Chapter – 4:

Different techniques for TQM: Benchmarking

Dr. Shyamal Gomes

Introduction:

When an organization / company want to maintain a level of quality that satisfy their customers at the appropriate time and price then that organization must follow some quality management techniques for fulfil those principles and planning. The techniques are:

- Benchmarking
- Kaizen
- Quality Circle
- Quality Function Deployment (QFD)
- Business Process Reengineering
- Total Productive Maintenance
- Six Sigma,
- Poka Yoka etc.

Actually the important principles of Total Quality are:

1. Focus or delighting the customer
2. Participation and team work
3. Continuous improvement and learning
4. Zero defect (maximum level)
Planning for quality must always start with the product attributes (or specifications) which are important to the customers. A method must then be devised to test and measure quality for each of product attributes. Next, the quality standards are set against which the actual quality is compared. Quality planning also involves setting of quality objectives, establishing quality strategies and formulating quality policies:

**Benchmark and Benchmarking:**

A benchmark is a point of reference against which things are measured. In business, these points of reference or standards can measure by questions about the product or service e.g how many, how much time, how much money, how reliable or how well made is it, by studying other organizations and comparing the answers to these questions, we will be able to measure our performance against that of others. As a result, an organization will be able to set new goals, and adapt the best practices to their organization. This exactly helps them to satisfy their customers with the best quality, cost, product and services.

Benchmarking is an effective technique, which helps organizations to create quality targets in the Strategic Quality Management Process.

Benchmarking is a systematic method by which an organization can continuously measure themselves against the best industry practices or world class or ‘Best in Class’ and improve accordingly. Simply it is “the search of industry best practices that lead to superior performance”

Benchmarking is systematic and continuous measurement improvement Process: A process of continuously measuring and comparing an organization’s business processes against process leaders any where in the world to gain information which will help the organization to take action to improve performance.

Thus, the goal of benchmarking is to make the best in class target for the organization, based on the information from both internal and external sources. The secret to
benchmarking technique is “borrow – adopt – refine” the best attributes for continuous growth and development.

When Benchmarking?

Where there are 8 negative answers like:

1. Is the company’s QMS properly developed, documented and implemented - no.
2. Are there systems to allocate appropriate resources and finding for the effective implementation of QMS- no.
3. Company’s great strength areas are measured – no.
4. Company’s great weakness areas are measured – no.
5. Company’s great opportunities are measured – no.
6. Areas have threats for its survival – no.
7. Customer needs assessed and rectified – no.
8. KSF application is central focus- no.

Levels of Benchmarking in Competitive environment:

• Internal benchmarking – within one’s org.
• Competitive benchmarking – analysis the performance and practices of best – in – class companies.
• Non – competitive benchmarking – is learning something about a process a company wants to improve by benchmarking.
• World class benchmarking- ambitious and looking towards recognized leader

General areas of Benchmarking / where benchmarking:

Operational Strategies:
• Inventory management
• Inventory control

Marketing management
• Customer service levels
• Purchasing
• Billing and collection
• Purchasing practices

Quality Improvement efforts / process
• Management of quality councils
• Overall equipment effectiveness etc.

H.R. Practices
• Talent Acquisition / Search
• Training and Development
• Compensation management etc.

Supply chain management
• Warehousing and distribution
• Transportation
Types of Benchmarking:

There are (7) seven types of Benchmarking:

- Performance or operational benchmarking
- Process or functional benchmarking
- Strategic benchmarking
- Functional Benchmarking
- Internal Benchmarking
- External Benchmarking
- International Benchmarking

A. Performance or operational benchmarking:
- It involves – pricing, technical quality, features and other quality
- Performed by reverse engineering in which competitor’s products are taken apart and analyzed
- It is also known as competitive benchmarking

B. Process or Functional benchmarking:
- Centres on work processes such as billing, order entry or employee training.
- It identifies the most effective practices in companies that perform similar functions, no matter in what Industry.

C. Strategic Benchmarking:
- Examines how companies compute and seeks the winning strategies that have led to competitive advantage and market success.
- Determine how well a company is prepared to compete in a segment and to help define a best-in-class competitor is to construct a key success factor (KSF).

<table>
<thead>
<tr>
<th>Key success factor</th>
<th>Competitive analysis – Computer Industry …… Segment</th>
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<tbody>
<tr>
<td>Sales Force</td>
<td>Performance Rating</td>
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<tr>
<td>Distribution</td>
<td>Weight</td>
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<td>Suppliers</td>
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<td>R&amp;D</td>
<td></td>
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<tr>
<td>Service</td>
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<td>Cost Structure</td>
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D. Functional benchmarking: or generic benchmarking – is used when an organization look to benchmark with partners drawn from different business sectors or areas of activity to find ways of
improving similar functions or work processes. This sort of benchmarking can lead to innovation and dramatic improvements.

E. Internal Benchmarking: Involves seeking partners from within the same organization. The main advantages of IB are that access to sensitive data and information is easier, standard data is often readily available and usually less time and resources are needed.

F. External Benchmarking: Involves seeking outside organizations that are known to be best in class. External benchmarking provides opportunities of learning from those who are at the cutting edge, although it must be remembered that not every best practice solution can be transferred to others. In addition, EB may take up more time and resources to ensure the comparability of data and information, credibility of findings and development of sound recommendations.

G. International Benchmarking: It is used where partners are sought from other countries because best practitioners are located elsewhere in the world. Globalization and advances in IT are increasing opportunities for international projects. However, this can be more time and resources to set up and implement and the results may need careful analysis due to national differences.

Phases of Benchmarking:

Benchmarking is usually treated as a structural process. The structure is best provided by developing a step by step model. Any type of benchmarking process model should provide an adequate framework for the successful planning and execution of a benchmarking exercise. It should be flexible enough to encourage people to modify the process to suit their needs and project requirements. There are 5 stages of Benchmarking:

- **Planning**: Identify the product, service or process to be benchmarked
- **Analysis**: Determine the gap between the firm’s current performance and that of the firm’s benchmarked and identify the causes of significant gaps.
- **Integration**: Establish goals and obtain the support of managers who must provide the resources for accomplishing the goals
- **Action**: Develop action plans, and team assignment, implement the plans, monitor progress and recalibrate benchmark as improvements are made.
• **Maturity**: Leadership position attended, best practices fully integrated into process.

**XEROX’s twelve steps of benchmarking (1980):**

**Phase 1: Planning**
1. Identify what to benchmark;
2. Identify comparative companies;
3. Determine data collection method & collect data.

**Phase 2: Analysis**
4. Determine current performance gap;
5. Project future performance levels.

**Phase 3: Integration**
6. Communicate finding and gain acceptance;
7. Establish functional goals.

**Phase 4: Action**
8. Develop action plans;
9. Implement specific actions & monitor progress;
10. Recalibrate benchmarks.

**Phase 5: Maturity**
11. Attain leadership position
12. Fully integrate practices into processes.

**The Process and of Benchmarking:**

Therefore, the process of Benchmarking may involve asking 4 key questions:

1. What should we benchmark?
2. Whom should we benchmark?
3. How do we perform the process?
4. How do they perform the process?

These 4 questions formed the basis on which Boeing, Digital equipments company, Motorola and Xerox jointly developed a benchmarking template.
Organizations that benchmark, adapt the process to best fit their own needs and culture. Although the number of steps in the process may vary from organization to organization, the following SEVEN steps contain the core method of benchmarking:

Step – 1: Determine the focus areas to be benchmark / identify what to benchmark.
Step –2: Carry out assessment on the existing practices to understand the current performance.
Step – 3: Determine what to measure – example compensation/ incentives structure for sales people.
Step – 4: Define the standard against which you are going to benchmark Identify who to benchmark.
Step – 5: Set goals and Carry out BM exercise.
Step – 6: Implement the action plan.
Step -7: Improve performance based on the information obtained through continuous Monitoring.

1. Most organizations have a strategy that defines how the firm wants to position it and compete in the market place. This strategy is usually expressed in terms of mission and vision statements. Supporting these statements is set of critical activities, which the organization must to successfully to realize its vision. They are often referred to as critical success factors. In general, when deciding what to benchmark, it is best to begin by thinking about the mission and critical success factors.

2. To compare practices to outside benchmarks it is first necessary to thoroughly understand and document the current process by applying techniques like follow diagrams, cause effect diagram etc. When documenting the process, it is important to quantify it. Units of measures must be determined. The key metrics like – unit costs, hourly rates, asset measures, quality measures etc. must be compared during the bench marking and investigation.
3. Once internal processes are understood and documented, it is possible to make decisions about who to benchmark and how to conduct the study. Benchmarking plan is a learning process including:
   - To use information in the public domain to focus the inquiry
   - To find appropriate benchmark pictures
   - Determine data collection method and collect data.

4. Three techniques are mainly use for this Step:
   - Questionnaire
   - Site Visit
   - Focus Group Discussion

5. Learning from the data collected in a benchmarking study involves answering a series of questions.
   - Is there a gap between the organization’s performance and the performance of the best – in – class organization?
   - What is the gap, how much is it?
   - Why is there a gap, what does the best in class do differently that is better
   - If best – in – class practices have adapted, what would be the resulting improvement.

6. When a benchmarking study levels a negative gap in performance, the objective is to change the process to close the gap. Benchmarking is a waste of time if change does not occur as a result. To effect change, the findings must be communicated to the people within the organization who can able to make improvement. The findings must translate to goals and objectives, and action plans must be developed to implement new processes.

7. Monitor the entire process and find out the key areas where more improvement is needed and finally document the final results.

**Different Approaches to Benchmarking**

<table>
<thead>
<tr>
<th>AT&amp;T's 12 step process</th>
<th>XEROX 12 step process</th>
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<tbody>
<tr>
<td>1. Determine who the clients are – who will use the information to improve their processes</td>
<td>1. Identify what is to be benchmark</td>
</tr>
<tr>
<td>2. Advance the clients from the literacy stage to the champion stage</td>
<td>2. Identify comparative organizations</td>
</tr>
<tr>
<td>3. Test the environment. Make sure the clients can and</td>
<td>3. Determine data collection method and</td>
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will follow through with benchmarking findings  

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<tr>
<th>1. Collect data.</th>
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<tr>
<td>4. Determine urgency panic or disinterest indicates little chance for success.</td>
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<tr>
<td>5. Determine scope and type of benchmark needed</td>
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<td>5. Project future performance levels.</td>
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<tr>
<td>6. Select and prepare the team</td>
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<td>6. Communicate B.M findings and gain acceptance</td>
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<tr>
<td>7. Overlay the benchmarking process on to the business planning process</td>
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<td>7. Establish functional Goals</td>
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<td>8. Develop business management plan</td>
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<td>8. Develop action plans</td>
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<tr>
<td>9. Analyze the data</td>
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<tr>
<td>9. Implement specific actions and monitor progress</td>
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<tr>
<td>10. Integrate the recommended actions</td>
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<td>10. Recalibrate benchmarks.</td>
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<tr>
<td>11. Take Actions</td>
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<td>11. Attain leadership position ;</td>
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<tr>
<td>12. Continue Improvement</td>
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<tr>
<td>12. Fully integrate practices into processes</td>
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Factors to be kept in mind to ensure success with benchmarking:

- Benchmarking must have the full support of senior management and they should actively involve. with this process
- For benchmarking team and process training is very imp.
- Benchmarking should be a team activity
- Benchmarking is an ongoing process.
- Benchmarking efforts must be organized, planned, and carefully managed.
- Used, correctly, benchmarking can lead you to the competitive edge in today’s business market place.

