A JOURNEY TOWARDS EXCELLENCE

S. P. SHARMA

AT&T Power Systems
3000 Skyline Drive
Mesquite, TX 75149

Total Quality Management is becoming a necessary survival issue for companies who are in highly competitive world markets. A brief historical perspective suggests that lack of focus on customer needs and product and process quality has led to the decline of U.S. competitiveness. Most businesses have realized this; they are undergoing a major revolution and are changing their management processes. This requires major process redesigns, changes in prioritization and synthesis tools, and employee involvement and empowerment. AT&T Power Systems, which manufacturers leading edge power supplies, reserve power systems, and components for the data processing and telecommunications industries and is a major user of magnetic materials, has gone through a major transformation during the last four years. We have been at the forefront of the Total Quality Management revolution in the U.S. and have been able to transform ourselves from an internally-focused company to a customer-focused, growing, and profitable business. Our experience to mold a culture where quality management becomes the key element of strategic management may help other manufacturers who strive to be successful in the world markets. In this paper we describe the key elements of our Total Quality Management and present some lessons that we have learned.

Manufacturing Situation in the United States

Continuous improvement in quality has become a survival issue for American business. Sometimes it is difficult to understand why a nation, which is the biggest economic force in the world, needs to worry about

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quality. The United States Gross National Product is significantly larger than the GNP of Japan, and in fact, it is larger than the combined Gross National Product of France, Germany, and England. Why then do we continue to lose market share in the world markets, and why do we keep on laying off people? American industry and businesses, whether they are in the manufacturing sector or service sector, continue to decline in the world markets. Our products are not as competitive as they used to be. In fact the trade deficit, which is the difference between what we export and what we import, continues to remain very large every year. We have a trade deficit in chemicals, petroleum, electronics, clothing, appliances, automobiles, trucks, auto parts, and in other major industries. The only place where we seem to have a trade surplus is in food and feeds, in military supplies, and in re-export of products which we buy from overseas. This trade deficit has cost us more than several million jobs in the last decade. We are losing a sustainable advantage in the high tech and service sectors also. We now have a trade deficit in high technology, financial, insurance, and in communications also. What is even more surprising and disheartening is the fact that 25% of Americans and more than 50% of Japanese and Europeans believe that U.S. industries cannot deliver and manufacture quality products. We have lost anywhere from 50 to 90% of the market share in areas that include steel, automotive, electronics, nuclear power plants, television sets, cameras, microwave ovens, and consumer goods. Fifty percent of the Fortune 500 companies have gone bankrupt since 1985 resulting in more than three million lost jobs.

In 1960 the Japanese industry accounted for about 3% of the world economic output while the U.S. accounted for about 34%. In 1993 Japanese industry accounted for about 17% of the world economic output while the U.S. share declined to 20%. This loss of leadership cannot be attributed to the difference in wages. In 1985 wages in the United States were roughly twice as much as in Japan and about 50% higher than the wages in Germany. But in 1993 the wages in Japan and Germany are higher. Therefore, the cost competitiveness of the Japanese and European businesses are not attributable to the low cost derived due to lower wages. The difference in productivity of the workers accounts for the lower cost and high quality of their products.

President's Commission on Industrial Competitiveness describes the competitiveness as the degree to which a nation under free and fair market conditions produces goods and services that meet the test of international markets while simultaneously maintaining and expanding the real income of its citizens. MIT Commission on Industrial Productivity cites four options on how a nation can compete in the world markets:
1. Place tariffs and quotas on all imported goods.
2. Introduce recession to slow down the demand for foreign goods.
3. Devalue currency.
4. Improve the quality of our products and service.

In the first three options, the cure is worse than the disease. In 1985 one U.S. dollar was 293 yen. By 1990 it was down to about 130 yen, and by 1993 its value decreased to 110 yen. But this continuous decline of the dollar's value against the foreign currencies has not improved our trading position and has not made us more competitive. The only viable option to become competitive is, therefore, to improve the quality of our products and services.

A nation's competitiveness primarily depends on the manufacturing sector. It is the basic source of wealth and in turn of societal well being. Without a strong manufacturing base, we also cannot have a strong R&D, technological innovations, and military strength. Manufacturing supports and nurtures the service sector also. More than half of the total economic activity of the United States depends directly or indirectly on manufacturing. The productivity in the manufacturing sector continues to surpass the total productivity gain in the U.S.

