

Implementation of BorgWarner Production System - Case Study at DivgiWarner Private Limited

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ABSTRACT

In the pursuit of manufacturing excellence BorgWarner, Inc., USA has utilized some key aspects of Toyota Production System and General Motors Quality System Basics tools to create a systematic framework called as Borg Warner Production System (BWPS). The goal of BWPS is to have robust manufacturing systems to deliver flawless quality products at lowest possible cost and give hassle free customer experience.

This case study covers the BorgWarner Production System implementation experience of DivgiWarner Pvt. Ltd. India, one of the BorgWarner's plant based in Pune and Sirsi, India.

The BWPS consists of 7 foundational elements and 23 tactical strategies. These seven foundational elements are

- Safety and Environment,
- Quality Systems,
- Employee Development,
- Continuous Improvement,
- Lean Manufacturing,
- Pre-Production Planning,
- Metrics and Audits

This framework delivered following benefits to the company:

- "Zero" safety incidences
- Customer PPM reduced from 675 to 122
- 100% On Time Delivery to customers
- Continual improvement - more than 300 kaizen projects implemented every year
- Overall Equipment Effectiveness increased from 41% to 82.9%
- Inventory Turn Over Ratio (ITOR) increased from 4.8 to 10.1
- Material movement in the plant reduced by 68%

This paper uses BWPS as an example to illustrate how to implement similar production systems, in order to improve manufacturing effectiveness. We also show how to set performance base lines, track continuous improvements, and communicate progress to pursue perfection.

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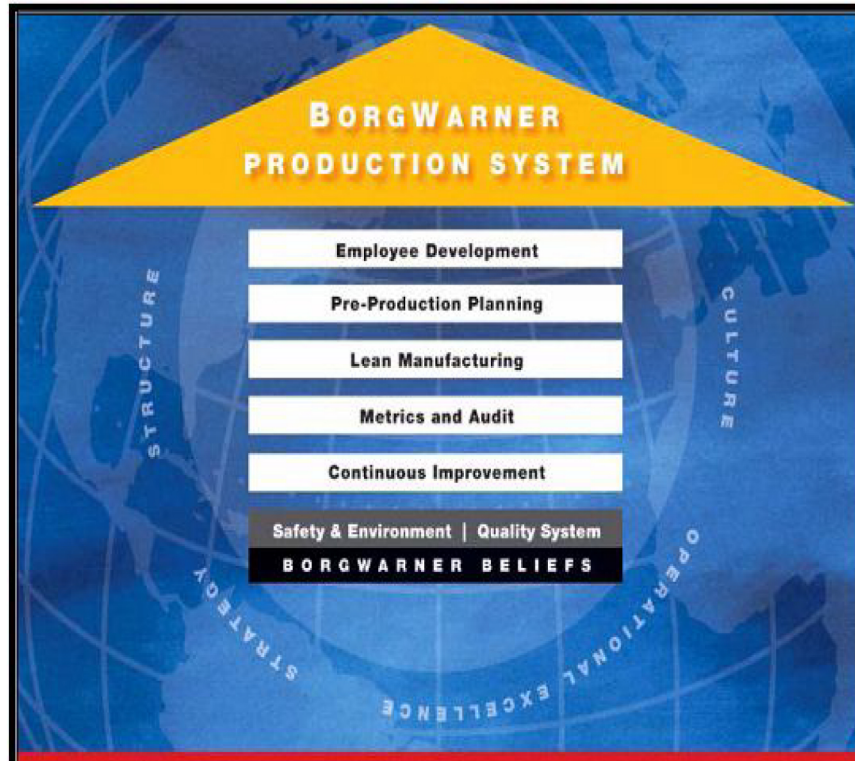


Figure 1. Seven foundational elements of the BWPS

INTRODUCTION

The Borg Warner Production System (BWPS) was developed by the BorgWarner Inc., USA (hence referred to as 'the company') on the lines of the Toyota Production System. The team of managers at BorgWarner studied individual lean techniques, different business tools and the requirements of other quality systems extensively, designed the entire production system from its inception till its implementation, continuously revised their strategies in every field of operation and finally succeeded in putting their work together in to a business system, which came to be known as BWPS. Continuous response to the problems faced during implementation of the BWPS further refined the system. Operations have now become more adaptable and flexible. Values are defined from the perspective of the customer. Frontline workers are encouraged to improve their own processes. Therefore, lean thinking is applied in a very comprehensive way and the BWPS continues to march towards the perfection in it's every single constituent.