Advantages:

- Benchmarking is a systematic method by which organizations can measure themselves against the best Industry practices
• It promotes superior performance by providing an organized framework through which organization learn how the “best in class” do things.
• It helps for continuous improvement.
• Benchmarking inspire managers (and organization) to compete.
• Through Benchmark process organization can borrow ideas, adopt and refine them to gain competitive advantages.

**Disadvantages:**

The most resistant criticism of Benchmarking comes from the idea of copying others. BM is not a panacea. It is not a strategy nor is it intended to be a business philosophy. Therefore, it is a time taking technique.

**Conclusion**

Now a days, more than 60% companies in the world uses this technique for fixing their target for continuous improvement. For them it is an important tool. But to be effective it must be used properly. It breaks down (waste money, time and energy and some times morale too) if process owners and managers feel threatened or do not accept and act on the findings. Finally, benchmarking is not a substitute for innovation; however, it is a source of ideas from outside the organization.

**Kaizen:**

‘Kai’ the Japanese word means change, while ‘Zen’ means good (for the better), so kaizen means improvement. It is an effective tool of continuous improvement in small increments that make the process more efficient, effective, under control and adaptable. It focuses on simplification by breaking down complex processes into their sub processes and then improving them. Massaki Imai, the chairman of the Cambridge Corporation, an international management consultancy firm based in Tokyo, propound this useful technique in 1986.

Kaizen relies heavily on a culture change that encourages suggestions by operators who continuously try to incrementally improve their jobs or processes.

Innovation is seen as major changes in the wake of technological breakthroughs, or the introduction of the latest management concepts or production techniques. Innovation is dramatic, a real attention getter. Kaizen is continuous and incremental, and its results are seldom immediately visible. Since Innovation requires large investment but little effort to maintain it because its effort orientation is technology, that means innovation may be challenging, creative and constructive but not cost effective; other hand Kaizen requires little investment but great effort to maintain it, because its effort orientation is People that means Kazen is not only for challenging, creative and constructive but cost effective too. This is we can consider as C4 – Innovation.
The management of the company encourages suggestions or kaizens from employees regarding possible improvements in their respective work areas. The employees are awarded on giving a large number of useful suggestions. These rewards are more of recognition such as ‘kaizen man of the month’ titles and certificates or small gifts rather than monetary rewards.

The objectives of Kaizen:

- To build ownership and establishing the acceptable working culture / environment because kaizen relies heavily on a culture change that encourages suggestions by operators who continuously try to incrementally improve their jobs or processes.
- To determining capital cost projects.
- To involves slow but steady incremental improvements.
- To create participatory approach on creativity and updated fashion design as per taste of the customer.
- To create zero defect production in the production line.

Kaizen mainly focus on:

1. Value - added and non-value – added work activities.
2. ‘Muda’ (work without a product or effort wasted), which refers to the seven classes of waste – over production, delay, transportation, processing, inventory, wasted motion and defective parts.
3. Principle of the motion study and the use of cell technology.
5. Documentation of standard operating procedures.
6. The 5S for work place organization, which are five Japanese words that mean sort/ proper arrangements (Seiko), Sort in orderliness (Seiton), shine / personal cleanliness (Seiketso), standardize (Seiso) and self discipline (Shitsuke).
7. Visual management by means of visual displays that everyone in the plant can use for better communications.
8. Just – in – time principles to produce only the units in the right quantities, at the right time, and with the right resources.
9. Poka – yoka to prevent or defect errors.
10. Team dynamics, which include problem solving, communication skills, and conflict resolution.

How Kaizen works:

The concept of continuous improvement is applied in all directions:

- industrial processes can be improved
- working methods can be improved
- quality defects can be eliminated
- waste can be reduced
- Customer service can be bettered
- The working environment can be improved
- Boss/subordinates relationship can be improved.

Now, improvements in industry can be obtained in many ways: new technology can bring improvement to a process or to products' quality - technology can also bring improvements in productivity and in efficiency - it can also bring improvements to customer service - external consultants can bring improvements to working methods, to processes, to interpersonal relations. But these types of improvements do not fall under the Kaizen umbrella.

Kaizen is improvement through the poor man approach: the poor man does not spend money on improvements because he has no money to throw at it - he rather uses his wisdom, and his brain, and his creativity, and his talent, and his patience....

Kaizen is brain power

This is the real power of Kaizen: by using their brain to obtain improvements, people perfect their skills and increase even more their talent. And there is an extra benefit: they are more satisfied. If you are a wealthy man, and build a sumptuous villa designed by the best architect in town, you may or may not be as satisfied as the average man who, through years of patient, creative work has transformed his house into a cosy, warm nest, filled with handmade decorations, each corner showing his dedication, each ornamental object purchased through intelligent savings but selected with care and rich in taste, and each detail showing and proving his love..... Each step of improvement, once completed, brings satisfaction, but probably the real satisfaction is in the improvement process itself: because improving mainly or primarily through creative efforts is a tough challenge, and challenge is a wonderful source of satisfaction.

Tools for kaizen

Surely, brain alone is not sufficient: specific techniques are available for Kaizen oriented people to perform effectively. Like a home improver needs to know sufficiently about interior decorating, and antiques' restoration, and soft furnishing (and landscaping, painting, plumbing, wallpapering......), similarly the industrial Kaizen improver needs:
• To know about problem-solving techniques, and tools for creativity, and *Pareto* and *Ishikawa Diagrams* (to mention but a few of the available instruments for systematic improvement).

• Valid *Kaizen* requires an extra skill from people: the ability to work effectively in team. Starting from the assumption that "the Pope and the Peasant together know more than the Pope alone", the Japanese have extensively deployed and mastered the "team" concept for real, methodical improvement.

• Their *Quality Circles*, for instance, are known world-wide.

In western industrial environments the concept of "effective team for systematic improvement" has somehow failed to deliver high level results, mainly due to considerable cultural differences. The ability to perform in team effectively, intentionally and regularly, with the objective of improving systematically all weak areas of an enterprise, seems to be, in the western world, not as high as in the far east. And many attempts to transplant Japanese methods and *Kaizen* approaches into western enterprises have somehow failed. The truth is that the original *Kaizen* concept must be tailored to suit not only the western industrial environment, but even the specific enterprise, taking into due consideration its culture and values (and objectives, strategies, policies.....).

Like a home improver cannot and will not merely transform his house following recommendations and ideas of an interior decorating magazine (ideas that he will rather vet and adapt to his or her specific needs and taste), similarly an enterprise willing to undergo a process of continuous, systematic improvement will have to identify, define and deploy a specific "style" and specific, personalised methods to pave its "road to excellence".

**Kaizen Sheet:**
A kaizen sheet is a useful way of depicting the information relating to the implementation of a kaizen suggested by an individual or a group of workers.

In Kaizen sheet important components are:

1. Kaizen theme (What and which)
2. Problem identified
3. Cause analysis ( why why analysis)
4. Root cause
5. Idea / possible alternative solutions
6. Counter measures
7. Before counter measures ( How)
8. After counter measures
9. Implemented by (Who)
10. Target and targeted date ( when)
11. Benefits / Result after implementation
12. Comparative analysis (before and after)
13. Place of Implementation (Where)
**KAIZEN SHEET**

<table>
<thead>
<tr>
<th>Name of the company / Organization</th>
<th>Where: Machine: Unit: Date:</th>
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<tbody>
<tr>
<td></td>
<td>How many and when:</td>
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<tr>
<td><strong>Kaizen theme:</strong> (What and Which)</td>
<td></td>
</tr>
<tr>
<td>Problem</td>
<td>Counter Measure</td>
</tr>
<tr>
<td>Analysis (Why, why)</td>
<td>Benefits: how</td>
</tr>
<tr>
<td>Rot Cause</td>
<td>Before counter measure</td>
</tr>
<tr>
<td>Idea / Alternatives</td>
<td>After counter measure</td>
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<tr>
<td></td>
<td>Benefits: how</td>
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<td></td>
<td>Scope and plan for</td>
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<td></td>
<td>horizontal development</td>
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<tr>
<td></td>
<td>Implemented by:</td>
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<td></td>
<td>Kaizen No. Zone:</td>
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**5W and 1H (WHAT, WHERE, WHEN, WHO, WHY and HOW)**

**Gemba Kaizen:**

*Muda* in Japanese means work without a product or effort wasted. *Muri* is refers to an overburden system. Mura means unevenness in the flow of work. Masaaki Imai, chairman of Kaizen Institute, propounded the concept of Gemba Kaizen. *Gemba* means ‘real place’ or the place where the real action takes place like factory or shop floor in an Industry, while in the service sector; Gemba refers to the administrative offices. According to M.Imai: Gemba is the teacher of any effective manager, when he or she go to gemba, what they see is the real data. The report from gemba they read sitting at their office, desk is merely secondary information.

Gemba management follows 5 golden rules, called the 5 – gemba principle, as follows:
1. When a trouble (abnormality) happens, go to gemba first and observe it by own eyes.
2. Check with *gembutsu- means some tangible things on which you can put your hands* (machines, tools, rejects, and customer complaints).
3. Take temporary counter measures on the spot for an ongoing solution but do not address the real issue that ads to the ext point.
4. Find out the root cause: by repeating the question ‘why’ several times with the team manager can find out the root cause of the problem.
5. Standardize for prevention of recurrence – once the root cause is identified, counter measures came up with solutions; it is the time to standardize such a countermeasure so that the same problem will not recur.

One major tool of Gemba Kaizen is Muda Elimination. Various types of muda are as follows:
Values of Kaizen in Total Quality Management:

- Safety
- Security
- High productivity
- Quality
- Commitment and partnership
- Cost effectiveness in entire business environment
- Team concept and ownership

Kaizen effects at Taj Hotels:

The famous Taj Hotels (Rs. 687 crore India Hotels Corporation Ltd) belong to the TATA group. The Taj Hotels chain is ranked amongst the best three hotel chains in Asia, but the aim is to be among the top chains in the world. Over the past three years, the group has institutionalized both the kaizen approach and total productive maintenance. Sr. vice president (corporate quality) Mr. H.N.Shrinivas, personally visited the world’s leading hotel chains such as the Ritz Carlton (Marriott group) and four seasons to pick up the best practices.

The Taj group benchmarked with Ritz Carlton on customer satisfaction measurement in luxury hotels. It has also adopted its ‘three steps to service’ philosophy which is used for defining performance requirements of employees at all levels – warm welcome, anticipatory, service, and farewell.