Manufacturing, in fact, is the primary source of export earnings that directly impacts the economy and jobs. A number of our business leaders have realized that manufacturing is the foundation of national competitiveness and have started using Total Quality Management (TQM) as the management system to run the business. The companies that have used TQM as a management system have reported 5 to 20 times improvement in various areas, have shown that the defect rate can be cut several fold, have significantly reduced manufacturing lead times, and have improved their costs.

Manufacturing System

A company is organized around key functional areas that may involve marketing, product design, financial, quality, production, shipping, etc. Through these different functions and processes, a company produces and delivers products and services to a customer. The competitors also try to provide the same products and services to customers. The business operates under an environment specific to the industry in which it operates. There are also legal and regulatory constraints. This environment defines a framework around which a company must define how it is going to compete. It must analyze its strengths and weaknesses and develop its strategies to become successful in meeting customer needs. In addition,
every company has a set of suppliers from whom it purchases service and materials before it adds value and sells to its customers. Supplier management, therefore, adds another dimension to a company's success.

Most companies are organized vertically. However, vertical management is not the way the products are distributed to the customer. Customer needs are identified by the marketing and sales organization. The needs and wants are converted to products by the design organization. The product is made by the manufacturing organization, and finally the product is shipped to the customer. Customer needs and wants move through an organization in a horizontal manner.

For a manufacturing company to be successful, it must continue to reinvent its manufacturing system in relation to its environment, changes in technology, and customer needs. This requires a major change in company culture, its organizational structure and continuous improvement and redesigns of its processes. These changes, while unsettling at times, are critical to succeed in the global market place. An organization must adopt a clear mission and a guiding vision around which it can galvanize its workforce. The organizational structure must be focused to serve specific sets of customers and markets. The short-term priorities must be based on meeting customer and business needs, and the organizational goals must be aligned with individual accountabilities.

Internal manufacturing and business processes must be based on elimination of waste from all operations, reduction of cycle time, and meeting customer needs at the lowest total cost to the business. Just-In-Time manufacturing methods with mistake proofing of operations through employee involvement and empowerment becomes the driving force in a new manufacturing system which starts from the customer and ends with the supplier. This chain is part of a total system which must be optimized to be successful. Most companies try to optimize a part of this system, and this sub-optimization leads to increased cost to society and reduces the company's competitiveness. AT&T Power Systems at Dallas has taken an approach in Total Quality Management (TQM) where we try to optimize the total system to gain maximum competitive advantage. Our experience can serve as a model for many other manufacturers who must make changes to survive and flourish in the global markets.

AT&T Power Systems - Mission, Vision, and Leadership

The power business requires high reliability and high quality. This business is also intensely competitive. The margins of the profit levels are not high. The customers demand cheaper power solutions. They also want reduction in the size of power systems, and they want their needs and
wants met quickly and at lower cost. Purchased products account for a large component of the total cost of a power system. The business is dominated by those companies who have a good system to convert customer needs through an efficient process into products and services. These manufacturers also need to have a good purchasing function to buy low cost and high quality components and materials. In order for us to be able to compete in this type of business, we realized that we needed a change in our thinking.

The guiding vision of AT&T Power Systems has been to be recognized by our customers around the world as the standard of excellence for power products. Our mission is to provide competitively priced products and services by empowering each employee to exceed the customer's expectations for quality, service, and features while providing a fair return to our investors. Each function within Power Systems has developed their own mission and vision to align with this mission and vision. Power Systems comprises of several Internal Business Units (IBU's) who have all the authority and resources necessary to meet the needs of their customers. The factory is arranged physically to match this structure, with a focused factory corresponding to each IBU. The engineering function within each IBU has been integrated to include development, product engineering, and process engineering.

Leadership is very critical in the TQM process because senior management must lead quality improvement efforts. Every one must be involved in quality. Quality is a fundamental change, which is difficult and takes time. It, therefore, needs a constant reinforcement and communication from the leadership. Quality cannot be achieved without proper direction and continuously strengthening from the top.

Power Systems' business is governed by the Quality Council, chaired by Power Systems Chief Operating Officer and includes all senior managers and Business Unit heads. The responsibilities of the Quality Council are to provide focus to teams, to select quality facilitators, to determine priorities for Quality Improvement (QI) teams, to select team leaders, to provide resources for QI teams and monitor their progress, to provide uniform recognition for Power Systems QI teams and to develop a training plan for all employees.

