2006-302: ENGINEERING MANAGEMENT IN A COMPETITIVE GLOBAL ENVIRONMENT

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Abstract

The world around us is changing. The beginning of the twenty-first century is a period of rapid transition in which the pace of this transformation continues to accelerate. New organizations, technologies, and products are materializing at an escalating rate. Those organizations unable to keep up and successfully compete will quickly fade away. The shifting dynamics of trade and business continually reflects the increasingly competitive nature of the global marketplace. Organizations along with their managers must adopt and adapt new methods in order to survive with these sweeping transitions. Together these changes have created an entirely new paradigm for global competitiveness in engineering and business.

While new technological achievements have in many ways created the global markets, they also offered the tools required to deal with the increased distance and competition in an effective and timely manner. However, these new information technology and transportation systems have posed a threat to organizations that refused to change with the times and continue to rely on traditional methods. The economy and marketplace, however, are far from the only transformations that have occurred in recent years. Basically it all relates to change and plenty of it. Organizations along with their managers and employees are not experiencing a single transformation, but rather a number of them simultaneously.

This paper focuses on essential tools and techniques that must be utilized by engineering managers in order to transform their organization into a competitive force in the global marketplace. These include customer value perception, reduced cycle time, cross-functional teams, concurrent engineering, and collaborative engineering management. Organizations that have successfully implemented and employed these techniques are prospering in the highly competitive global environment while those that haven’t are languishing and on the verge of extinction.

Introduction

Competition in a competitive environment is nothing new. It has existed since the very first exchange, perhaps by barter, of an item to satisfy a customer’s need or want. Once that occurred, the race was on to design, develop, manufacture, and offer a better product at a lower price to the customer. Initially the competition was localized existing in the same block, village, or town. Then as transportation and communication systems developed and improved, so did the range of the competition spreading out to ever growing territories. The cart was replaced by the wagon, which was replaced by the train, leading to the truck, and airplane. Modern transport had opened up entirely new areas to market and sell products. Gaining momentum this expansion continued and even accelerated to entire countries, continents, and finally the entire world. Aided by almost instant communication utilizing the telegraph, telephone, fax machine, and internet in rapid succession new global markets emerged. Competitors that were at one time next door are now thousands of miles away changing forever the environment in which organizations compete.
Some have adapted to this new playing field while many have not and have simply gone out of business.

Today’s markets are characterized by speed and scale. The time to market for new products has been drastically reduced while the production volume has increased, resulting in lower prices for the consumer. Only those organizations that have integrated speed and scale along with high quality products will remain competitive. All others will slowly fade away and join the many once well known and prominent organizations in the graveyard of failures unwilling to change. Engineering and product development have evolved into a race to market with the winners producing the highest quality products at the best price. Rapid responses to shifting market conditions require immediate management decisions followed by swift action by the entire organization to deliver new products that exceed customer expectations. Slow responders will miss the opportunity, be beaten to the marketplace, lose market share, suffer reduced profits, and become laggards in their field. In order to be successful organizations must be willing and able to change rapidly by responding to new business conditions or creating their own new opportunities.

Engineering managers along with their corresponding organizations must be both proactive and reactive to the changing competitive nature of the global market. In many cases this may require substantial organization change. In fact, a number of key organizational concepts are absolutely vital for remaining competitive in a highly aggressive global environment. Among these organizational aspects are increased awareness of customer value perception, reduced cycle time, cross functional teams, concurrent engineering, and collaborative engineering management. The overall goal or objective is to simply get new products to market faster, easier, and cheaper than your competitors. By accomplishing this, organizations will gain market share, increase profits, and prosper. These concepts are so important that they will each be addressed separately.

**Customer Value Perception**

Organizations need to develop a new philosophy centered on customer value along with their perception of value in order to successfully compete in global markets. These customer centered organizations can produce and deliver superior value to their clients and consistently win in the marketplace. The basic idea is that consumers, whether other organizations or individuals, will “buy from the firm that they perceive to offer the highest customer delivered value” (Kotler, 1994, p.37). Essentially the process involves rating a number of characteristics about the organization and then making a decision. The consumer “adds the values from … four sources – product, services, personnel, and image – and perceives … total customer value” (Kotler, 1994, p.37). Once the total customer value has been determined the consumer can make their purchase decision.