According to Taj Hotels, three functions should happen simultaneously within any organization – **maintenance, innovation, and kaizen**. Maintenance refers to
maintaining the current status, where procedures are set and the standard standards implemented. Innovation refers to breakthrough activities initiated by top management, buying new machines, new equipments, developing new markets, directing R & D, change of strategy etc. In the middle, there is kaizen, small steps but continuous improvements ‘without large capital investments’. Kaizen should be implemented by the staff at all levels with encouragement and direction from the management. Taj Hotels follow the ten basic tips for kaizen implementation:

- Discard conventional fixed ideas
- Think of how to do it, not why it cannot be done.
- Do not make excuses, start by questioning on current practices
- Do not search perfection, do it right way, even it for only 50% of the target.
- For any mistake, correct it right away.
- Don’t spend money for kaizen, use wisdom.
- Wisdom is brought out when faced with hardship.
- Ask ‘why? Five times and seek root causes.
- Seek the wisdom of ten people rather than the knowledge of one.
- In kaizen, ideas are infinite and sky is the limit.

<table>
<thead>
<tr>
<th>Energy conservation at Taj Bengal, Kolkata – an example</th>
<th>Before Kaizen</th>
<th>After Kaizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical energy was being wasted due to misuse of electricity operated kitchen equipments such as hot ranges, ovens etc.</td>
<td>After a proper study and discussion with the concerned team, all the under used electrically operated kitchen equipments have been disconnected and removed</td>
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<tr>
<td>Fresh air and exhaust fans were running beyond the operating hours in various kitchen</td>
<td>Timers have been provided for the fresh and the exhaust fans of various kitchens.</td>
<td></td>
</tr>
<tr>
<td>Air conditioner of various offices were running beyond working hours</td>
<td>Timers have been provided for the air – conditioners of various offices.</td>
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</tr>
<tr>
<td>Unwanted lights in lobby corridors were on during the night.</td>
<td>The 300W halogen lights have been replaced with 70W metal halide lamps. Timer have been provided and cabling modified for the alternative handy lights of lobby corridors</td>
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ULTIMATE GAINS FROM THIS KAIZEN APPLICATION AT TAJ
Annual savings of Rs. 19.62 lakh and in terms of savings in electricity, there is a total savings of 4,01,317 KWH annually.

Finally, there are always two external forces acting on an organization:
1. The improvements made by competition
2. The ever-increasing pressure from customers and the market.

A company will fail it its people have “Let’s stop here”, ‘Hold performance at this level”, or “We have done enough” attitude. Therefore, it is important to build awareness of Kaizen as a continuous process through out the company; use the Kaizen strategy as management tool within the TQM movement.
Quality Circle

Historical Background and why an organisation should institutionalise this concept

Dr. K. Ishikawa started Quality Control Circles (known as Quality Circles in India and in many nations) originally for the self and mutual development of the workmen. They are also a very logical outcome of the Japanese drive for training and accomplishment in quality control and quality improvement.

From the early 1950's, Japanese learnt from the seed courses of Dr. E. Deming's on statistical methods for quality control and Dr. J. Juran's courses on Quality Management. With zeal for learning and self-sufficiency, they vigorously promoted quality education by local experts across their country. It began with massive education of engineers, and then top and middle managers, supervisory levels.

Under their system of organising work, it became logical to extend training on quality to the Gemba-cho', the 'leading hand' of the workers in a section. Dr. Kaoru Ishikawa and his associates realised the immense potential of front line employees. It is not only the best way to help people to develop their own potential but also from the organisation point of view for contribution through training, development and motivation for quality control and improvement.

The training featured intra departmental groups of 10 or so workers seated around a table and hence the name 'QC Circle'. This thought revolution has been of immense benefit to Japan as a country, to the Japanese organisations that adopted it and to most of the ASEAN countries who have been pursuing it.

Problem solving was no more the exclusive purview of supervisors and managers (with workers only to do as told) but the people who are performing the tasks at work place are trained and empowered to solve work related problems and recommend solutions. Persons becoming members of Quality Circles realise and develop their potential, individually and in groups, acquiring new skills and competencies. Such competencies only will help to improve their performance and capabilities for their own betterment.

ROAD MAP RECOMMENDED AND USED BY QCFI FOR THIS PROCESS

Assessment of the prevalent conditions in the organisation/units/divisions through a survey.

Exposure programme to top management, senior management, discussion on survey findings and decisions for next steps.
Formation of a Quality Council/Steering Committee and choice of the coordinator and facilitators; roles and responsibilities of each.

Working out an action plan and schedule, taking care to incorporate.

Key concerns arising from the survey findings and actions agreed upon.

Developing facilitators and internal trainers through intensive training.

Exposure to all the supervisory/middle management personnel, from areas where Quality Circles are to be started.

Exposure to all the workmen in the division/unit where initially circle formation is aimed at formation of the initial Circles, education and training to all the members of the Circles on the processes, tools, techniques, maintenance of records, etc.

Guiding and troubleshooting in the implementation stage by attending monthly review meetings of the steering committee/quality council for the first 6 months and bi-monthly, afterwards

**What is quality circle?**

A group of employees who perform similar duties and meet at periodic intervals, often with management, to discuss work-related issues and to offer suggestions and ideas for improvements, as in production methods or quality control, called quality circle.

Therefore quality circle is nothing but a small group of employees who come together to discuss with the management issues related to either quality control or improvement in production methods form a Quality Control Circle (QCC). These employees usually work in the same areas, and voluntarily meet on a regular basis to identify, analyze and solve their problems.

**Key Characteristics of quality circle:**

- A circle, usually consisting of 6-8 members, from the same section.
- Membership of a Quality Circle is voluntary.
- Circle members should meet regularly, ideally once a week, in particular place also in particular time.
- Circle members select a name for their circle in the first meeting and elect a leader to conduct the meetings.
- Members are specially trained in problem solving and analysis techniques in order to play their role effectively.
• Circle works on a systematic basis to identify and solve work-related problems for improving quality and productivity not just discussing them.
• The management must ensure that solutions are implemented quickly once they have been accepted.
• The management must give appropriate and proper recognition to solution.

**Why Quality Circle:**

It is said that 95% of the problems in workshops can be solved through quality control tools. The Japanese have experienced this! The quality control tools useful for QCCs are Pareto Diagrams, Cause-and-Effect Diagrams, Stratification, Check Sheets, Histograms, Scatter Diagrams, Graphs and Control Charts. Also, logical thinking and experience are a must for solving problems. Therefore the main objectives of QC are:

• To improve quality and productivity.
• To reduce the cost of products or services by waste reduction, safety, effective utilization of resources, avoiding unnecessary errors and defects.
• To identify and solve work-related problems and interfere with production as a team.
• To tap the creative intelligence of people working in the org. and make full use of human resources.
• To improve communication within the organization.
• To improve employees loyalty and commitment to the organization and its goals. *(Promoting Morale of employees)*
• To build a happy, bright, meaningful work environment.
• To satisfy the human needs of recognition, achievement and self development.

**The benefits of introducing a quality control circle program in the work place are many.**

• Heightened quality awareness reveals faults in the system that might obstruct good practices.
• It improves the quality of your firm’s products and services, thereby increasing the value of your brand, and securing your customers’
confidence. The quality of customer relationship management can be further enhanced by using help desk software from the likes of Pro software.

- The people who are part of the quality control circle will feel a sense of ownership for the project. Higher yields and lower rejection rates also result in enhanced job satisfaction for workers, which in turn drives them to contribute more.
- A quality control circle program also brings about improved two-way communication between the staff and the management.
- Finally, the financial benefits will certainly exceed the costs of implementing the program. A study revealed that some companies improved their savings ten fold!

Basic Organizational Structure of QC:

A quality circle should have an appropriate organizational structure for its effective and efficient performance. The structure may vary from one org. to another, but it is useful to have basic framework as a model:

In a typical organization, the structure of a QC may consist of the following elements:
• **Steering committee** – Gen. manager / works manager, rep. from top management, rep. of human resource development and a rep. of employees’ union.

• **Coordinator**; an administrative officer / personnel officer from middle level management.

• **Facilitator**; senior supervisory officer / foreman. A facilitator may manage up to 10 circles. A facilitator is usually from one of the three departments – quality control, production or training.

• **Circle Leader**; circle leaders may be from the lowest level of supervisors. A circle leader organises and conducts circle activities.

• **Circle members**; line and / or staff workers ( circle members should attend all meetings as far as possible, offer suggestions and ideas, participate actively in group processes, and attain training seriously.

**How to implement quality circle:**

• Firstly, the management is informed about the quality control circle process that is being planned.

• A committee is formed, and key persons such as a coordinator and in-house coach are selected.

• The scope is defined, and areas of application identified.

• First-line supervisors in the identified areas are given QCC presentations. It is important to make these impressive, and valuable tips on the subject are available.

• This is followed up with extensive training for coordinators and middle management on the process and their roles.

• Employees are invited to become members of a circle, and trained suitably once they sign up. Thus, a circle is formed and begins work. These may give rise to other circles.

• Problems are discussed and solved in a systematic manner in the QCCs. It is very important that solutions are implemented as quickly as possible, to maintain the momentum.

Usually QCC programs must operate in all sections of the company i.e., in the offices, service operations and manufacturing. But remember, while the size of the company is not important to a program’s success, the following factors certainly are:

• Voluntary participation.
• Management support.
• Employee empowerment.
• Training programs.
• Team work.
• Problem solving skills.

Conclusion:

Generally, a quality control circle program requires the same framework as an ISO 9000 quality standard with regard to the management structure and training. Hence, QCCs should be part and parcel of your company’s Total Quality Management (TQM) initiative. However, QC followed some ethics, those are:

• Criticise ideas, not persons.
• The only stupid question is the one that is not asked.
• Everyone in the team is responsible for the team’s progress.
• Be open to other’s ideas.
• Pay, terms of employment and other negotiable items are excluded.

Limitation OR when QC is inactive?

• Inadequate Training
• Unsure of Purpose
• Not truly Voluntary
• Lack of Management Interest
• Quality Circles are not really empowered to make decisions.
• Too many suggestions.
QUALITY FUNCTION DEPLOYMENT (QFD):

Introduction:

QFD is a technique used to carry the voice of the customer through design and the production process. It is actually, a customer – driven planning process to guide the design, manufacturing and marketing of goods. It tries to eliminate the gap between: What customer want in a new product and what the product must deliver. QFD is designed to help planners focus on characteristics of a new or existing product or service from the viewpoints of customer market segments, company, or technology development needs.

QFD was originated at Bridgestone Tyre, Kurume plant, where the quality chart was used for the first time in 1966. Dr. Mizuno, professor of the Tokyo Institute of Technology, is credited with initiating the Quality Function Deployment (QFD) system. The first application of QFD was at Mitsubishi, Heavy Industries Ltd., in the Kobe Shipyard, Japan, in 1972. Professor Yogi Akao (Asahi University, Tokyo) has been credited with developing this technique to the present form. QFD was successfully implemented by Mini Vans by Toyota in 1977.

**Quality function deployment (QFD)** was originally developed by Yoji Akao in 1966 when the author combined his work in quality assurance and quality control points with function deployment used in Value Engineering. Mr. Akao described QFD as a “method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process.”

QFD is a structured method in which CRs are translated into appropriate Technical Descriptors / specifications for every stage of product development and production. It is a technique consisting of a series of interlocking Matrices that translates customer need into product and process characters.