This document in hand discusses the implementation of BWPS at DivgiWarner Pvt. Ltd., India (hence referred as the organization) one of the BorgWarner plants based in Pune and Sirsi, India.

The BWPS aims at achieving manufacturing excellence throughout its enterprise of 64 plants worldwide, thus maintaining common goals, targets and system throughout

these firms. This system helps to minimize the consumption of resources and time, and results in maximization of return on investment and production of superior quality goods. In addition to this, the system facilitates fast, flawless launches and therefore, achieves desired results in a very systematic and scheduled way, thus satisfying the customer needs. The BWPS embraces five beliefs that unite all the production units of the company together. These beliefs are as follows:

1. Respect for each other
2. Power of collaboration
3. Passion for excellence
4. Personal integrity
5. Responsibility to our communities

The BWPS rests on seven foundational elements, supporting twenty-three tactical strategies as mentioned below. These are discussed in detail under the section 'BWPS ASSESSMENT TOOLS'.

1. Employee Development

- 1). Employee Empowerment
- 2). Employee Reviews
- 3). Communication

2. Continuous Improvement

- 4). Problem Solving
- 5). Cost Reduction Process
- 6). Develop / Protect Proprietary Process Technology
- 7). Kaizen Activities
- 8). Benchmarking

3. Pre-Production Planning

- 9). BW Program Management

4. Quality System

- 10). Warranty Analysis
- 11). Change Management
- 12). Quality Management Standards
- 13). Supplier Quality
- 14). Traceability
- 15). Quality System Basic (QSB)

5. Lean Manufacturing

- 16). One Piece Flow Production
- 17). Inventory Management
- 18). Pull Systems
- 19). Standardized Work
- 20). Total Preventive Maintenance
- 21). 5S / Visual Factory

6. Safety and Environment

- 22). Safety

7. Metrics and Audit

- 23). Manufacturing Metrics

HISTORY

A corporate team of the company decoded the DNA of Toyota Production System and developed this framework in the year 2003. Earlier this framework had 44 tactical strategies to implement.

After implementation process, all the plants were audited for these 44 tactical strategies and weaknesses were identified in the framework itself. The following problems were observed by the company:

1. With more than 40 elements of the BWPS, it was observed to be as "too bulky"

2. Most of the strategies were repetitively addressed

3. Common processes and training material were not available

4. Strategic core competencies through information sharing and collaboration were not capitalized

5. Multiple page assessment criteria were defined to evaluate the implementation progress

6. Reports were not user friendly

After thorough review of the auditing results, the weaknesses were eliminated and the company re-launched the framework in 2006. Following changes were made to the previous framework:

1. Number of tactical strategies reduced from 44 to 23.

2. Multiple page assessment criteria defined to evaluate the implementation progress

3. Integrated level reports separated into the executive level and the detail level as shown in [figure 2](#) and [3](#).

4. Development of training materials for the top management as well as for the shop floor workers

WHY 'BWPS'

The company observed that few manufacturers had difficulties in implementing the Toyota Production System (TPS) successfully. Many of them had confusion about the tools and practices used by TPS within the system itself. They also found the rigid activities, connections and irregular production flows during the implementation of the process. Based on these findings, company customized the TPS and General Motors QSB tools to suit their manufacturing practices and operations in the form of BWPS. It covers all the key aspects of business. It has implementation guidelines and evaluation criteria rated on a scale of 0 to 5. This facilitated identification of action items to go to the next level. We can use evaluation criteria to set performance base lines, track continuous improvements, and communicate progress to pursue perfection.

IMPLEMENTATION OF 'BWPS'

The fundamental approach adopted for the implementation of the BWPS was by increasing employee's awareness through training session. Below mentioned three levels of training were held in the organization:

1. **Executive Training:** This training session was organized for top level managers consisting of the president, the vice president, the directors and the plant managers. The main purpose of this training was to develop basic knowledge, to broaden the support for transformation activities, to consult on vision, policy, and structure and to increase the commitment level of top management in supporting activities.