The most effective way to establish customer value is to listen to your existing and potential customers’ needs and wants. However, in many cases the customer makes this process rather difficult. Customers don’t always make their needs and wants obvious. In addition, their needs and wants could be actually quite different. Then adding to the complexity other customers will likely have needs and wants that also disagree. As a result the perception of value can vary greatly from one customer to another making the determination difficult.
The other side of value perception is customer satisfaction. Consumers typically form a judgment and create a satisfaction level based on the value received. This satisfaction is based on a comparison of the perceived expectations relative to the actual performance. Value perceptions or expectations are influenced and can be formed in a variety of ways. “Expectations are formed on the basis of the buyer’s past buying experience, statements made by friends and associates, and marketer and competitor information and promises” (Kotler, 1994, p.40). Many of today’s leading organizations are raising customer value perceptions and expectations while actually delivering high quality performances to match. By satisfying the value perceptions of customers they are retained. “The fact is that high satisfaction or delight creates an emotional affinity with the brand, not just a rational preference, and this creates high customer loyalty” (Kotler, 1994, p.40).

All organizations are in a continual quest for a competitive advantage. This has always been the case in a highly competitive environment and today is no exception. One technique that has produced positive results is to conduct a customer value analysis. This five step process is all about the customer. In the first step the customers are simply asked what features and functions they want or desire in the product. These items or attributes are then rated or ranked in importance by the customer in the second step. Then the relative ability of the company and its competitors to perform to this level of expectation is judged by the customer. The goal in step three is to have the company viewed high on the features and functions the customers’ value the most. Step four segments the customers to determine which ones can be best served by the company and which ones the competitor has a distinctive advantage with. The last step is to repeat this self examination process because customer values may change as technologies and economic conditions evolve. This inclusive analysis will reveal the organizations strengths and weaknesses in comparison to its competitors. In addition, this process will provide valuable information concerning who the organization can effectively compete against in the global market. It is a key component for determining the value perception of its customers.

Basically, the customer centered organization is better able to identify new opportunities, determine a strategy, and be competitive. This is accomplished by monitoring the perceived value expected by its customers and setting a long-term course to satisfy those expectations. In many cases, it is all too easy for organizations to become fixated on their competitors actions and lose sight of its customer focus. These competitor centered organizations plan their moves based upon their competitors’ actions and reactions while customer centered organizations focus on the needs and wants of their customers. To them, the customers’ perception of value is paramount to their success.

**Reduced Cycle Time**

A major and integral part of the product development process is the prospect for real invention and innovation. A window of opportunity often exists for utilizing new processes and technologies in products that can offer a distinct competitive edge. However, a rapid product development process reducing cycle time is required to achieve this competitive advantage through technological innovation.
An organization’s greatest strength might well be its ability to transform new ideas, technologies, and processes into improved or totally new products. Basically there are three critical aspects of time compression “(1) shortened product life cycles; (2) shortened development times; and (3) … decreasing payback periods” (Narayanan, 2001, p. 48). It is becoming clear that product life cycles are decreasing over time as new products are introduced at an accelerated pace increasing the speed through which a product penetrates the market. In order to accomplish this task the time to develop a new process or technology into a marketable product must also shorten. Finally there is increased pressure from the capital markets to yield quick returns from investments in development of new products and technologies. They demand decreasing payback periods forcing a reduction in the cycle time for the entire development process. Combined these three elements of time compression have changed the way organizations compete on a global scale.

It all relates to a shorter window of opportunity for the organization. Making matters even more complicated, the product must be designed to meet or exceed the customers’ expectations in terms of application, performance, features, cost, safety, and dependability. Basically these characteristics reflect a dilemma between reducing cycle time for the organization and improving the product for the customer. However, achieving speed is often difficult during the development of a product. The fundamental reasons are associated with discrepancies, changes, and uncertainties encountered during the development process that are typically the sources of errors and delays.