Therefore, QFD is a technique used to carry the voice of the customer through design and the production process. It is actually, a customer – driven planning process to guide the design, manufacturing and marketing of goods. It tries to eliminate the gap between what customer want in a new product and what the product must deliver.

QFD is designed to help planners focus on characteristics of a new or existing product or service from the viewpoints of market segments, company, or technology development needs. The technique yields graphs and matrices. QFD has been used by several corporations and organizations.

**Purpose of QFD**

The main purpose of QFD is to ensure that CRs are incorporated into every aspects of the design and production process. However, in 1987, the QFD research group of the Japanese Society of Quality Control (JSQC) led by Akao published a final survey
report on the status of QFD application among 80 Japanese companies. The companies surveyed listed the following as the purpose of using QFD:

- Setting design quality and planned quality
- Benchmarking competitive process
- New product development that sets the company apart from competitors
- Analysing and accumulating market quality information
- Deploying design intent into manufacturing
- Identifying control points for the Gemba

The Quality Function Deployment (QFD) Technique:

The structure of the QFD is based on a set of Matrices. The main matrix relates CRs (WHAT) and their corresponding technical requirements (HOW)

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<th>CRs</th>
<th>Importance to the customer</th>
<th>TDs</th>
<th>Relationship Matrix</th>
</tr>
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</table>

The primary planning tool used in QFD is the “House of Quality”. The house of quality translates the voice of the customer into design requirements that meet specific values. It also matches those requirements against the ability of the organization to meet them. The basic structure of QFD can be thought of as a framework of a house like:
1. **Identifying the Customer and determining Customer Requirements**: Who is the customer? In addition to the person buying the product, the customers of the design engineer would also include the manufacturing and assembly engineers and workers. (or anyone else downstream of the design process). The goal is to develop a list of all the customer requirements (made up in the customer’s own words) that will affect the design. This should be accomplished with the whole design team, based on the results of customer surveys.

2. **Identify Technical Descriptors / Requirements (Voice of the organization)**: The ceiling or second floor, of the house contains the technical descriptors / requirements. The goal of the house of quality is to design or change the design of a product in a way that meets or exceeds the customer expectations.

   - Each engineering characteristics must directly affect a customer perception and be expressed in measurable terms.
   - These characteristics are an expression of the voice of the customer.
   - Brainstorming among the engineering staff is a suggested method for determining the technical descriptors.
   - Eventually, technical requirements are the “hows” by which the company respond to the “whats” – customer requirements.

3. **Interrelationship between Customer requirements & Technical requirements**: The next step in building a house of quality is to compare customer requirements and technical descriptors and determine their respective relationships.

   - The interior walls of the house are the relationships between customer requirements and technical descriptors.
   - Customer expectations (customer requirements) are translated into engineering characteristics (technical descriptors)

4. **Interrelationship between Technical Descriptors**: The roof of the house is the inter-relationship between any pair of technical descriptors. Various denotes these relationships. **For Example**: the symbol $\bigcirc$ denote a very strong relationship, $\bigodot$ for a medium relationship and $\bigtriangleup$ denotes a weak relationship. This relationships indicate answers to questions such as, “How does one change of product attributes affect others”? And assessment of trade-offs between attributes.

5. **Competitive Assessment through Competitive Benchmarking**: The goal here is to determine how the customer perceives the competition’s ability to meet each of the requirements. This forces awareness of what already exists and points out opportunities for improving upon that which already exists. Each competing product is compared with customer requirements. Some comparisons are objective and others are subjective.

6. **Prioritizing the Customers Requirements**: A weighting factor is generated for each requirement. The weighting factor will give the designer an idea of how much effort, time and money to invest in achieving each requirement.
6. **Translating the Customer Requirements into Measurable Engineering Requirements:** The goal here is to develop a set of engineering requirements (often called design specifications) that are measurable for use in evaluating the proposed designs:

1. Transform the customer requirements into engineering requirements and
2. make sure that the engineering requirements are measurable.
Benefits of Quality Function Deployment:

QFD was originally implemented to reduce start up costs. Organizations using QFD have reported a reduced product development time. For example US car manufacturers of the late 1980s and early 1990s needed an average of 5 years to put a product on the market, from drawing board to showroom, whereas Honda put a new product on the market in two and a half years and Toyota did it in 3 years. Both organizations credit this reduced time to the use of QFD. Product quality and, consequently, customer satisfaction improve with QFD due to numerous factors depicted in following:

| A. Improve Customer Satisfaction | • Creates focus on customer requirements |
|                                 | • Uses competitive information effectively |
|                                 | • Prioritizes Resources |
|                                 | • Identifies items that can be acted upon |
|                                 | • Structures resident information |
| B. Reduce Implementation Time   | • Decreases mid stream decisions changes |
|                                 | • Limits post introduction problems |
|                                 | • Avoids future development redundancies |
|                                 | • Identifies future application opportunities |
|                                 | • Surfaces missing assumption |
| C. Promotes Teamwork            | • Based on consensus |
|                                 | • Creates communication at interfaces |
|                                 | • Identifies actions at interfaces |
|                                 | • Creates global view of details |
| D. Provides Documentation       | • Documents rationale for design |
|                                 | • Is easy to assimilate |
|                                 | • Adds structure to the information |
|                                 | • Adapts to changes |
|                                 | • Provide frameworks for sustainability analysis |

Operational process of QFD:

1. When an organization decides to implement QFD, the project manager and team members need to be able to commit to form small team and significant time to it, especially in the early stage.
2. Priorities of the project must be inform to all departments within the organization, so team members can budget their time accordingly.
3. Formation of two teams designing a new product or improving existing products (Team members are from marketing, design, quality, finance and production).
4. Periodic team meetings
5. Inter team communication and feedback
6. Improve the quality as well (fulfil the customer requirements)

Application of QFD:

The first application of QFD was at Mitsubishi, Heavy industries Ltd. in the Kobe Shipyard, Japan in 1972. After 4 years of case study development refinement, and training, QFD was successfully implemented in the production of mini – vans by Toyota. Using 1977 as a base, a 20% reduction is start up costs was reported in the launch of the new van in October 1979, a 38% reduction by Nov. 1982 and a cumulative 61% reduction by April 1984. QFD was first introduced in the United States in 1984 by Dr. Clausing of Xerox. QFD can be applied to practically any manufacturing or service industry. It has become a standard practices by most leading organizations, who also require it of other suppliers.
Conclusion:

Because QFD concentrates on customer expectations and needs, a considerable amount of efforts is put into research to determine customer expectations. This process increases the initial planning stage of the project definition phase in the development cycle. But the result is a total reduction of the overall cycle time in bringing to the market – a product that satisfies the customer.

The driving force behind QFD is that the customer dictates the attributes of a product. Customer satisfaction, like quality, is defined as meeting or exceeding customer expectations. Words used by the customers to describe their expectations are often referred to as the voice of the customer.

Sources for the determining customer expectations are focus groups, surveys, complaints, consultants, standards and federal regulations. Frequently, customer’s expectations are vague and general in nature. It is the job of the QFD team to analyze these customers’ expectations into more specific customer requirements. Customer requirements must be taken literally and not incorrectly translated into what organization officials’ desire.

QFD begins with marketing to determine what exactly the customer desires from a product. During the collection of information, the QFD team must continually ask and answer numerous questions, such as:

- What does the customer rally want?
- What are the customer’s expectations?
- Are the customers expectations used to drive the design process?
- What can the design team to do to achieve customer satisfaction?

Finally, the goal of QFD is not only to meet as many customer expectations and needs as possible, but also to exceed customers’ expectations.

Business Process Reengineering:

Introduction: “Incremental improvement” and ‘Total customer satisfaction’ are the main mantra in competitive edge of any business. But to incremental improvement and TCS, improvement / change in manufacturing process is not enough, need radical change in inter functional, inter organizational and customer based processes. Similarly, in service industry, rapid changes in information technology and its applications have been a major enabler of successful business.


What is BPR?
According to Michael Hammer, Reengineering has been defined as “the fundamental rethinking and radical design of business processes to achieve dramatic or break through improvement in critical contemporary measures of performance such as Cost, Quality, Service and Speed.
Therefore, Business Process Reengineering or process reengineering, or simply \textit{reengineering} is focused on breakthrough improvement to dramatically improve the quality and speed of work and to reduce its cost by fundamentally changing the processes by which works get done. Hammer states that B.P may be defined as a set of logically related task to achieve a defined business outcome. A set of process forms a business system the way in which a business unit or a collection of units carries out its business. Requirement of Reengineering process are:

1. **Critical processes** – core business process rather functional process
2. **Strong leadership** – a sense of ownership
3. **Cross functional team** for continuous growth - top down and bottom up initiatives can be combined – the top down for performance targets and the bottom up for deciding from to achieve the target.
4. **Information Technology**: who need the information when they need it and when?
5. **Clean state philosophy**: price target for the product or services, deduct profit desired and then find a process that providing what customers wants at the price the customer will pay.
6. **Process analysis** – what, where, when, why and the outcomes.

Fig. Business Process Reengineering Process Flow

**When and why BPR is required?**
For organizations that want to survive and grow, improvement is not an option but a compulsion and key to success. When an organization realizes that the old ways of doing things needs changing or its customers are taking over its market share, or not, many processes in the organization may need reengineering, not a major tweak, but a major overhaul. Some of the symptoms that signal that it is the time to start reengineering these are:

- If takes too long time for an organization to move its products from conception to the market place as compared to its competitors.
- The budgeting process may be too complex
- The services provided by the organization are not compatible with its customers needs.

Assuming that a company has decided that its processes are ineffective and inefficient the following are the major steps the company should embark on to redesign its process:

- **Strategic Redesign of Process:**
  - Understand and measure existing processes
  - Identify processes to be redesign
  - Develop business vision and process objectives.

2. **Identify information technology levels:**
   - 100% utilization of a new technology
   - Brainstorming sessions to identify new approaches

3. **Design and build a prototype of the process:**
   - Plan as per strategic redesign
   - Implementing organizational and technical aspects

4. **Involvement of Right teams of people**
5. **Continuous feedback and improvement of processes.**

**BPR / Reengineering entail the following seven rules or principles:**

1. Organize around outcomes, not tasks
2. Have those who use the output of the process perform the process.
3. Merge information processing work into the real work that procedures the information
4. Treat geographically dispersed resources as through them work centralized.
5. Link parallel activities instead of integrating their results.
6. Put the decision point where the work informed and build control into the process.
7. Capture information once at the sources.

**Reengineering in Service Industry:**
Like manufacturing industry, RE is also important for service industry. According to Janson, 3 salient features of reengineering in the Service sector are:

1. Make the customer the starting point for change
2. Design work processes in light of organizational goals and
3. Restructure to support front line performance

**Impacts:**

- Human dimension - focuses on customers and employees
- Work process dimension – multi skilled services profession
- Technology dimension – new techniques and automations

**Benefits of Reengineering:**

1. Achievements of radical changes in performance measured by cost, cycle time, services and quality.
2. Boosting competitiveness in the operational networks
3. Helps to think big (revolutionary thinking)
4. Helps to make noticeable changes in the pace and quality of response to customers needs
5. Resulting new org. designs that help firms respond better to competitive pressures, increase market shares and profitability and improve cycle times, cost ratio and quality (org. renewal)
6. Bring change in the corporate culture, encourage workers for better participation and better result.
7. Reengineering has helped to create more challenging and more rewarding jobs with broader responsibilities for employees.

