thus it is possible to have better design at lower cost.

Like wise, it is a common belief that production of conforming product entails stoppage of process for correction of errors that reduces production and productivity and enhances cost per unit of conforming product. Thus suggesting that quality of conformance also costs more. This too, is false. Consider the consequences of having produced a non-conformity and hence a non-conforming item. It has to be either reworked or scrapped. The former requires re-handling and re-inspection, increases inventory of in-process goods and re-processing. Re-processed goods are often not as good as the originals. If, however a non-conforming unit slips the inspection system and reaches the customer, it adversely affects the market share, generates fire-fighting and might lead to even struggle for survival besides involving extra costs to compensate the customer including free replacement and fulfill the legal and statutory obligations, if any. It also places additional burden of enquiry and investigations to detect and correct the source of error and to put the appropriate fool-proof system in place, including training, to avoid its recurrence. The latter alternative of scrapping the item implies wastage of all the resources consumed and continued generation of losses till the snag causing the problem is removed. Together the total cost and associated repercussions constitute Herculean prohibitive task. Non-conformities are not free. It costs to produce these. It costs extra to eliminate these and their associated side effects. The cost of prevention of nonconformities and thereby nonconforming units should be compared with total losses, that are likely to be caused to the society by these imperfections, that shall vanish if these were avoided. Hence, quality of conformance always costs less, lack of it more.

Thus quality is always an economically viable alternative. Quality control aims at and achieves improved quality at reduced costs. This way we have best of both worlds. Utility of product or service per rupee is the real index of quality, the higher the better.

1.5 WHAT ARE QUALITY PROBLEMS?

The problems are in abundance. One needs to create a problem bank, prioritise these, organize teams with proper facilitation and empowerment to resolve these as per planned schedule.

The quality problems fall in two distinct categories. These are sporadic and chronic.

Let us look at Figure F1.2. This shows sequence of production on X- axis and quality index on Y- axis, say percent non-conformities, the lower the better. The non-conformities in
fifth batch are too low and in thirteenth batch too high to be ignored. Such occurrences here and there arise from what are termed SPORADIC problems. These have roots in lack of process control. The process is suspended and reasons for the abrupt change identified. These need to be inculcated in the former case, if economical and avoided in the latter case to benefit in either situation. These measures are parts of process control. Its organization include the following steps:

- Assess Process Capability (Variation due to Chance Causes only)
- Fix Optimal Target
- Choose Appropriate Chart
- Detect Abnormal Deviation
- Investigate the Cause
- Restore the status
- Identify Uncontrollable Assignable Factors. Monitor these and Manipulate, such among the Rest Appropriately that counter the harm-full effect adequately. Reference is invited to IS: 397 parts 0, 1, 2, 3 and 4.

Now consider another situation where a competitor organizes special studies and succeeds to improve product design that enhances product worth or process design that enhances degree of conformance and or reduces cost. See Figure F1.3. He can market his product competitively and pose challenge to others. Further his gain from this improvement is eternal for all future time to come. These situations are best described as chronic problems and approach to achieve this better level of performance is called break through. The steps to execute this programme include the following:

- Developing positive change in the attitude
- Laying down priority
- Developing and executing relevant training programmes
- Constituting Steering and Diagnostic Arms
- Bringing in desired Cultural change
- Organising Switchover to put the improved system in place
The cycle of control (of process) and break through should form a permanent feature of every organization, since quality is a journey and not a destination.

One needs to plan one's path to resolve problems in time bound programme.

Any perception, at this stage that all is well and that there is no problem, signals the start of the fatal journey. In the absence of any apparent problem, the problem of breakthrough always exists. There is always a challenge to do better and occupy the space at the top. In fact when there is no crisis that warrants fire fighting and all is peaceful, it is the best time to attempt improvement of breakthrough type, with a cool mind free of any tension whatsoever.

The problems listed in problem bank are prioritized. Once the priority list has been made, on the basis of the harm that it causes; the steps, shown in Figure F1.4, are proposed to resolve the problem on hand.

It is imperative to choose more than one appropriate indices to measure or assess the effectiveness of improvement. Often a single index can be misleading. The improvement may be taking place at the cost of some other adverse effect with overall loss increasing. For example, the inventory might increase disproportionately to the benefit accrued from enhanced availability of the material. One may begin with a couple of indices.

Having decided on the indices, one needs to go in for planning the generation of data that will help valid calculation of the indices and provide link with the causative factors.

All the tools, that form the subject matter of this booklet, learnt should be innovatively applied to analyse the data gathered to derive maximum information and chalk out a comprehensive plan of action for improvement.

Take action(s) and review the improvement attained against the projected one's.

FIGURE F1.3 Illustration of chronic problem fit for breakthrough.
The gap constitutes the basis for next iteration to repeat the cycle of activities for resolution of the problem for further improvement.

May it need be reminded, that, any glaring deficiency observed that can cause an imperfection or contribute to the problem on hand, even though unintended, need to have been satisfactorily attended to, before resorting to any structured approach to resolving the problem.