Quality Council members are personally responsible for monitoring customer, employee, and business indicators and reporting progress or problems on these indicators.
Quality Planning

There are three elements of our Total Management system. Number one is the Quality Policy Deployment (QPD) which allows us to prioritize the issues from the point of view of the customers and the point of view of the business. The second is Quality Improvement that involves the tools and processes to make improvements. These tools must be taught to all the people, and all people must be involved in improvement through teams or through their individual contributions. The third element is Daily Work Management. This assures that improvements once achieved become part of day-to-day operations and that the variation in day-to-day processes remains within control. These three elements are supported by four basic principles. We must focus on customer satisfaction; our decision making process must be based on facts; we must provide respect for people; and there must be continuous improvement.

The needs of customers, employees, and stakeholders are used to determine quality indicators. These are then analyzed to verify consistency with our mission, vision, and quality principles before they are prioritized and included in both short- and long-term quality planning processes.

Our mission, vision, principles and values drive our long-term plan exceeding five years. We include human resource needs and our supplier capabilities in development of our long-term plan. Financial, market, and societal factor, coupled with our strengths in technology, projected business environment in which we will operate in the future are also included in the long-term plan. These factors together with the changing customer and business needs and their expected evolution determine a course of action to be pursued for the long-term success of the business. The long-term plan is used to define our three to five year mid-term plans, and certain fundamental objectives and key quality elements are defined which must be achieved as part of mid-term plans. We have three fundamental objectives--customer satisfaction, employee satisfaction, and stakeholder satisfaction.

The quality elements, under customer satisfaction, include competitive offerings, product performance and deployment, service delivery, and service support. Similar quality elements are defined for the other two fundamental objectives. Under each of these quality elements, we have performance indicators. The mid-term plans drive our short-term (one to two years) plans for improvement in performance indicators. Data are collected to determine the current level of performance for critical indicators and to identify gaps with respect to competitive benchmarks or our goals based on future business environment and needs. The targets are
established and improvement projects are implemented to achieve them. Appropriate resources are committed by the Quality Council to meet these goals.

Fig. 1. Long-term and short-term planning processes

Quality Policy Deployment is our approach to deploy strategic priorities. It is defined as "a management process for achieving breakthroughs on major business problems by deploying resources on a few high priority items." The prioritization and implementation of key customer and business focused improvement projects is the heart of Policy Deployment. Resources are aligned at every level to achieve the objectives set in the short-term plan.

Management monitors quality improvement activities and results each month. Management is responsible for initiating Quality Improvement teams, assigning team members to them, monitoring and evaluating their progress, and assigning team angels who own the master indicators at the Power Systems level. Management is also accountable for seeing that indicators are integrated into the business plan and that management is involved in and enthusiasm is maintained for the TQM process. Senior
managers review quality improvement projects and provide guidance, support, and direction as needed. Managers review countermeasures proposed by teams to verify information consistency and to approve additional expenditures when warranted. Input from employees, teams, and management is used to improve the planning process.

Quality Improvement

Power Systems uses three approaches to quality improvement. These are QI story, poka-yoke (mistake proofing), and suggestion system. The Quality Improvement (QI) story process adopted by Power Systems is a simple, seven-step problem solving process illustrated graphically in Figure 2. By following these steps in each step, a team of employees solve the problem they have selected.

![Quality Improvement Story](image)

**Fig. 2. QI Story**

The seven steps are 1) reason for improvement; 2) current situation; 3) analysis; 4) countermeasures; 5) results; 6) standardization; and 7) future plans.

In the reason for improvement, the team identifies a theme or problem areas and the reason for working on that problem. The purpose of the second step, current situation, is to clearly define the problem and stratify data to a level where an identifiable problem emerges.
In the analysis step, cause and effect analysis is done down to an actionable level. The team selects the root causes with the greatest impact and verifies those root causes with data. In the fourth step, the countermeasures are selected which will prevent the verified root causes, meet customer valid requirements, and be cost beneficial. A formal action plan is used to schedule and track the implementation of the countermeasures.

In the results step, the team monitors the effects of their countermeasures to see that the root causes have been reduced and that the original indicator has improved. If the original target has not been met, the team reevaluates to see if the root causes were truly identified and implements additional countermeasures until they have met their goal.

The purpose of the standardization step, number six, is to prevent the problem or the root causes from recurring and to look for other parts of the business where the same countermeasures can be replicated. Training, documentation of new procedures, process controls, or periodic checks are established. Finally in step seven, future plans, the team analyzes remaining problems and develops further actions, if necessary.