**Limitations:**

1. Not a panacea for all problems
2. Not simple or easily done, not is it appropriate for all processes for all organization.
3. Use of information technology is a must to gain significant process improvement.
4. Improvement of processes requires active participation of people who actually perform the work.

**Reengineering Process and TQM:**

Michael Hammer argues that the two concepts are compatible and actually complement each other. Both concepts have the same focus – “customer satisfaction”

**However, the relevance of REP in TQM are as follows:**

TQM has advocated continuous and incremental improvement of processes (Kaizen) where as reengineering is about radical discontinuous change (break through improvement) through process innovation.
However, the reengineering gave; together with quality Gurus such as Deming and Juran all agreed that innovation and break through in processes are essential parts of Quality Management. In fact incremental and breakthrough improvements are complementary approaches that fall under TQM umbrella. Reengineering requires the support of TQM to be successful.
Chapter – 9:

Total Productive Maintenance

Dr. Shyamal Gomes

Introduction: TPM - History:

TPM is an innovative Japanese concept. The origin of TPM can be traced back to 1951 when preventive maintenance was introduced in Japan. However the concept of preventive maintenance was taken from USA. Nippondenso was the first company to introduce plant wide preventive maintenance in 1960. Preventive maintenance is the concept wherein, operators produced goods using machines and the maintenance group was dedicated with work of maintaining those machines, however with the automation of Nippondenso, maintenance became a problem as more maintenance personnel were required. So the management decided that the routine maintenance of equipment would be carried out by the operators. (This is Autonomous maintenance, one of the features of TPM). Maintenance group took up only essential maintenance works.

Thus Nippondenso which already followed preventive maintenance also added Autonomous maintenance done by production operators. The maintenance crew went in the equipment modification for improving reliability. The modifications were made or incorporated in new equipment. This leads to maintenance prevention. Thus preventive maintenance along with Maintenance prevention and Maintainability Improvement gave birth to Productive maintenance. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment.

In Total Quality Management, Total Productive Maintenance (TPM) is an important and effective tool for the excellence. Total productive maintenance (TPM) is keeping the current plant and equipment at its highest productivity level through cooperation of all areas of the organization. Generally, the first bridge to cross is to break down the traditional barriers between maintenance and production personnel so they are working together.

Now, Maintenance management is planning, organizing, controlling maintenance activities such that the over all maintenance cost is the minimum.
Maintenance is required not only by equipment but also by other facilities such as building, land, garden, lawn etc. Maintenance lawns and garden of the premises of the factory may be important aspects of environment protection especially in process industries. However, maintenance of equipment used directly in the production process is much more important for a business enterprise.

Maintenance of facilities and equipment is done to ensure that these are in good working condition at any point of time and if breakdowns occur, necessary repairs should be done in order to bring these back to running condition as early as possible.

What is Maintenance and what is Maintenance Management?

- Maintenance is an initiatives that covers all those operations such as monitoring, inspecting, adjusting, repairing and/or doing whatever is necessary to keep a machine, a facility, a piece of equipment or transportation vehicle in the proper working conditions.
- Maintenance Management is reviewing, planning, organising and controlling maintenance activities such that the overall maintenance cost is the minimum.

Maintenance development stages:

1. Breakdown maintenance:

1. Break-down maintenance: is remedial or corrective maintenance that occurs when equipment fails and must be repaired on an emergency or priority basis. It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

   - Obviously this is not an ideal way of keeping equipment or machinery operating because of the down time of the equipment or machinery when break down occurs.
   - This results in loss of production due to idling of equipment and machinery and consequently idling of labour also. Ultimately customers orders cannot be delivered as promised

2. Preventive maintenance (1951):

It is a daily maintenance (cleaning, inspection, oiling and retightening), design to retain the healthy condition of equipment and
prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2a. Periodic maintenance (Time based maintenance - TBM):

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

2b. Predictive maintenance:

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

In this concept, OPERATORS operates the machines for production and the MAINTENANCE group is responsible with work of maintaining those machines, however, maintenance became a problem as more maintenance personnel are required.

3. Autonomous Maintenance:

When the maintenance part is not always controlled by outside forces like maintenance group and the operator can able to handle it everyday, called autonomous maintenance.

4. Productive Maintenance:

Thus preventive maintenance along with Maintenance prevention and Maintainability Improvement gave birth to (4) Productive maintenance. According to Nakajima, ‘Total productive Maintenance is productive maintenance carried out by all employees through small group activities. In TPM, the machine operator is responsible for the maintenance of the machine as well as its operation.

What is Total Productive Maintenance?

It can be considered as the medical science of machines. Total Productive Maintenance (TPM) is a maintenance program which
involves a newly defined concept for maintaining plants and equipment. TPM seeks to maximize equipments effectiveness throughout the life time of that equipment. It strives to maintain optimum equipment conditions in order to prevent unexpected break downs, speed loses, and quality defects arising from process activities.

- **Total** = all encompassing by maintenance and production individuals working together.
- **Productive** = Production of goods and services that meet or exceed customer’s expectations.
- **Maintenance** = Keeping equipments and plant in as good as or better than the original condition at all times

The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.

TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process.

The goal is to hold emergency and unscheduled maintenance to a minimum.

**Why TPM / The objective of TPM:**

TPM was introduced to achieve the following objectives:

- Avoid wastage in a quickly changing economic environment.
- Producing goods without reducing product quality.
- Reduce cost.
- Produce target quantity at the earliest possible time.
- Goods send to the customers must be non defective.
To fulfill those objectives and the goal TPM has dual targets: 1. Zero defects, zero accidents and zero loss; 2. Zero breakdown (100% equipment availability). It is true that when defects and breakdown are reduced the operating costs come down and hence productivity increases and the products are delivered to the customer at a reasonable cost and at the right time.

**Six core principles of TPM:**

- Obtain Minimum 90% OEE (Overall Equipment Effectiveness) Run the machines even during lunch. (Lunch is for operators and not for machines!)
- Operate in a manner, so that there are no customer complaints.
- Reduce the manufacturing cost by 30%.
- Achieve 100% success in delivering the goods as required by the customer.
- Maintain a accident free environment.
- Increase the suggestions by 3 times. Develop Multi-skilled and flexible workers.

Now the question comes -why should we consider TPM is an effective tech. for continuous Improvement? Because it

- Aims to maximize equipment effectiveness – overall effectiveness.
- Various departments – engineering, operations, and Maintenance – collectively implement it.
- Involves every single employee from the top management to workers in the shop floor.
- In TPM the machine operator is responsible for the maintenance of the machine as well as its operation.

However, Smart TPM requires the following:

- Restoring equipment to a like – new condition.
- Having operators involved in the maintenance of the equipment.
- Improving maintenance efficiency and effectiveness.
- Training the labour force to improve upon their job skills.
- Equipment management and maintenance prevention, which is considered inherent in the reliability strategy and
- The effective use of preventive and predictive maintenance technology.
Therefore, the aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment. In 1971, the Japan Institute of Plant Maintenance (JIPM) defined TPM as a system of maintenance. JIPM introduced TPM award to respective organization as a standard of quality in 1972.

| Motives of TPM | 1. Adoption of life cycle approach for improving the overall performance of production equipment.  
                      2. Improving productivity by highly motivated workers which is achieved by job enlargement.  
                      3. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications. |
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<tbody>
<tr>
<td>Uniqueness of TPM</td>
<td>The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of “I (Production operators) Operate, You (Maintenance department) fix” is not followed.</td>
</tr>
</tbody>
</table>
| TPM Objectives | 1. Achieve Zero Defects, Zero Breakdown and Zero accidents in all functional areas of the organization.  
                      2. Involve people in all levels of organization.  
                      3. Form different teams to reduce defects and Self Maintenance. |
| Direct benefits of TPM | 1. Increase productivity and OPE (Overall Plant Efficiency) by 1.5 or 2 times.  
                              2. Rectify customer complaints.  
                              3. Reduce the manufacturing cost by 30%.  
                              4. Satisfy the customers needs by 100% (Delivering the right quantity at the right time, in the required quality.)  
                              5. Reduce accidents.  
                              6. Follow pollution control measures. |
| Indirect benefits of TPM | 1. Higher confidence level among the employees.  
                               2. Keep the work place clean, neat and attractive.  
                               3. Favorable change in the attitude of the
operators.
4. Achieve goals by working as team.
5. Horizontal deployment of a new concept in all areas of the organization.
7. The workers get a feeling of owning the machine.

Steps in introduction of TPM in a organization:

Step A - PREPARATORY STAGE:

STEP 1 - Announcement by Management to all about TPM introduction in the organization:

Proper understanding, commitment and active involvement of the top management is needed for this step. Senior management should have awareness programmes, after which announcement is made to all. Publish it in the house magazine and put it in the notice board. Send a letter to all concerned individuals if required.

STEP 2 - Initial education and propaganda for TPM:

Training is to be done based on the need. Some need intensive training and some just an awareness. Take people who matters to places where TPM already successfully implemented.

STEP 3 - Setting up TPM and departmental committees:

TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

STEP 4 - Establishing the TPM working system and target:

Now each area is benchmarked and fix up a target for achievement.
STEP 5 - A master plan for institutionalizing:

Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

STAGE - B - INTRODUCTION STAGE

This is a ceremony and we should invite all. Suppliers as they should know that we want quality supply from them. Related companies and affiliated companies who can be our customers, sisters concerns etc. Some may learn from us and some can help us and customers will get the communication from us that we care for quality output.

STAGE C - IMPLEMENTATION

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

STAGE D - INSTITUTIONALISING STAGE

By all there activities one would has reached maturity stage. Now is the time for applying for PM award. Also think of challenging level to which you can take this movement.

Organization Structure for TPM Implementation:
PILLAR -1 - JISHU HOZEN ( Autonomous maintenance ):

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

Policy:

1. Uninterrupted operation of equipments.
2. Flexible operators to operate and maintain other equipments.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activities.

JISHU HOZEN Targets:

1. Prevent the occurrence of 1A / 1B because of JH.
2. Reduce oil consumption by 50%
3. Reduce process time by 50%
4. Increase use of JH by 50%
Steps in JISHU HOZEN:

1. Preparation of employees.
2. Initial cleanup of machines.
3. Take counter measures
4. Fix tentative JH standards
5. General inspection
6. Autonomous inspection
7. Standardization and
8. Autonomous management.

Each of the above mentioned steps is discussed in detail below.

1. Train the Employees: Educate the employees about TPM, Its advantages, JH advantages and Steps in JH. Educate the employees about abnormalities in equipments.

2. Initial cleanup of machines:
   - Supervisor and technician should discuss and set a date for implementing step 1
   - Arrange all items needed for cleaning
   - On the arranged date, employees should clean the equipment completely with the help of maintenance department.
   - Dust, stains, oils and grease has to be removed.
   - Following are the things that has to be taken care while cleaning. They are Oil leakage, loose wires, unfastened nits and bolts and worn out parts.
   - After clean up problems are categorized and suitably tagged. White tags is place where problems can be solved by operators. Pink tag is placed where the aid of maintenance department is needed.
   - Contents of tag is transferred to a register.
   - Make note of area which were inaccessible.
   - Finally close the open parts of the machine and run the machine.