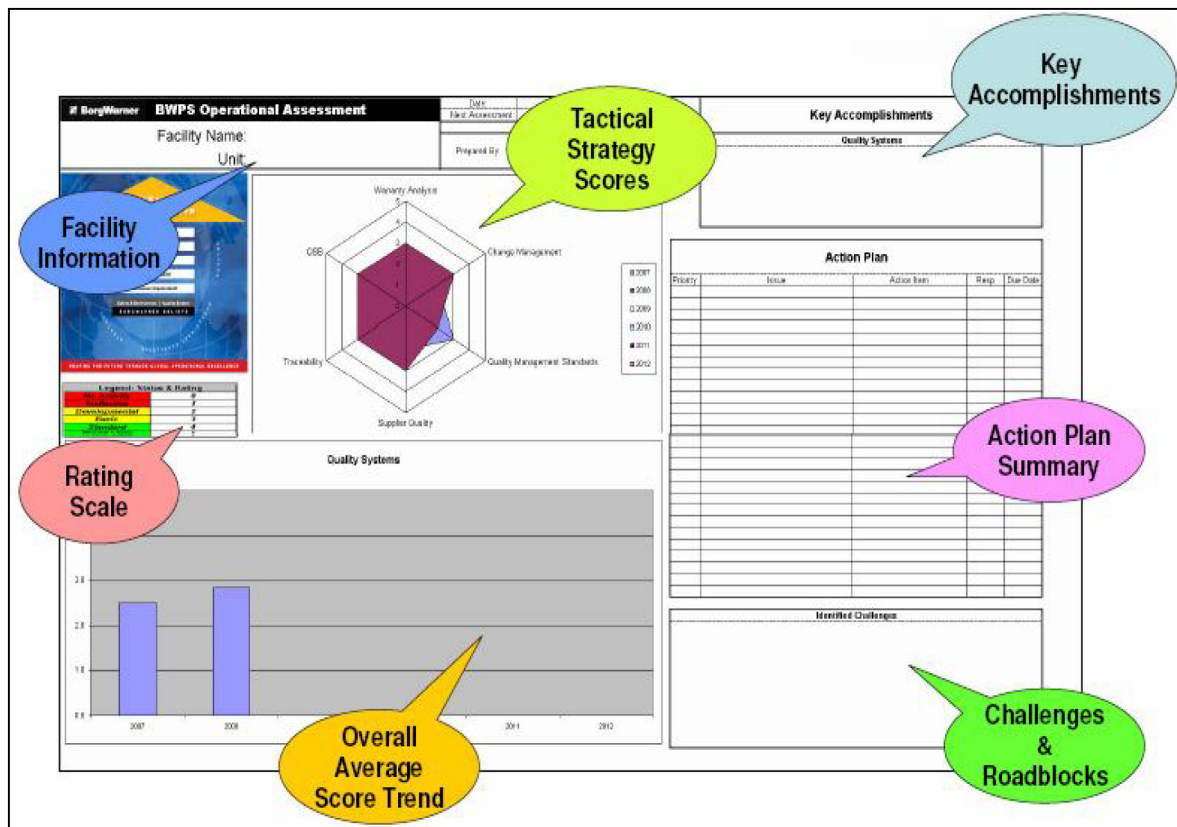


Figure 2. Integrated Reporting - Detail Level

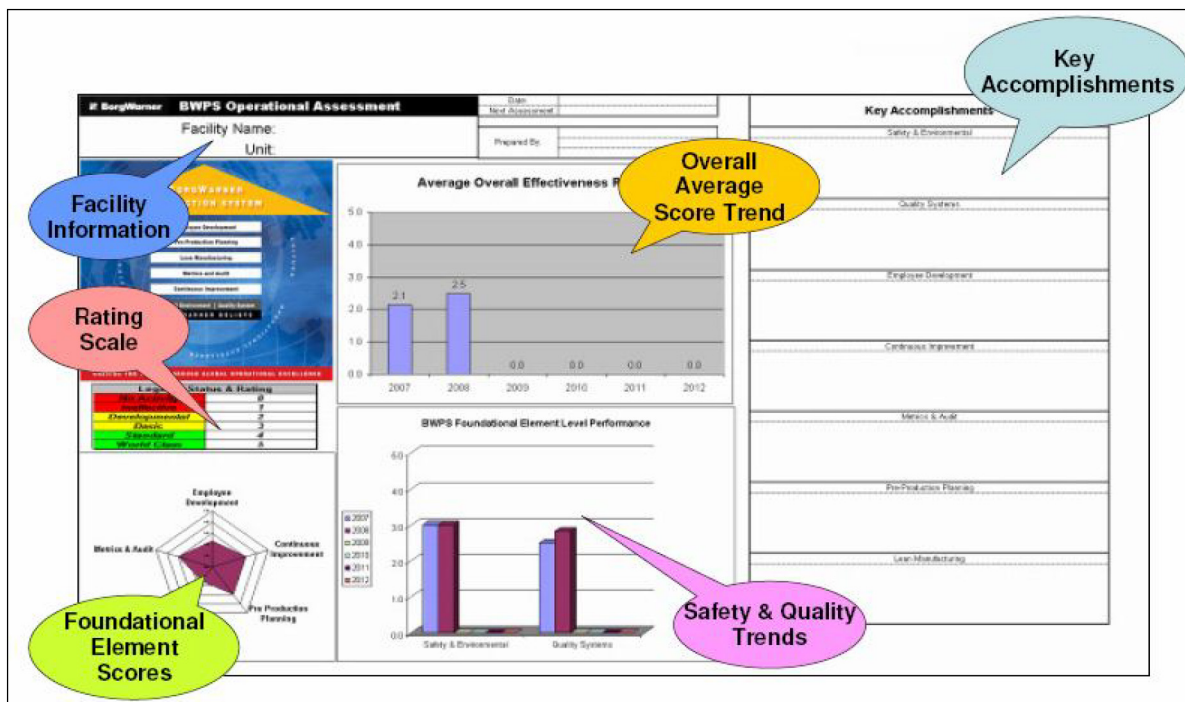


Figure 3. Integrated Reporting - Executive Level

2. Champion Training: This training session was organized for middle level managers consisting of the lean champions, the supervisors of different cells and the

managers of various departments. The main propose of this training was to develop internal expertise to plan, lead, manage activities, perform continuous reviews and

Table 1. Assessment criteria for BWPS elements and strategies

SCORE	INTERPRETATION OF THE SCORE
0	No activity: means the organization is not at aware of the element or there is not even a slight hint of use of the element in the firm
1	Ineffective: Means that the firm is aware of the element but has failed to implement it to an extent that it serves its purpose
2	Developmental: means the element is under implementation in the firm and is currently the concern of the top management and higher office-holders of the firm
3	Basic: means that the element's implementation is complete and its basics are understood by all; but the use is selective and needs further implementation in other sections of the firm to yield desirable results
4	Standard: means the element has started showing positive results; it is now being fully implemented, implementation is maintained and audits are tracked as an indicator
5	World Class: means that the element is highly recognized; goals set under it are met; consistency has set in; all the employees are well aware and have sense of responsibility in the proper implementation of the element

assessments of processes and to set new targets for continuous improvement.

3. Workforce Training: This training session was organized for front-line managers and employees consisting of the production operators, the quality inspectors, the material handlers and other shop floor workers. The main propose of this training was to develop end user understanding, participation, acceptance, to enhance the workers' knowledge and understanding about the new concepts and to increase awareness of BWPS among the employees.

After the completion of training sessions for all level workers, an implementation strategy was developed to plan various activities and to set the annual targets. Further, cross functional teams (CFTs) were formed to achieve the set targets as per the schedule. Weekly meetings were planned to check the progress regularly and audits were conducted monthly to evaluate the existing status. Thus, all processes were continuously reviewed and changes made on regular basis. The organization tried to close the audit findings as soon as possible so as to choose new focus areas for improvement. Sustainable program was also developed to maintain the world class status of already improved areas.

With the initial audit, present status was assessed for each element. Review meeting was called to review status and action items in each element. Since it was impractical to work on all elements simultaneously, priority elements were decided to move to upper score.