The methods for reducing cycle time have many similarities relating to speed and organization. Allen (2003) utilizes goal setting, documentation, along with accountability to save time. Chang (2005) also uses goals while expanding the solution to systems and habits of organization to increase the efficiency of the team and individual. Betz (2003) stresses the management aspect of the entire process for organization and cooperation. The goal is to make tasks more efficient and eliminate wasted time and effort. Collectively they are all techniques utilized in one way or another for project management. Viewing reduced cycle time as a project makes sense. After all, the objective requires the coordination of resources from many areas within and perhaps outside the organization to meet a deadline. In this case a tight schedule is needed to reduce cycle time for product development. Although the three approaches differ in the techniques employed, they are all after the same goal. The solution for any organization will be some combination of these three approaches, one that best fits their unique situation.

Reduced cycle time is crucial for the success of organizations engaged in a highly competitive global market. The quest for speed in design, development, and introduction of new products is continual for organizations seeking a competitive advantage. In the long term, organizations survive by beating their competitors to market with better and cheaper products.

Cross Functional Teams

Another business characteristic that has become vital to organizational success is cross functional teams. The basic principle involves utilizing individuals along with their expertise from a number of different functional areas as a unified team to solve some type of problem. In effect a team of experts is assembled from throughout the organization to attack and resolve a critical issue by collectively using resources from every department or functional area.
Cross functional teams are typically assembled by integrating multiple functions to address a problem, resolve issues, or investigate opportunities. Individuals are selected for the team from multiple areas based upon their familiarity with the situation at hand. Cross functional teams are frequently referred to as task forces, product launch teams, or process improvement teams. Closely related to the cross functional team is the multi functional team. Multi functional teams focus on organizational issues including creating policy, planning direction, defining philosophies, and developing opportunities. Members selected for multi functional teams include individuals from all levels of the organization. In many cases they may be actually empowered as the management team for the organization. It is not uncommon for both of these types of functional teams to be utilized in harmony by the organization.

These cross functional teams can be created for a number of reasons. Teams are formed to “generate recommendations, such as a strategy to enter a specific regional market or solve a specific customer-related problem; make or do things - for example, design products, develop new processes, install new assembly lines; and … operate plants” (Chang3, 2005, p. 63). However there is also a much more significant reason for establishing cross functional teams. It is an important aspect often overlooked in traditional function based organizations. The output of a team is the total of the work accomplished by each individual member plus the results from the members working together. “It is the work product delivered by the members together (the team synergism) that is responsible for the superiority of the overall team performance over the sum of the performances of the individuals” (Chang3, 2005, p.63). In other words, much more can be accomplished by using cross functional teams. The synergy that develops unleashes a power for problem solving that simply cannot be matched by individuals acting alone.

Cross functional teams are often the preferred method to address issues and problems that interface or require coordination between functional areas. This becomes clear after looking at the time-honored product development process. The traditional functional organizational structure is a very linear process where each department (sales, marketing, engineering, manufacturing, and distribution) performs its function and then hands the problem or project off to the next department. These types of sequential operations are very inefficient in terms of the sharing of information, making decisions, and coordination.

Utilizing cross functional teams including members from the above functional areas along with others from finance, procurement, testing, logistics, suppliers, and vendors are also included. Every issue related to the project or problem is considered during the initial stages in parallel. All team members are backed by the full support of their functional area to insure the best possible information is shared with the team. The goal is to develop an optimum solution or product for the organization in the shortest time interval, at least cost, with all requirements met, and all constraints satisfied.

**Concurrent Engineering**

Concurrent engineering (CE) was originally conceived as a means to shorten product development time. However, over time many variations, interpretations, and versions have emerged. Concurrent engineering is essentially a parallel approach replacing the traditional serial
or linear engineering process that was quite often time consuming. The intention is to have the engineers and other developers consider the big picture or total process from the very beginning. That is to spend more time initially planning and designing the product so time can be saved later.