3. Counter Measures:
   - Inaccessible regions had to be reached easily. E.g. If there are many screw to open a fly wheel door, hinge door can be used. Instead of opening a door for inspecting the machine, acrylic sheets can be used.
To prevent work out of machine parts necessary action must be taken.
Machine parts should be modified to prevent accumulation of dirt and dust.

4. Tentative Standard:
- JH schedule has to be made and followed strictly.
- Schedule should be made regarding cleaning, inspection and lubrication and it also should include details like when, what and how.

5. General Inspection:
- The employees are trained in disciplines like Pneumatics, electrical, hydraulics, lubricant and coolant, drives, bolts, nuts and Safety.
- This is necessary to improve the technical skills of employees and to use inspection manuals correctly.
- After acquiring this new knowledge the employees should share this with others.
- By acquiring this new technical knowledge, the operators are now well aware of machine parts.

6. Autonomous Inspection:
- New methods of cleaning and lubricating are used.
- Each employee prepares his own autonomous chart/schedule in consultation with supervisor.
- Parts which have never given any problem or part which don't need any inspection are removed from list permanently based on experience.
- Including good quality machine parts. This avoid defects due to poor JH.
- Inspection that is made in preventive maintenance is included in JH.
- The frequency of cleanup and inspection is reduced based on experience.

7. Standardization:
- Upto the previous stem only the machinery/equipment was the concentration. However in this step the surroundings of machinery are organized. Necessary items should be organized, such that there is no searching and searching time is reduced.
- Work environment is modified such that there is no difficulty in getting any item.
Everybody should follow the work instructions strictly.
Necessary spares for equipments is planned and procured.

8. Autonomous Management :
OEE and OPE and other TPM targets must be achieved by continuous improve through Kaizen.
PDCA ( Plan, Do, Check and Act ) cycle must be implemented for Kaizen.

PILLAR -2 – KOBETSU KAIZEN :

"Kai" means change, and "Zen" means good ( for the better ). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Kaizen Target:
Achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Tools used in Kaizen:
1. Problem analysis
2. (Root cause ) Why - Why analysis
3. Summary of losses
4. Kaizen register

PILLAR -3 - PLANNED MAINTENANCE :
It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into 4 "families" or groups which was defined earlier.
1. Preventive Maintenance
2. Breakdown Maintenance
3. Corrective Maintenance
4. Maintenance Prevention

With Planned Maintenance we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment.

Policy :

1. Achieve and sustain availability of machines
2. Optimum maintenance cost.
3. Reduces spares inventory.
4. Improve reliability and maintainability of machines.

Target :

1. Zero equipment failure and break down.
2. Improve reliability and maintainability by 50 %
3. Reduce maintenance cost by 20 %
4. Ensure availability of spares all the time.

Six steps in Planned maintenance :

1. Equipment evaluation and recoding present status.
2. Restore deterioration and improve weakness.
3. Building up information management system.
4. Prepare time based information system, select equipment, parts and members and map out plan.
5. Prepare predictive maintenance system by introducing equipment diagnostic techniques and

PILLAR -4 – Hinshitsu Hozen or QUALITY MAINTENANCE :

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, then move to potential quality concerns.
Transition is from reactive to proactive (Quality Control to Quality Assurance).

QM activities is to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition are checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand.

Policy:

1. Defect free conditions and control of equipments.
2. QM activities to support quality assurance.
3. Focus of prevention of defects at source
4. Focus on poka-yoke. (fool proof system)
5. In-line detection and segregation of defects.
6. Effective implementation of operator quality assurance.

Target:

1. Achieve and sustain customer complaints at zero
2. Reduce in-process defects by 50 %
3. Reduce cost of quality by 50 %.

Pilar – 5: Development Management / Early Management:

Early management or development management helps in drastically reducing the time taken to receive, install, and set–up newly purchased equipments (known as vertical start–up). Early management can also be used for reducing the time to manufacture a new product in the factory.

PILLAR 6 – TRAINING and EDUCATION:

It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-why". By experience they gain, "Know-How" to overcome a problem what to be done. This they do without knowing the root cause of the problem and why they are doing so. Hence it become necessary to train them on knowing "Know-why". The employees should be trained to achieve
the four phases of skill. The goal is to create a factory full of experts. The different phase of skills are:

| Phase – 1: | Do not know |
| Phase – 2: | Know the theory but cannot do. |
| Phase – 3: | Can do but can not teach |
| Phase – 4: | Can do and also teach |

**Policy:**

1. Focus on improvement of knowledge, skills and techniques.
2. Creating a training environment for self learning based on felt needs.
3. Training curriculum / tools /assessment etc conductive to employee revitalization
4. Training to remove employee fatigue and make work enjoyable.

**Target:**

1. Achieve and sustain downtime due to want men at zero on critical machines.
2. Achieve and sustain zero losses due to lack of knowledge / skills / techniques
3. Aim for 100 % participation in suggestion scheme.

**PILLAR- 7: SAFETY, HEALTH AND ENVIRONMENT**

**Target :**

1. Zero accident,
2. Zero health damage

In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis.

A committee is constituted for this pillar which comprises representative of officers as well as workers. The committee is headed by Senior vice President ( Technical ). Utmost importance to Safety is given in the plant. Manager (Safety) is looking after functions related to safety. To create awareness among employees
various competitions like safety slogans, Quiz, Drama, Posters, etc. related to safety can be organized at regular intervals.

**PILLAR -8 : OFFICE TPM**

Office TPM should be started after activating four other pillars of TPM (JH, KK, QM, PM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses. They are

1. Processing loss
2. Cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories
3. Communication loss
4. Idle loss
5. Set-up loss
6. Accuracy loss
7. Office equipment breakdown
8. Communication channel breakdown, telephone and fax lines
9. Time spent on retrieval of information
10. Non availability of correct on line stock status
11. Customer complaints due to logistics
12. Expenses on emergency dispatches/purchases

**Conclusion:**

Today, with competition in industry at an all time high, TPM may be the only thing that stands between success and total failure for some companies. It has been proven to be a program that works. It can be adapted to work not only in industrial plants, but in construction, building maintenance, transportation, and in a variety of other situations. Employees must be educated and convinced that TPM is not just another "program of the month" and that management is totally committed to the program and the extended time frame necessary for full implementation. If everyone involved in a TPM program does his or her part, an unusually high rate of return compared to resources invested may be expected
**Six Sigma**

**Introduction:**

Six sigma is a long journey. However, it is one of the rewarding journeys that an individual or company may elect to take. Six Sigma is many things, but foremost it is a data driven leadership approach using specific tools and methodologies that lead to fact based decision – making. The focus is on performance throughout the organization. The resulting culture of leaders is one that does not tolerate waste or inefficiency. It is very creative in its approach to doing business, and it offers solutions that exceed the customer’s requirements and expectations.

The concept of a culture of leaders may seem strange at first glance. Yet one of the things that Six Sigma does is empower individuals throughout the organization to develop individual leadership skills and capabilities. This is accomplished through projects that teach them to gather data, analyze them, and as a part of a team, determine the best course of action for the company to follow to enhance performance.

Six Sigma pioneer Motorola started the program in 1987. It took five full year to see significant results of six sigma. Motorola attributes 15 billion dollars in savings over the past 11 years to Six Sigma. In 1997, General electric (GE) invested 380 million US dollars in Six Sigma mostly for trainings, and in the same year GE received 700 million US dollars in documented benefits from increased productivity.

The basic of Six sigma quality initiative, very briefly, means going from approximately 35,000 defects per million operations, which is average for most companies, including GE, to fewer than four defects per million in every element in every processes that this company engages in every day.

Six sigma has been adopted as a quality philosophy by companies such as Texas Instruments, Allied signal, Eastman Kodak, and in India by ICICI, Godrej Appliances etc. Godrej Appliances is one of the few companies in India where the six sigma initiative was started as early as 1995, courtesy GE (JV partner). Another Six Sigma project at Godrej Appliances was related to remittance of payment made anywhere in the country to their Mumbai headquarters. Earlier, it used to take 4—5 days at least, but six sigma resulted in a reduction in this duration to bring it down to 3.46 days. The reduction was only marginal, but it resulted in savings around Rs. 1 Crore.

**What is Six Sigma exactly means:**
• Six sigma is a way of thinking and the results of the approach can yield a spectrum of improvement choices based on the balance of values and risk.

• Six sigma is an internationally recognized management process focused on producing high quality products or services to meet the customer’s need and satisfaction.

• Six Sigma is not a set of statistical tools, neither it is a bureaucratic, stage-gate approach to managing the projects but it represents a philosophy to reduce variation continuously and create a win-win situation for all the partners in and around the business or services.

• Motorola describe Six Sigma as a standard methodology "for driving and achieving transformational change within an organization. It is a business improvement process that focuses an organization on customer requirements, process alignment, analytical rigor, and timely execution."

**Objectives of Six Sigma:**

• To reduce variation.
• To solving the problems in scientific manner.
  Six Sigma places an emphasis on the DMAIC approach (define, measure, analyze, improve, and control) to problem solving.
• To develop the bottom line responsibilities towards continuous improvement.
  Organizations using Six Sigma often utilize teams that are assigned well-defined projects with a direct impact on the bottom line.
• To create importance on Business level strategy
  Upper management typically supports Six Sigma as a key of business strategy.

**THREE KEY CHARACTERISTICS OF SIX SIGMA**

1. **Leadership Commitment**

Achieving Six Sigma is not easy – it requires serious commitment in the form of time, effort, and resources. For a company to be successful, such commitment must come first from the top executive leadership of the organization and must be practiced by everyone.

2. **Managing Decisions with Data**

It is not enough to run a business based on one's experience or "tribal knowledge." Decisions must be based on data versus the typical "I think", "I feel", or "In my opinion" practices that often exist today. With the maturation of the information economy, data is available to virtually everyone in the organization, along with the tools for analyzing that data. Properly using data to Measure, Analyze, Improve, and Control performance forms the foundation of the Six Sigma methodology.
3. Training and Cultural Change

Improved performance does not and will not happen automatically. High-caliber training is required. Disciplined implementation must follow, and people at all levels have to change the way they go about doing their jobs. In short, new ways of thinking, communicating, and operating must pervade the entire organization. You also need a methodology. DMAIC and DFSS provide a structured problem solving roadmap and tools towards obtaining the results you expect.

Six Sigma Tools kits and its overview:

- DMAIC Process
- Six Sigma Training Hierarchy
- Poaka - Yoka
- The Seven Magnificent Quality Tools
  - Histogram
  - Ishikawa’s fish bone diagram
  - Flowcharts
  - Pareto Chart
**Full Six Sigma Deployment**

The core elements of implementing Six Sigma – training for Black Belts, Green Belts, Yellow Belts, Ground School, Master Black Belt, Leading Six Sigma, RADD and Senior Executive Six Sigma – to deliver Six Sigma skills throughout your organization.