BWPS ASSESSMENT TOOLS

Under the BorgWarner Production Systems (BWPS), there are seven foundational elements and under these elements come twenty three tactical strategies. To evaluate the level of implementation of these elements in the

organization, BorgWarner has an assessment criteria and methodology in place. This evaluation, performed once in a year, is referred to as the 'BWPS Operational Effectiveness Assessment'. The Assessment is done by a team of auditors and each tactical strategy is rated on a scale of 0 to 5, each score implying the level of strategy as shown in the table below:

Below is provided an overview of the 7 foundational elements of BWPS and the 23 tactical strategies that fall under these elements. Refer [figure 5](#) for the score sheet used for evaluation of the foundational elements and tactical strategies of BWPS.

Element 1: Employee development

As the name implies, this foundational element focuses on the human resources management activities of the organization. This element ensures that the leaders embrace and promote the corporate philosophy. Three tactical strategies that fall under this element are:

1. Employee Empowerment This strategy focus on the level of involvement of the employees in process development, and improvement, new equipment design and approval, kaizen events and safety programs, quality improvement plans and other such activities. To ensure healthy participation of employees working at various levels of hierarchy, in these activities, the organization introduced a monthly suggestion program and scheduled weekly team meetings. Success and valuable contribution in various operations at the shop floor is recognized and awarded. Measures are taken to reduce the gap between the management and the shop floor employees. Most employees are trained in lean manufacturing and basic problem solving concepts. Different work areas are headed by various teams such as the kaizen, 5-S, safety, FMEA, preparation of standardized operator sheets. These teams consist of a team

Foundational
Pillar

Scoring

Tactical
Elements

Rating
Scale

Foundational Elements	Tactical Strategies					Performance Assessment				
	2007	2008	2009	2010	2011	1	2	3	4	5
Employee Development	2	2				Employee Engagement The workforce and processes are fully engaged and committed to organizational success.	Core team activities utilize various approaches to encourage and sustain employee engagement in organizational success. The work is done with full commitment.	Employee participation in projects, problem solving and decision making is actively encouraged and supported by management. Employee engagement is a key component of the organization's success.	Employee engagement is a key component of the organization's success. Employee engagement is a key component of the organization's success.	Employee engagement is a key component of the organization's success. Employee engagement is a key component of the organization's success.
	2	3				Employee Review The organization has a formal process for reviewing employee performance and providing feedback to the employee.	Just the 30% of successful performance is reviewed. There is a formal process for reviewing employee performance and providing feedback to the employee.	Employee review is a formal process for reviewing employee performance and providing feedback to the employee. Employee review is a formal process for reviewing employee performance and providing feedback to the employee.	Employee review is a formal process for reviewing employee performance and providing feedback to the employee. Employee review is a formal process for reviewing employee performance and providing feedback to the employee.	Employee review is a formal process for reviewing employee performance and providing feedback to the employee. Employee review is a formal process for reviewing employee performance and providing feedback to the employee.
	2	2				Communications Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.
Continuous Improvement	3	3				Problem Solving The organization has a formal process for identifying and solving problems.	Problems are solved using a formal process for identifying and solving problems. Problems are solved using a formal process for identifying and solving problems.	Problems are solved using a formal process for identifying and solving problems. Problems are solved using a formal process for identifying and solving problems.	Problems are solved using a formal process for identifying and solving problems. Problems are solved using a formal process for identifying and solving problems.	Problems are solved using a formal process for identifying and solving problems. Problems are solved using a formal process for identifying and solving problems.
	3	3				Cost Reduction Focus The organization has a formal process for identifying and reducing costs.	Cost reduction is a formal process for identifying and reducing costs. Cost reduction is a formal process for identifying and reducing costs.	Cost reduction is a formal process for identifying and reducing costs. Cost reduction is a formal process for identifying and reducing costs.	Cost reduction is a formal process for identifying and reducing costs. Cost reduction is a formal process for identifying and reducing costs.	Cost reduction is a formal process for identifying and reducing costs. Cost reduction is a formal process for identifying and reducing costs.
	2	3				Process/Process Proprietary Process Technology Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.	Management actively shares information with employees and encourages them to share information with management. Management actively shares information with employees and encourages them to share information with management.
Pre Production Planning	3	3				Process Analysis The organization has a formal process for identifying and analyzing processes.	Process analysis is a formal process for identifying and analyzing processes. Process analysis is a formal process for identifying and analyzing processes.	Process analysis is a formal process for identifying and analyzing processes. Process analysis is a formal process for identifying and analyzing processes.	Process analysis is a formal process for identifying and analyzing processes. Process analysis is a formal process for identifying and analyzing processes.	Process analysis is a formal process for identifying and analyzing processes. Process analysis is a formal process for identifying and analyzing processes.
	3	3				Benchmarking The organization has a formal process for identifying and benchmarking processes.	Benchmarking is a formal process for identifying and benchmarking processes. Benchmarking is a formal process for identifying and benchmarking processes.	Benchmarking is a formal process for identifying and benchmarking processes. Benchmarking is a formal process for identifying and benchmarking processes.	Benchmarking is a formal process for identifying and benchmarking processes. Benchmarking is a formal process for identifying and benchmarking processes.	Benchmarking is a formal process for identifying and benchmarking processes. Benchmarking is a formal process for identifying and benchmarking processes.