One of the most important considerations for concurrent engineering is timing. On many occasions the timing of problem discovery and the related decision making is critical to the success of the project. However, time enters into many aspects of concurrent engineering. Basically there are eight fundamental principles of concurrent engineering: “early problem discovery, early decision making, work structuring, teamwork affinity, knowledge leveraging, common understanding, ownership, and constancy of purpose” (Prasad, 1996, p. 170). Each of these principles are time related and worthy of further discussion.

The first principle is early problem discovery. “Problems discovered early in the design process (particularly during the first 20% of the cycle time) are easier to solve than those discovered later” (Prasad, 1996, p. 169). This makes perfect sense. The earlier a problem is found, the earlier a solution for it can be created and implemented. Early solution of problems often results in considerable cost savings as well.

Early decision making constitutes the second principle. “The ‘window of opportunity’ to affect a design is much wider during an early design stage than at a later stage - when some of the decisions are frozen and when the design is matured” (Prasad, 1996, p. 169). Teams typically have the tendency and ability to make quick decisions. Making design decisions early in the project has the greatest impact and potential for payback.

The third principle of CE is work structuring. Exactly how the work is planned and arranged has a profound affect on project outcomes. “Human minds cannot practically work on multiple tasks simultaneously, parallel computers do. What a human mind is good at is systematically structuring the work or, more importantly, structuring the work-environment – so that each task can be performed independently” (Prasad, 1996, p. 169-170). Even though tasks are scheduled in parallel they have to be assigned to individuals to perform in series. The end result is that tasks are actually accomplished concurrently.

Teamwork affinity is the fourth fundamental principle. “Teams of people working in separate groups are likely to create designs, which may be optimal in their individual domains but will seldom remain optimal in a combined domain which is a union-sum of those individual domains” (Prasad, 1996, p. 170). Teams also have a healthier affinity when they trust in each other. Teams that trust each other have the ability to create solutions that unite both of their efforts and encompass a broader aspect of the problem.

The fifth principle is knowledge leveraging. The scope of new product design often is quite large. “It may be impossible to create a general purpose automated or knowledge-based system, which will use appropriate tools and knowledge-driven rules (mostly computerized) to guide decision making” (Prasad, 1996, p. 170). Instead linking the human knowledge base along with decision support tools will likely be the most practical method for unraveling complex problems.
It is a combination of human knowledge and computerized tools that will yield the best results, leveraging from both.

Common understanding is the sixth CE principle. “Teams will work better if they know what other members are doing. This includes operational understanding of all relevant interplay; for example, what constraints a team-member would encounter when certain parameters will be changed” (Prasad, 1996, p. 170). The sharing of information among team members allows for discovery and discussion of all possible ramifications whether good or bad. Retaining information or working in isolation only has negative consequences for the project.

The seventh principle is ownership. When teams are given the capability and authority to make decisions they work harder to produce better results. “Teams will work enthusiastically to make a good product if they are empowered to make decisions in shaping the design and are given ‘ownership’ of what they produce” (Prasad, 1996, p. 170). Ownership of the design is a powerful force that can drive a team to do extraordinary things. The best results usually come from teams that have accepted the project as their responsibility for completing on time and within budget.

Constancy of purpose is the final CE principle. Most workers have a tendency to make their departments look better to others even when it may be unfavorable to the corporate goals in general. “The whole corporation will do better if every one works toward a common set of consistent goals irrespective of the departments they have allegiance to” (Prasad, 1996, p. 170). In many cases this mandates a change from thinking only about the goals of one department to the goals of the organization. “The obligation of any supporting unit is not to suboptimize its own goals … without a clear and direct relationship to the company’s overall goals. It must contribute its best towards the system goals” (Prasad, 1996, p. 170). Building a constancy of purpose leads every worker to contribute their very best as they strive for this common set of organizational goals.