**Green belt Training:**

This course is designed to enhance technical problem solving skills in line managers. Participants will successfully complete a project while completing the classroom portion of the training.

Green Belt Certification takes candidates through a proven, step-by-step training course based on the transfer of knowledge and process skills that leads to improved
project results through support of Black Belt initiatives and enhanced technical problem solving skills. Courses are designed to include sophisticated adult learning theory and no-nonsense evaluation of learning success, while supporting the framework for true cultural change within an organization.

Manufacturing Green Belt Certification is a 6-8 week course involving 11 days of classroom training. Classroom training consists of 3 modules, each followed by 2-3 week periods of “real world” project-driven applications in the workplace.

**Black Belt Training:**

The Black Belt is a key change agent for the Six Sigma process. Typically the "best of the best," these individuals lead teams working on chronic issues that are negatively impacting the company’s performance.

Black Belt Certification takes candidates through a proven, step-by-step training course based on the transfer of knowledge and process skills that lead to improved customer satisfaction, increased profit margins, shortened cycle times and reduced costs. Courses are designed to include sophisticated adult learning theory and no-nonsense evaluation of learning success, while constructing the framework for true cultural change within an organization.

Typically, the entire Black Belt training investment can be justified by results from the first project. The median return on each trained Black Belt is in and around $100,000 per project.

**Master Black Belt (MBB)**

As a leader, the MBB will have responsibility for overseeing projects with multiple Black Belt and Green Belt participation that will significantly change the way the organization does business.

**MBB program delivers:**

- Project Management skills to ensure project completion.
- Advanced tools and capabilities useful in daily activities.
- Mentoring skills to achieve results, transfer knowledge more effectively.

**The Program**

For an example, Six Sigma Qualtec a premier Six Sigma Training Institute, create a customized program to meet training needs.

Master Black Belt candidates are certified after completing their Super Project and the required course work, both of which specifically address your organization’s goals. The training duration varies but includes 13-19 days of instruction over a period of 6-12 months.

The two primary components of the MBB Certification:
1. Individual MBB Candidate Mentoring: the personalized review of prerequisite credentials, the Super Project, and the evaluation and certification of teaching and mentoring; and

2. Advanced Study Options: the classroom instruction portion of the program.

Mentorship and Project Management Skills

MBB candidates will mentor several individuals who are working on Six Sigma projects or other problem solving efforts. Six Sigma instructors evaluate their mentoring abilities using defined criteria to measure the breadth and development of these skills. A positive evaluation will earn the candidate a mentorship certification.

**Design for Six Sigma (DFSS)**

Design for Six Sigma (DFSS) is a rigorous approach to designing products and services to meet customer expectations. Companies implementing Six Sigma find that many defects are actually created during the design process. DFSS facilitates a redesign of processes – factoring in manufacturing and transactional capabilities from the very beginning – and ensures that end products are “producible” using existing technology. Additionally, DFSS integrates the engineering and process design functions enabling concurrent product and process design, thereby eliminating defects before they can occur.

Integrating the principles of MAIC (Measure, Analyze, Improve, Control) with design tools and the IDEaS™ (Initiate, Design, Execute and Sustain process), the result is product designs that consistently meet Six Sigma standards – from inception.

**Methodology:**

Mention Six Sigma and you will hear folks refer to a mnemonic known as DMAIC. DMAIC stands for Define, Measure, Analyze, Improve and Control. These steps represent the five components of the Six Sigma improvement process.

**Define.** The key to the first step is for your team to ask: What is important? What are the areas that you see as a chance to make an improvement that will reach the organization's objectives and grant the greatest outcome? To do this, use a SIPOC diagram. On a white board, write at the top Suppliers, Inputs, Processes, Outcomes and Customers and under each heading define that aspect of the process. Breaking down a process and its parts so everyone can see them offers a good first step for gaining an objective appreciation of the process you wish to improve.

**Measure.** Often we brainstorm on a process and make adjustments with the hope of improving it before we've ever taken the time to measure how the process is doing in the first place. The second step involves measuring the process you hope to improve. This allows the establishment of a benchmark of current performance and the ability to differentiate between variations in the process that are common and those that are of a special cause.
**Analyze.** Now, we get to finally ask what's wrong. Step three is traditionally where most folks begin their improvement efforts. In this improvement effort, however, we enter this phase with a clearly defined process and objective data to help us investigate the root cause of its issues. This helps us avoid focusing attention on what we perceive to be the problem and aligns us toward accurately targeted solutions.

**Improve.** The first three steps of the DMAIC process form the foundation for asking what needs to be done. What are the possible solutions and how do we execute the best one? Now that you have an informed perspective on the process and potential problems, you are in a good position to assess various solutions, evaluate their potential success and develop a sound implementation plan.

**Control.** The final phase of the process involves an often forgotten and misunderstood step in a change process. Once a solution has been implemented and the data shows you are achieving the desired improvement, how do you sustain the new level of performance? With confirmation in hand that your improvement is effective, verifiable and reproducible, it’s time to mesh the new process into day-to-day operating practices. Doing so ensures that the new and improved process replaces its troubled predecessor. Only then will the process truly be improved and the initial problem remains fixed.

<table>
<thead>
<tr>
<th>Define the priorities of the customers with respect to quality</th>
<th>Measure the processes and the defects arising in the product due to the process</th>
<th>Analyse the process to determine the most likely causes of defects</th>
<th>Improve the performance of the process and remove the causes of the defects</th>
<th>Control to ensure that the improvements are maintained over time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the problem</td>
<td>Brainstorming</td>
<td>Identify the cause of the problem</td>
<td>Eliminate (define effect of the cause)</td>
<td>Maintaining the solution (control)</td>
</tr>
<tr>
<td>Cost Benefit priority</td>
<td>Cause and effect diagram</td>
<td>Identify the problem solving team</td>
<td>Assure employees involvement</td>
<td>Control Chart</td>
</tr>
<tr>
<td>Written project statement and Identify process owner</td>
<td>Apply basic tools: Pareto 80/20 chart, Check sheet, Process Map.</td>
<td>Build their capacity through training</td>
<td>Change the process for common cause</td>
<td>Revised standard operating procedures</td>
</tr>
<tr>
<td>For project Implement technique set and develop</td>
<td>QFD (Quality function development)</td>
<td>Prepare the improvement plan</td>
<td>Aim to increase of EBIT (Earning before</td>
<td>Design for six sigma (DFSS)</td>
</tr>
</tbody>
</table>
Motorola’s Six Sigma as an example:

Motorola’s six sigma quality levels allow an off centring of the process up to 1.5 sigma. Table given below shows the number of defectives (parts per million) for specified off-centring of the process and quality levels. Note that in the table the first row shows the DPMO (Defects Per Million Opportunities), where there is no off-centring of the process. At 3 sigma quality level, it shows the DPMO as 2700, while at 6 sigma quality level the DPMO is 0.002, that is, 2 defects per billion. For an off-centring of 1.5 sigma (row 7) and six sigma quality level, the DPMO is given as 3.4. Thus, Motorola has quality level such that 3.4 defects per million are allowed.

<table>
<thead>
<tr>
<th>Sigma / Quality level</th>
<th>Off centring</th>
<th>3 Sigma</th>
<th>3.5 Sigma</th>
<th>4 Sigma</th>
<th>4.5 Sigma</th>
<th>5 Sigma</th>
<th>5.5 Sigma</th>
<th>6 Sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2700</td>
<td>465</td>
<td>63</td>
<td>6.8</td>
<td>0.57</td>
<td>0.034</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>0.25 Sigma</td>
<td>577</td>
<td>666</td>
<td>99</td>
<td>12.8</td>
<td>1.02</td>
<td>0.1056</td>
<td>0.0063</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>6440</td>
<td>1382</td>
<td>236</td>
<td>32</td>
<td>3.4</td>
<td>0.71</td>
<td>0.019</td>
<td></td>
</tr>
<tr>
<td>0.75</td>
<td>12288</td>
<td>3011</td>
<td>665</td>
<td>88.5</td>
<td>11</td>
<td>0.02</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>22832</td>
<td>6433</td>
<td>1350</td>
<td>233</td>
<td>32</td>
<td>3.4</td>
<td>0.39</td>
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<tr>
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<td>40111</td>
<td>12201</td>
<td>3000</td>
<td>577</td>
<td>88.5</td>
<td>10.7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>66803</td>
<td>22800</td>
<td>6200</td>
<td>1350</td>
<td>233</td>
<td>32</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>1.75</td>
<td>105601</td>
<td>40100</td>
<td>12200</td>
<td>3000</td>
<td>577</td>
<td>88.4</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>158700</td>
<td>66800</td>
<td>22800</td>
<td>6200</td>
<td>1300</td>
<td>233</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

For a process without off-centring, 3.4 defects per million lie somewhere between 4.5 and 5 sigma quality level. In row one (for zero off centring) , the 4.5 sigma quality level has DPMO of 6.8, while 5 sigma quality level has DPMO 0.57. Thus the value DPMO 3.4 lies somewhere between DPMO 0.57 and 6.8 (i.e between 4.5 and 5 sigma quality level with an off-centring of 1.5 sigma, in other words, they produce 66,803 defectives out of every million units produced. Thus, Motorola and GE have made a quantum leap in quality enhancement.

Conclusion:

Defining a problem is the most critical part of the Six Sigma methodology. A problem defined is a problem half-solved. We can dance around a problem as much as we want, but if we don't define it properly, we will run around in circles, writing corrective action reports and working on keeping people busy.
The distinctive feature of Six Sigma is its integrated approach. Jim has said that TQM has evolved. Six Sigma takes all those tools that have been developed and integrates them into a structured approach. We can use all those tools and define it as a methodology and clarify the intent. Six Sigma requires aggressive goal setting. Six Sigma is about innovation because we must learn to be intellectually engaged with our processes.

Again, Six Sigma is like running, and TQM is like walking. Six Sigma is results-oriented and learnable, and TQM is ill-defined, philosophy-driven and, overall, very questionable. The methodology still needs to find a way to simplify and clarify its approach so that people can do something with it. We need systems that are performance-driven.

The fundamental difference is the intent. TQM is for incremental and continual change, and Six Sigma represents rapid, radical and dramatic change through innovation. It's not about behavioral or cultural change; it's about intellectual engagement. The question is, how do you get people intellectually involved to drive dramatic improvement? Tom Peters said that it's not difficult to learn new things; what's difficult is forgetting old things. If you're having difficulty forgetting the old method of TQM, then move beyond TQM to Six Sigma.

