This chapter includes the suggestions made by researcher for the sample companies. These suggestions are based on the discussions done in the previous chapter. Recommendations have been made separately for each critical element of TQM.

**Design and Development Assurance**

1. MUL and GMI should regularly verify the designing of products giving prime importance to customer needs and market requirements.
2. MUL and GMI should improve their system of analyzing customer returns, complaints, and feedback of failures in systematic manner. All failures and complaints should be related to mechanical, electrical, metallurgical, thermal etc properties of materials and parts used in product designs.
3. GMI and TATA motors need institution of failure analysis programmes in a big way. This would also help in verification and validation of design change by simulation/alternate calculations.
4. Statistically designed experiments with quality critical variables based on Taguchi’s concept should be used by all companies to improve quality by design.

**Vendors Control**

1. MUL and GMI should carry out process capability studies of vendors more regularly in order to ascertain their suitability to provide desirable specifications and predict inspection requirements on receipt of materials from such vendors.
2. Companies should pre-qualify more and more vendors on an objective basis. At least 2/3 of the vendors be pre-qualified on the basis of their performance. All the sample companies ought to focus more on this aspect. Post-contract performance awards should be installed to reward vendors for their exemplary performance and cost-reduction.
3. MUL and GMI should develop a formal mechanism for settling quality disputes with vendors. For this these companies should increase training sessions for vendors and also can provide technical help.

**Control of Purchased Material**

1. MUL and GMI should develop proper in-coming quality inspection plans based on statistical sampling.
2. MUL and GMI should maintain source-inspection test records in order to avoid duplicate test and inspection efforts upon receipt and have pre-certified quality.

3. Percent supplies accepted as concessional quality is still quite high in the range of 1-5-10%. In order to have zero defects, companies could try to bring down concessional quality to nil level.

**Process Engineering, Verification, and Analysis**

1. MUL should focus more on carrying out verification of process capabilities of quality critical processes to meet product specifications and tolerances.

2. HSCIL and TATA motors should establish workmanship standards for each operation in the quality critical processes.

3. MUL should carry out process flow analysis through methods engineering particularly Flow Process Charts at regular intervals in order to have continuous process simplification and improvement.

4. MUL and TATA motors need to improve their mechanism to identify special processes, which affect product quality only after use.

5. In MUL, there is a need to carry out analysis of pre-pilot/pilot runs of processes critical for quality and adjust process plans based on this more frequently.

6. In MUL and TATA motors, most of the work instructions for process are maintained at centralized level. There is dire need of documenting process-instructions for operators at decentralized level.

7. MUL also need to qualify process operations, control conditions, equipments and operators for special processes on more urgent and regular basis.

**Process Control**

1. There is scope for HSCIL to go in for automatic inspection, mistake-proofing devices and non-destructive technologies (NDT’s) for on-stream condition based monitoring of controlled conditions and parameters for the quality-critical processes.

2. It is highly recommended for HSCIL and GMI to improve and increase the use of fixed inspection stations at different stages of quality control.

3. HSCIL should try to reinforce a schedule based condition based maintenance (CBM) programme for on-stream inspection of process.

4. MUL should increase number of audits at manufacturing process.
5 Statistical analysis of rejects/ rework/failure needs to be done in a more systematic manner by MUL and TATA motors. The analysis could be useful in reduction of quality failure costs and losses as advocated by Taguchi.

6 MUL and TATA motors should try to find out new methods and techniques for SPC suited to the quality critical processes being carried out and use visual control charts for easier control.

7 MUL and GMI should set-up effective procedures and emphasize on process control with feedback mechanism to adjust the process and/or machines.

**Maintenance of Production and Auxiliary Facilities**

1 HSCIL, GMI, and TATA motors must reduce the inventory levels from the prevailing 2-10 days, to say maximum of a day for cost effectiveness and efficiency in use of materials. If JIT could be impractical, let there be inventory for a limited period only. It could be n-JIT (near JIT) if not JIT. More companies should follow use of visual stock cards (Kanbans), single if not double for stream-lining material issues and receipts based on demand-pull created at the work centres.

2 All the companies should work to reduce the ratio of breakdown maintenance as a ratio of breakdown maintenance as a ratio of total maintenance and proper predictive and preventive maintenance be undertaken for machines and utilities based on analysis of failure data. A total preventive maintenance (TPM) programme should be implemented consisting of proper mix of:
   a. Improvement maintenance (Reliability engineering-design out maintenance).
   b. Corrective maintenance (Breakdown, repair, remedial, unscheduled, trouble shooting and diagnostic fault detection).
   c. Preventative maintenance (condition monitoring, looking for threshold conditions of quality critical parameters).
   d. Predictive maintenance (use of tools, statistics and probability to detect trends in failure and take preventive measures).
   e. Schedule Preventive maintenance.