Figure 4. BWPS Assessment tools - score sheet

head and other shop floor employees. Team leaders have authority to halt production for quality issues.

2. Employee Review This strategy focuses on the performance of employees. Organizational goals are set and formal training plans are scheduled for employees. Procedures are in place for annual performance reviews of employees. Under these reviews, safety and SMART (specific, measurable, achievable, realistic and timely) objectives are evaluated. To improve employee's performance and to equip him/ her with latest working practices, employee training is planned. A minimum of 80 hours of annual training per employee implies 'World Class' (score = 5) employee review.

3. Communications This strategy is to check that the management should not draw conclusions by just reviewing the monthly financial reports. There is proper exchange of information between the shop floor employees, middle management and the top management. Regular visits and interaction of top level managers with the root level employees helps in bridging the gap between them and aligning whole organization to the common goal. Departmental meetings are held weekly and quarterly business reviews are done with 100% participation. Employees are knowledgeable of plant developments and are not afraid to voice their ideas. Short meetings are held at the start of the shift. Communication boards are updated weekly with action items being addressed.

Element 2: Continuous improvement

Continuous improvement is very important to bring out quality in work and to achieve growth. This element ensures that the organization optimizes its resources whether human or material and focuses on year on year improvement in key

result areas, systems and processes. Five tactical strategies fall under this element. These are as discussed below:

4. Problem Solving Problems provide an opportunity to avoid the recurrence of similar events. There are two types of problem solving methods: one is proactive, where problems are anticipated in advance and solved before they arise; the other is reactive, where problems are solved once they come into existence. The organization utilizes proactive and reactive approaches across multiple functions to solve the problems. For this purpose, different tools are used such as why-why, DOE, fishbone diagram, FMEA, & 7 Quality Control (QC) tools. Six Sigma DMAIC approach is used proactively and reactively for breakthrough projects and 8D problem solving approach is used for systematic documentation and communication. This strategy aims at building the culture of proactive problem solving using Six Sigma DMAIC approach. Engineers and technicians are trained on Six Sigma Green belts and Black belts so that they can effectively utilize DMAIC approach. Results of projects and solutions to problems are shared with rest of the company.

5. Cost Reduction Process It is very important to provide quality products to the end users at such a cost that no other production stands in competition. Minor changes/ activities can bring down the expenses considerably. Thus, cost reduction process becomes very important for an organization. Cost reduction goals are set followed by weekly cross functional; activities are coordinated to a cohesive plan. Organizational goals cascade to create targets for departmental continuous improvement activities. Savings contributions are made from all functions internally. Plant consistently meets annual cost reduction goals.

6. Develop/ Protect Proprietary Process Technology It involves great deal of resources to develop new processes and

products. Their protection thus becomes very important, at least till the point, invention disclosures are submitted and 'trade secrets' or 'patents' awarded for development work. Organization has effective systems to protect proprietary processes. Invention disclosures are submitted only when processes are developed and improved. Engineers are trained on developing and protecting proprietary processes. Non Disclosure Agreement is made with the customer and the supplier made for the same.