Six Sigma works; TQM has not worked. To summarize, Six Sigma is a TQM baseline system powered by a new approach. Six Sigma has been the most successful methodology to date in introducing corporate improvement. Six Sigma provides focused, real-world results. Therefore, the main contrast between Six Sigma and TQM are as follows:

<table>
<thead>
<tr>
<th>SIX SIGMA</th>
<th>TQM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Executive Ownership</td>
<td>• Self directed work teams</td>
</tr>
<tr>
<td>• Business Strategy execution system</td>
<td>• Quality Initiative</td>
</tr>
<tr>
<td>• Truly cross functional</td>
<td>• Largely within a single function</td>
</tr>
<tr>
<td>• Focused training with verifiable return on investment</td>
<td>• Mass training with no quantified return on investment</td>
</tr>
<tr>
<td>• Business result oriented</td>
<td>• Quality oriented</td>
</tr>
</tbody>
</table>
Poka Yoke:

Shigeo Shingo was one of the industrial engineers at Toyota who has been credited with creating and formalizing Zero Quality Control (ZQC), an approach to quality management that relies heavily on the use of poka-yoke (pronounced POH-kah YOH-kay) devices. Poka-yoke is Japanese for mistake-proofing. These devices are used either to prevent the special causes that result in defects, or to inexpensively inspect each item that is produced to determine whether it is acceptable or defective.

A poka-yoke device is any mechanism that either prevents a mistake from being made or makes the mistake obvious at a glance. The ability to find mistakes at a glance is essential because, as Shingo writes, "The causes of defects lie in worker errors, and defects are the results of neglecting those errors. It follows that mistakes will not turn into defects if worker errors are discovered and eliminated beforehand" [Shingo 1986, p.50]. He later continues that "Defects arise because errors are made; the two have a cause-and-effect relationship. ... Yet errors will not turn into defects if feedback and action take place at the error stage" [Shingo, 1986, p. 82]. We suspect that Shingo and Deming would have a protracted discussion about whether workers or management are responsible for defects. No resolution of that issue is undertaken here.

An example cited by Shingo early in the development of poka-yoke shows how finding mistakes at a glance helps to avoid defects. Suppose a worker must assemble a device that has two push-buttons. A spring must be put under each button. Sometimes a worker will forget to put the spring under the button and a defect occurs. A simple poka-yoke device to eliminate this problem was developed. The worker counts out two springs from a bin and places them in a small dish. After assembly is complete, if a spring remains in the dish, an error has occurred. The operator knows a spring has been omitted and can correct the omission immediately. The cost of this inspection (looking at the dish) is minimal, yet it effectively functions as a form of inspection. The cost of rework at this point is also minimal, although the preferred outcome is still to find the dish empty at the end of assembly and to avoid rework even when its cost is small. This example also demonstrates that poka-yoke performs well when corrective action involves trying to eliminate oversights and omissions. In such cases, poka-yoke devices are often an effective alternative to demands for greater worker diligence and exhortations to "be more careful."

An example of a poka-yoke device at General Motors (GM) was described by Ricard [Ricard, L.J., "GM's just-in-time operating philosophy", in: Y. K. Shetty and V. M. Buehler, (Eds.), Quality, Productivity and Innovation. Elsevier Science Publishing, New York, 1987, pp. 315-329.]: "We have an operation which involves welding nuts into a sheet metal panel. These weld nuts will be used to attach parts to the car later in the process. When the panel is loaded by the operator, the weld nuts are fed automatically underneath the panel, the machine cycles, and the weld nuts are welded to the panel. You must remember these nuts are fed automatically and out of sight of
the operator, so if the equipment jams or misfeeds and there is no part loaded, the machine will still cycle. Therefore, we have some probability of failure of the process. An error of this nature is sometimes not detected until we actually have the car welded together and are about to attach a part where there is not a nut for the bolt to fit into. This sometimes results in a major repair or rework activity."

"To correct this problem, we simply drilled a hole through the electrode that holds the nut that is attached to the panel in the welding operation. We put a wire through the hole in the electrode, insulating it away from the electrode so as it passes through it will only make contact with the weld nut. Since the weld nut is metal, it conducts electricity and with the nut present, current will flow through, allowing the machine to complete its cycle. If a nut is not present, there will be no current flow. We try to control the process so that the machine will actually remain idle unless there is a nut in place."

Shingo identified three different types of inspection: judgment inspection, informative inspection, and source inspection.

**JUDGMENT INSPECTION**

**INFORMATIVE INSPECTION**

**SOURCE INSPECTION**

**Judgment inspection** involves sorting the defects out of the acceptable product, sometimes referred to as "inspecting in quality." Shingo agreed with the consensus in modern quality control that "inspecting in quality" is not an effective quality management approach, and cautioned against it.

**Informative inspection** uses data gained from inspection to control the process and prevent defects. Traditional SPC is a type of informative inspection. Both successive checks and self-checks in ZQC are also a type of informative inspection. Successive checks were Shingo's response to the insight that improvements are more rapid when quality feedback is more rapid [1986, pp. 67-69]. Work-in-process undergoes many operating steps as it is moved through a manufacturing facility. Often inspections are conducted at intermediate stages in the process. Shingo's concern was that the inspections may not occur soon enough after production to give the best information necessary to determine the cause of the quality problem so that it can be prevented in the future. By having each operation inspect the work of the prior operation, quality feedback can be given on a much more timely basis. Successive checks are having the nearest downstream operation check the work of the prior operation. Each operation
performs both production and quality inspection. Effective poka-yoke devices make such an inspection system possible by reducing the time and cost of inspection to near zero. Because inspections entail minimal cost, every item may be inspected. Provided that work-in-process inventories are low, quality feedback used to improve the process can be provided very rapidly.

While successive checks provide rapid feedback, having the person who performs the production operation check their own work provides even faster feedback. Self-checks use poka-yoke devices to allow workers to assess the quality of their own work. Because they check every unit produced, operators may be able to recognize what conditions changed that caused the last unit to be defective. This insight is used to prevent further defects. Self-checks are preferred to successive checks whenever possible.

Since the main difference between successive checks and self-checks is which work station performs the inspection, in this research we do not distinguish between the two types of informative inspection. Both successive and self-checks provide information "after the fact."

**Source inspection** determines "before the fact" whether the conditions necessary for high quality production exist. (Note that Shingo's use of the term source inspection is not the practice of having the buyer's representative inspect the quality of work-in-progress at the supplier's facility, which is also called source inspection.) Shingo writes, "It had dawned on me that the occurrence of a defect was the result of some condition or action, and that it would be possible to eliminate defects entirely by pursuing the cause" [Shingo, 1986, p.50]. He further writes that "I realized that the idea of checking operating conditions before the operations rather than after them was precisely the same as my concept of source inspection" [Shingo,1986, p.51].

With source inspection, poka-yoke devices ensure that proper operating conditions exist prior to actual production. Often these devices are also designed to prevent production from occurring until the necessary conditions are satisfied. Norman [1988] refers to this type of device as a "forcing function." The example from GM that "forces" the nut to be present before welding can occur is an example of source inspection.

Source inspection, self-checks, and successive checks are inspection techniques used to understand and manage the production process more effectively. Each involves inspecting 100 percent of the process output. In this sense, zero quality control is a misnomer. These inspection techniques are intended to increase the speed with which quality feedback is received. And although every item is inspected, Shingo was emphatic that the purpose of the inspection is to improve the process and prevent defects, and therefore is not intended to sort out defects (although in some cases that may also be an outcome) [Shingo,1986, p. 57]. Shingo believed that source inspection is the ideal method of quality control since quality feedback about conditions for quality production is obtained before the process step is performed. Source inspection is intended to keep defects from occurring. Self-checks and successive checks provide feedback about the outcomes of the process. Self-checks and successive checks should be used when source inspection cannot be done or when the process is not yet well enough understood to develop source inspection techniques.
In Shingo's seminal book on ZQC [1986], he criticized SPC and suggested that ZQC should supplant SPC as the pre-eminent tool for defect elimination in quality control. His main argument against SPC was that it is by nature an intermittent form of inspection, and therefore allows for some number of defects to occur. He further argued that SPC is designed to maintain the current level of defects, rather than to aggressively seek to eliminate them. In addition, Shingo claimed that "...a look at SQC methods as they are actually applied shows that feedback and corrective action - the crucial aspects of informative inspections - are too slow to be fully effective." [Shingo, 1986, p.68]

Given the fact that applications of SPC generally have substantial intervals between the taking of samples, it seems reasonable to argue that feedback will be faster with source inspection and informative inspection in ZQC. However, it is not clear that ZQC should be systematically faster than SPC at insuring corrective actions. Indeed, according to Shingo [Shingo, 1986, p.71], "Defects will never be reduced if the workers involved do not modify operating methods when defects occur." The willingness to take corrective action is a function of the attitude and commitment of both managers and workers, not an intrinsic attribute of a particular approach to quality management. Shingo's complaint about the actual implementation of SPC may also apply to ZQC.

A detailed, academic treatment of the relationship between SPC and ZQC is presented in working papers by Grout and Downs (1995). The essence of their conclusions is when used for informative inspection,

- ZQC is not as effective as SPC for defects that result from variance in measurement data
- ZQC is a special case of SPC for defects that result from variance in attribute data.
- ZQC's source inspection can be used effectively to eliminate mistakes and in conjunction with SPC to eliminate the recurrence of special causes.

Therefore, Shigeo Shingo explained that for ZQC, the following three components have to be followed:

1. **Source Inspection**: In this form of inspection, factors causing defects are inspected rather than the resulting defects.
2. **100% Inspection**: Inexpensive poka yoka are used for automatic 100% inspection of items and defective operating conditions.
3. **Immediate action**: wherever a mistake is detected, operations are stopped immediately and resumed only upon corrective action.

**Zero Defect Planning**:

1. Explaining the concept and program to all the supervisors and preparing them to explain it to their people.
2. Determination of the material required and assuring its preparation.
3. Deciding what method of launching a program will be the best for any particular operation.
4. Spelling out the functions that will be accomplished.
5. Examining the recognition policy of the industry and determining what type of recognition should be used in praising improved performance.
6. Setting up the time schedules, and making the participants rehearse.
7. Identifying the error – cause program and making plans for its execution.

Now the question come how we can implement poka yoka in our organization.

- Educate the team about poka-yoke devices
- Find the source of the errors
- Brainstorming

**Brainstorming** is a method for developing creative solutions to problems unanimously. It works by focusing on a problem, and then coming up with as many deliberate, unusual solutions as possible and by pushing the ideas as far as possible. *According to Mr. Alex F. Osborne: The father of brainstorming, “it is a tool for maximizing a group’s creativity in problem solving”. It is ‘a conference technique by which a group attempts to find a solution for a specific problem by amassing all the ideas spontaneously by its members”*

**How Brainstorming?**

The following rules are important for successful brainstorming:

- Make sure everyone understands and is satisfied with the central questions before you open up for ideas.
- You may want to give everyone a few seconds to jot down a few ideas before getting started
- Being by going around the table or room, giving everyone a chance to voice his or her ideas or pass. After a few rounds, open the floor.
- More ideas are better. Encourage radical ideas and piggybacking.
- Suspend judgment for all ideas.
- Record exactly what is said. Clarify only after everyone is out of ideas
- Don’t stop until ideas become sparse. Allow for late coming ideas
- Eliminate duplicates and ideas that are’nt relevant to the topic.
- Set out the rules for any B. session.
- Once finished the B session, go through the results and share with everyone for immediate response.

**Conclusion:**

It is true that Poka Yoka devices are simple and inexpensive, and used for 100% inspection of all the items produced so that zero defects can be achieved, but this is not applicable for every organization until and unless they able to develop the organization as a centre of excellence (*Total Culture Change for continual improvement*).