**Measurement Assurance: Inspection, Testing and Calibration**

1 GMI should improve its system of identifying correct measurements and specification for inspection and test purpose giving prior importance to customer feedback.
For MUL, GMI, and TATA motors care need to be given to proper maintenance of test and inspection status of all in-process materials and final product. The status should be granted or withdrawn only by qualified, competence and authorized personnel for the purpose.

Non-Conformity (NC): Analysis and Control

1. GMI should display non-conformity (NC) in relevant work areas for periodic summarization and reporting in terms of quality achievement.

2. GMI should identify NC’s by quaranting, labeling, marking and placing in demarcated areas for disposition.

3. Quite a significant level of non-conformity (5-10%) has been observed in HSCIL and TATA motors even after complete product verification and testing indicating thereby less stringent process control, poor incoming quality, generation of rework and poor skill of operators. All this requires that corrective and preventive actions be taken in concerned areas in order to reduce final levels of non-conformity (NC).

4. There is still a significant volume of scrap and rework being generated in most companies to the extent of 2-10% of production volume which could be further lowered by sustained methods engineering and training of man power.

5. GMI should increase its frequency of taking corrective and preventive actions based on traceability of NC. All the changes implemented by virtue of changes in procedures due to corrective actions taken to prevent non-conformity (NC) should be properly recorded for better follow-ups and supervision, improvisations upon suggested action and analyzing feedback.

Post-Production Functions: Handling, Storage, Packaging, Preservation and Delivery

1. The use of stock card control system like Kardex needs to be introduced and implemented properly by MUL and GMI in order to have integrated codification, identification, indexing, stock control and replenishment systems for materials.

2. TATA motors need to improve its design of packaging material and methods based on rigors of transport so as to reduce the damages to products while transportation.

3. There is still a scope for improvement in packaging system and its integration with modes of transportation and delivery in most companies across all industries. The extent of damage during storage and transit needs to be further decreased especially in HSCIL and TATA motors where it is 5-10%. There is a need to validate new packaging materials and
methods through mock-up tests, etc. Unitisation of loads for packaging also needs to be implemented in a big way to eliminate in-transit damages and conform to international standard material handling, traffic and transportation requirements particularly in view of multi-modal transport.

**Product Installation and Servicing**

1. GMI need to have qualified service staff in terms of product knowledge and skills in trouble shooting and repair.

2. MUL need to develop a mechanism to trace these installation problems to manufacturing stage, installation stage itself, and non availability of service personnel.

3. GMI and MUL need to tackle problem of non-availability of service-spares to improve installation servicing. For this, companies should study spare-parts consumption pattern and develop appropriate spare-parts control and replenishment policies.

4. HSCIL and TATA motors need to reduce returns from sites during installation to nil as it lessens confidence in the mind of customer. To avoid this, only perfect quality product should be delivered at the customers end in order to have defect-free installation ultimately ensuring smoother post-installation service operations.

**Customer Feedback, Servicing and Satisfaction; Product Liability and Quality Costs**

1. GMI need to develop a mechanism for compiling customer returns and complaints, and analyse them on a more frequent and regular basis, say atleast on monthly basis and this should be done not only within warranty period but outside warranty period also.

2. TATA motors should emphasize more on compilation of feedback from post-installation servicing to customer on a monthly/quarterly/ half yearly basis.

3. Though HSCIL, GMI, and TATA motors do have training and awareness programmes for customers, mostly through technical brochures and demonstrations relating to use and maintenance of product. MUL should try to develop simple training, awareness and orientation programmes for customers regarding the product use, handling, safety, and maintenance.

4. With product liability and consumer protection in focus, GMI should develop formal mechanism to settle disputes with customer’s out-of-courts to save the customers from harassment, inconvenience and in a speedy manner. Again this is to be done not only within warranty periods but also outside warranty periods.
5. In most companies, in-warranty returns and complaints need to be reduced to a low level, say 0.05% by taking appropriate actions in design, manufacturing, installation and post-installation functions.

6. GMI should try to quantify quality failure costs both internal and external because what cannot be measured is difficult to improve. The internal & external failure costs which are 1-3% and 1-5% respectively at HSCIL should be reduced to say <1%. These costs of quality could be reduced by taking regular preventive and corrective actions to bring out zero defects at every stage.

Quality Documentation, Records and Audits

1. GMI should develop documents of their special process operator qualification reports which are not maintained.

2. TATA motors should develop provisions for periodic review at management level of quality procedures, documentation, systems and records and fix their retention times.

3. More frequent internal quality audits need to be undertaken by MUL. Self-assessment audits could be carried out internally with a facilitator from the company itself.