7. Kaizen Activities Kaizen activity is continual through events and team activities. Specific improvement goals are established keeping customer in focus. This strategy ensures that the waste elimination and lean manufacturing training is given to all employees. Value stream mapping is one of the useful lean tool which helps to identify Kaizen opportunities. Kaizen strategy expects more than 4 Kaizen workshops per year i.e. at least 4 large breakthrough project per year. Tasks are performed consistently to achieve improvement in throughput, lead time, and value added content. Methodology is embraced and understood by majority. Departmental area teams identify opportunities and also conduct workshops. Activities are less than 15% management directed.

8. Benchmarking Benchmarking is important in that it helps the organization to gauge their increment or decrement of certain parameters. The organization has a Benchmarking procedure documented. The management identifies improvement areas and actively seeks out benchmarks as a part of project plans. The unit actively identifies Best Practices and Lessons Learned with other facilities to improve their operational efficiency. Multiple examples of organization influence benchmarks to improve operations.

Element 3: Pre production planning

Planning is the first activity that is discussed, documented and then implemented once a new idea is conceived and to be put into action. The organization believes that 'it is better to spend a little extra time during the upstream process so that the downstream processes are free from errors'. Pre production planning is one of the foremost steps towards new product development.

9. BW Program Management New product development is initiated in a very systematic way. Weekly cross-functional team meetings are held and action items are assigned. In addition to this, monthly financial reviews are held to review contract and obstacles. EOT (Executive Over site Team) reviews are conducted quarterly depending on program size/scope. Advanced Product Quality Planning (APQP) meetings are held weekly while Product Failure Mode and Effect Analysis (PFMEA) are scheduled regularly. Ongoing changes and issues are discussed and resolved. Launch readiness and performance issues are reviewed and addressed to ensure no interruption for customer at launch.

Element 4: Quality systems

The intent of Quality Systems is to develop systems and processes to deliver quality products and provide hassle free

experience to the customer. There are six tactical strategies that help the organization to achieve world class quality practices. We discuss these strategies briefly below:

10. Warranty Analysis Warranty Analysis system helps to monitor and improve warranty performance. The system demonstrates effectiveness through the measurement of warranty return level performance. The organization uses advanced statistical tools for improvements to new and existing product by measuring warranty performance to identify product and process needs. Related activities are implemented in Design, Supply Chain and Manufacturing areas.

11. Change Management Managing engineering changes in design and drawing is very important for an organization. In this regard, all engineers in the plant are trained on Change Management procedures. Weekly meetings are held with participation of people from various departments of the organization like Engineering, Manufacturing Engineering, Supply Chain Management, Quality, Manufacturing etc. The change management process puts a check that no customer incidence occurs due to failure to follow change management procedure.

12. Quality Management Standards The organization has a thoroughly documented quality system to maintain its standards. The Quality System is well understood and followed throughout the plant. Layered Process Audit is scheduled and performed on monthly basis. Customer metrics and balanced scorecard (BSC) demonstrate that the quality expectations are clearly surpassed. The organization has recorded 'Zero non conformances' in last 3 surveillance audits of TS- 16959.

13. Supplier Quality Committed supplier chain is an integral part of the whole process. The intent of supply chain management is to utilize systems and processes to develop, monitor and control supplier's quality and delivery standards. The organization has a Supplier Manual so that the quality expectations are met by all suppliers. Suppliers and organization have developed close relationship to ensure 100% APQP compliance, on-time Production Part Approval Process (PPAP), zero launch issues and minimal on-going quality and delivery issues.

14. Traceability To meet customer requirement, it is important to have formalized traceability systems in place. The organization has the ability to trace component, assembly data, supplier and raw material with no gaps in system. Parts shipped to customer can be traced to unique serial number, manufacturing date and operator, electronically. Effectiveness is demonstrated in all such processes.

15. Quality Systems Basics (QSB) Quality System Basics, (QSB) is a set of initiatives meant to reinforce the current quality management system. QSB consists of 10 fundamental but very powerful elements which help to deliver world-class quality products. QSB was, first of all,