The culture of facing a problem as it arises is synonym with fire fighting. One successfully resolves the problem perhaps very speedily too, but then the organization and the society pays a very heavy price. The fire fighter might earn his promotion too! On the contrary, a system of prevention needs to be practiced as a way of life. This culture shall avoid the menace of firefighting. The system consists of anticipating the problem, developing a fool proof system to forestall it and to put the system in place.

1.6 WHAT IS THE ROLE OF STATISTICS?

Before attempting answer to this question, it is only fair to understand, what is statistics?

*It is a science in search of truth* and truth alone, nothing else but truth. It is a great pity that yet one of the quotes is; lie, damn lie, white lie and statistics. Statistics never tells lies. Some statisticians might do in the circumstances they are placed. Then telling lies is not their monopoly. It is not being said in their defence, but again a statement of facts. No doubt, the profession demands highest order of integrity.

Statistics is a science that serves all other sciences and is master of none. It delves into the void, to know the unknown and traverses from uncertainty to certainty. The un-intended risks arising from sampling and non-sampling errors are contained within acceptable norms with due consideration of long term economic impact.


Specifically the word statistics means an appropriate function of observations made on a sample of units selected suitably to represent the population to estimate the corresponding population parameter. Based on sample size and its method of selection, its confidence level can always be determined. Conversely, sample size can be determined to provide an estimate of desired accuracy and confidence.

Statistics has also been defined as a key technology. It consists of Formulating the Problem Precisely, Gathering Adequate Relevant Representative Data, Aptly Analysing, Validly Concluding, Making Confirmatory Trials, Making Recommendations Based on the Cumulative Findings, Implementing these to Reap the Expected Gains, Assessing the Gap(s), Repeating the Cycle to Bridge the Gap(s) and Continue the Chain of improvements to Reach the Evasive Goal of perfection—may be Zero non-conformity, Zero Wastage, Zero Deviation from the Target and the like. No wonder ISO : 9000 family of standards on Quality Systems makes use of Statistical Methods Obligatory.

Statistics provides indispensable scientific tools to solve problems of quality control including break through to sustain continuous improvement. The Basic tools of Statistical Quality Control include Cause and Effect Diagram, Check Sheet, Pareto Analysis, Stratification, Scatter Diagram, Histogram and Run Chart. These are Simple, Easy and Quick to learn and practice fruitfully. Reference is invited to IS : 15431. There are a host of other techniques to develop optimal solutions to problems encountered in almost all variety of situations.

Statistical methods are available to assess inspection inaccuracies arising from sampling and non-sampling errors. For the cumulative effect to be harmless, the error ought to be less than one tenth of acceptable quality levels and in no case in excess of one sixth. Generally these errors are found to be on the higher side. Statistical studies have helped to, reduce these to acceptable norms, standardize, and sustain these. These studies fulfill the obligations under the title Repeatability and Reproducibility Errors pertaining to ISO : 9000 family. This activity should precede planning for Process Control System and putting it in place. Statistical aids for process control have been mentioned in preceding section (1.5)

Statistical approach of experimentation for determination of optimal product and process designs have been exploited massively by advanced countries and in a limited way by developing one's. These help in getting valid conclusions with minimum of effort and investment. The optimal product parameters may constitute International and National Standards while optimal process parameters may form by and large only Company or Plant Standards.

As stated above, there are a large variety of other Statistical tools to cater to variety of other situations. These include decision to choose the product and location of the plant, choice of equipment; choice of suppliers, their rating and development; production scheduling, inventory and store maintenance, scheduling despatches, assessment of customer satisfaction and what not.

The above unambiguously makes it crystal clear that any worthwhile Total Integrated and Synchronized Quality Management Programme for Continuous Improvement is incomplete without adequate dose of statistics.

Adherence to systems for conformance, to optimal developed standard, assures quality and yield delivered at right time and place at economically viable and competitive prices.
Lastly, it needs to be emphasized that there is one and only one unique optimal or right quality for desired use to cater to specific market segment. A car or a motor bike run at unique optimal speed consumes least fuel, is more safe and comfortable on the road; minimises maintenance, service costs & pollution and simultaneously maximizes life of vehicle. This way it benefits both direct and indirect stake holders.

Quality level designed to be better than the optimal might cost more and render it uncompetitive. While quality level worse than the optimal will not do. In either case, it is not possible to sustain the market and the fall begins sooner than later leading to dissolution, the obvious logical end. Thus quality conforming to the rightly designed products and services benefits all stake holders, direct and indirect, the society at large. It requires thorough planning, execution, review and updating. This cycle needs to be sustained eternally.

Secret of Japan to become global leader in quality lay in harnessing its mass media network and institutional infrastructure to educate its entire human resource in the concepts, methodology and practice of simple quick and cost effective techniques. This enabled them to fully exploit the resources available to generate other necessary resources to create superior products that endeared the people world over. Japan took two decades to achieve this status. India has the potential to lead the world in much shorter time now. It only needs to start working earnestly.