4. GMI in particular and MUL should emphasize more on external audits like adequacy and compliance audits.

Strategic Planning, Commitment and Leadership for quality

1. Companies should establish full-fledged TQM departments with on-line authorities to install TQM in the company. Else, the existing quality assurance departments be developed and strengthened in terms of human resources to introduce, implement and sustain TQM movement in an organisation. Alternatively, special task force/steering committees with executives from all areas could also be set-up for TQM. If needed, help of outside facilitator could also be sought but focus should be on building up internal capabilities for TQM in a continuous but perseverant manner.

2. For effective organisation to implement total quality management (TQM) MUL, HSCIL, and GMI should have flat departmental organisation structure with less number of players to reduce communication barriers between top management and operatives in order to make communication two way, free and frequent.
3. Management at TATA motors should review its quality systems organisation wide more regularly so that strategic plans with goals and objectives be achieved in a time frame.

Training and Humanistic Aspects of TQM

1. Under TQM concept, training in quality is a pre-requisite for all employees irrespective of their hierarchical levels and functional areas as total quality pervades all departments and levels in an integrated manner. For this GMI should identify training needs in systematic and comprehensive manner.

2. At GMI, there is a need to give training programmes in quality awareness and appreciation and TQM tools at all levels and in all functional areas.

3. The awareness about TQM tools at GM and middle management level is remarkably lower in MUL, than in other sample companies. In MUL, all GM’s and middle managers should be trained in TQM concepts and tools. At operatives level, where there is lot of ignorance about TQM, more awareness is to be created regarding TQM. Various in-house training methods like video films, lectures, case-studies could be used for workers.

4. MUL is following limited variety of job-enrichment programmes. The following schemes could be used in an extensive manner:
   a. Job-mobility from one department/machine to another to facilitate multi-skilling amongst workers and then their redeployment.
   b. Suggestion schemes regarding quality and methods improvement.
   c. Delegation of self-inspection power and authority.
   d. Financial rewards.
   e. Delegation of machine-keeping and maintenance to workers.
   The objective should be to inculcate a sense of pride in workers regarding quality consciousness, machine responsibility and ownership and workmanship.

5. It is further acknowledged on the basis of data collected that most of the quality problems arise due to attitude, resilience, mind-set and work culture of employees rather than knowledge and skills. Most of the quality assurance departments have adequately qualified and skilled executives but their attitude and work culture together with that of operatives needs to be transformed in all the sample companies. For this appropriate intervention strategies have to be undertaken by TQM facilitators for bringing about cultural transformation slowly and in a perseverant manner.
6. MUL and GMI should implement TQM while HSCIL and TATA motors are already done so. It is now well established by data collected and interview responses that most companies face resistance to change during implementation of TQM. Choice of only appropriate organizational development (OD) intervention strategy to bring about the cultural transformation would ensure a smooth transition to TQM implementation. Internal and/or external facilitation should be supplemented with T-training, process consultation etc to smoothen out the transformation for TQM.

Use of Statistical and Other Tools for TQM

1. MUL, HSCIL, and GMI should make use of failure tree analysis (FTA) and/or failure mode effect analysis (FMEA) for root cause analysis and prevention of defects. FTA/ FMEA is a basic tool for quality improvement and planning corrective and preventive actions. Regular use of FTA/ FMEA would eventually lead to development of robust and reliable design. MUL, GMI, and TATA motors should also start using flow charts like Process Decision programme Charts (PDPC).

2. As a prelude to building in quality of performance from design stage itself to manufacturing stage, matrix data analysis as a part of Quality Function deployment (QFD) should be used by all sample companies to translate customer requirements into a robust and reliable product design.

3. For continuous process simplification and improvement which is a hallmark of TQM, regular production flow analysis (PFA) through flow charts etc should be under taken by MUL to attain process quality and reduce wastivity through methods engineering over a strategic course.

4. IN MUL, HSCIL, GMI kanbans stock control card for uniform material flow and control need to be used frequently and regularly.

5. MUL and HSCIL need to follow a schedule based total preventive maintenance programmes (TPM) to ensure high availability of facilities and lowered down-time of machines. These companies can synergise their TQM programmes by combination with total preventive maintenance (TPM) programme consisting of calibration, lubrication, inspection, condition based monitoring, use of non-destructive techniques (NDT’s) and other allied actions in a systematic manner.
6. TATA motors need to analyse feasibility of using synchronized manufacturing or optimized production technology (OPT) in order to effectively manage bottleneck operations and streamline production flow thereby avoiding inventory hold-ups, machine and man-power scheduling problems, process wastes and defects.

7. GMI in order to have long term operations efficiency should install flexibility in their production system in order to meet customer requirements in diverse jobs at short notice. This would also ensure better customer service and market growth in a competitive business environment particularly with respect to product and process varieties. Only those companies which can respond faster to customer requirements in terms of product, process, and material change at a short notice are going to be leaders in international markets even if quality factor is fixed.