Poka-yoke is a Japanese name for mistake proofing of operations. In poka-yoke we distinguish between errors and defects. Defects are the results which are caused by errors. Mistakes are natural, but they can be reduced or eliminated through appropriate changes in the production and delivery system. Poka-yoke devices are simple and inexpensive and used to prevent errors. There are three types of poka-yoke devices. Type 1 devices eliminate the error at the source before it occurs. Type 2 devices detect errors in the process as it occurs but before it results in a defect. Type 3 devices detect a defect after it is made but before it reaches the next operation. We have trained all our employees on how to design and implement simple, inexpensive devices to prevent these types of errors. The focus is on Type 1 and Type 2 devices. In the last two years alone, we have implemented 1700 new devices to mistake proof our operations. This has resulted in significant improvement in quality and cost of our products.

The third element of quality improvement is our suggestion system. Our suggestion program recognizes the contribution of individuals and teams. Through a new program called Powerful Ideas Program, our suggestions have increased 100 fold from two years ago. Employees can suggest and then implement ideas to make their job easier. They are recognized through awards for their contributions.
Employee Involvement and Education and Training

Power Systems fosters an environment of empowerment, full participation, enrichment, self-development, and self-direction through a variety of Human Resources programs and initiatives. We recognize that providing an excellent work environment is fundamental to the TQM process as evidenced by the fact that employee satisfaction is one of our three imperatives.

Employees are empowered to facilitate change and improvement through participation in QI teams and self-directed work teams, suggestions submitted to the Powerful Ideas Program, and ability to stop a production line if problems occur.

Self-directed teams of occupational employees are empowered to perform such functions as prioritizing work flow, making work assignments, determining the need for overtime, and shutting down production lines. These teams provide an opportunity for occupational employees to learn and demonstrate decision making skills, leadership skills, and organizational abilities.

All employees are involved in quality planning and improvement activities. Newly hired employees are provided with an orientation program which emphasizes our quality values and expectations. Employees are empowered to be personally responsible for all products and services and to stop the production or shipment of any product not meeting internal or customer requirements.

Assessments of training support and training needs are conducted through surveys. Each supervisor also identifies short- and long-term training needs and priorities for each employee and coordinates the training schedule with the Training organization.

Managers continually evaluate their own training and development needs and work with the Training organization to verify that their needs are met. In addition to formal training, satellite programs are used from several prominent universities. Shop skill certification is used to assure that production associates have the skills needed to do an effective job on their assignment. All Power Systems employees are required to have 40 hours of training every year. Each year, based on identified gaps, there are certain mandatory courses which every employee must have. These courses in the past have included QI story course, poka-yoke, and SPC.

Results

The commitment to customers is the hallmark of our TQM program. This commitment is reviewed on an annual basis through competitive analysis, customer need analysis, and customer satisfaction survey. With
our goal of exceeding our customers’ expectation, the commitments are very carefully reviewed to be sure that we lead our industry and have no gaps.

We conduct annual customer satisfaction surveys to evaluate our performance. The results of these surveys are reviewed on an annual basis to set the yearly targets. Customer report cards are also evaluated to assess and understand the gaps between customer expectations and our performance and are used in setting the priorities for improvement. The following results are examples of the improvements achieved to date:

- Average outgoing quality defects reduced by 70% as measured in PPM
- Rework reduced by 70%
- First-pass yield increased from 87 to 95%
- Inventory reduced by over 50% and investment reduced by 43%
- Customer order interval reduced by 50%
- Manufacturing interval reduced 70%
- New product introduction interval reduced up to 50%
- Shipping improved to meet the customer’s requested date 95% of the time
- CFC usage completely eliminated in Dallas; toxic air emission reduced 76%
- Customer satisfaction in all measurable attributes improved.

In 1992 we received the Shingo Prize for Excellence in Manufacturing. The Shingo Prize recognizes companies and plants located in the United States that have demonstrated outstanding achievement in manufacturing processes, quality, productivity enhancement, and customer satisfaction. We have also received awards from our major OEM and internal customers. Our Dallas headquarters location has achieved ISO 9001 registration, and all our factories have achieved ISO 9002 registration.

**Conclusion and Lessons Learned**

Quality improvement begins with an attitude and working structure that supports change and focuses on the customer. TQM drives the entire organization to focus on meeting customers’ and business needs. During our TQM journey, we have learned that while the concepts of TQM may be simple, they are difficult to communicate and implement. Learning