Successful concurrent engineering projects can result from the direct application of these eight basic principles. The likely overall end result is a shortened product development time. However, other criteria for successful management of projects using concurrent engineering have also been suggested.

Concurrent engineering is often depicted as a linear procedure with overlapping phases that occur simultaneously. “These conditions are very similar to conventional modern project management, which provides the operating platform for concurrent engineering…. [and] is synonymous with cross-disciplinary cooperation, involving all project teams and support groups of the enterprise, internally and externally” (Thamhain, 2005, p. 66). Organizational linkages and integration are required for the successful use of concurrent engineering. The point is that it is not an easy process to establish, implement, and manage. It requires an effort from each team member regardless of their duties on the team.

There are many similarities between the concurrent engineering approaches. They all stress the importance of teamwork. This requires an improvement in cooperation and communication between functional areas or departments including finance, marketing, research, engineering, and
manufacturing. The crucial aspects of prior and proper planning are also evident in all approaches although not mentioned explicitly in them. Timing is another common critical success factor requiring that tasks be completed early on in the process for best results. All of these characteristics, when combined, lead to speed of execution in the product development process.

**Collaborative Engineering Management**

As a direct result of increased competition caused, in part, by globalization more departments within and between organizations are working together. This collaboration or social interaction has led to a team effort that excels in new product development and problem solving. The collaborative team approach creates synergism and social capital, both vital to the success of a project or the solving of a problem. Much of an organization’s success can be explained by their team’s collaboration and social interaction. It is the combination and coordination of complementary capabilities that foster success. The advantages obtained from a team results from a blending of individuals with diverse skills, capabilities, and knowledge. In fact, the social interaction or collaboration within a team can be described in terms of six factors: “communication…, cohesion…, work norms…, mutual support…, coordination of tasks…, [and] balance of member contributions and conflicts” (Dorf & Byers, 2005, p. 269). Basically, these factors all relate to working together as a team. Teams that realize a high degree of quality social interactions typically tend to attain their objectives and goals. It is this complementary combination of varied capabilities that ultimately leads to an organization’s success.

Before further investigation, it is perhaps opportune to first define collaboration and review the key trends. “Collaborative arrangements involve two or more firms in which the partners hope to learn and acquire from each other the technologies, products, skills, and knowledge that are not otherwise available” (Narayanan, 2001, p. 269). This type of operation is often common in the typical day-to-day operation of an organization. However, in technology-related matters two unique characteristics have been noted. The first relates to knowledge transfer between organizations. “Unlike a supplier-customer relationship, the transfer of knowledge requires that the individual firms understand the operations of their partners much more intensely than in the case of the supplier-customer relationship” (Narayanan, 2001, p. 269). The second deals with how and why partners are selected. “The choice of the partners is determined greatly by strategic reasons. Thus, whereas firms may avoid competitors in their day-to-day operations, many technology-related collaborative arrangements are between competitors” (Narayanan, 2001, p. 269). As a result, collaborative efforts have led to some very strange arrangements between very unlikely organizations, each with the hope of gaining from the cooperative team effort.

Organizations are increasingly collaborating with both other domestic and foreign entities to acquire new technologies and then utilize them. Increased competition along with the realization by many organizations that they simply don’t possess the needed competencies has lead to this situation. “Recent years have witnessed four distinctly new trends in collaborative arrangements: (1) R&D alliances, (2) marketing alliances, (3) outsourcing arrangements, and (4) collaboration between small and large firms” (Narayanan, 2001, p. 269). Each of these four trends is worthy of further investigation.
R&D alliances are typically formed to conduct research and development into new technologies and products. They are often created to fill a gap in an organization's technical capabilities or to obtain a technology already developed by another company. Rather than trying to discover and develop the technology alone, it can be researched and developed as a team, spreading out the cost and risk. By utilizing a technology already developed by another organization, the time to market for a new product can be drastically reduced, offering a competitive advantage.

Marketing alliances are also being formed to capitalize on the advertising, promotion, and selling expertise that some organizations possess. These types of arrangements are often in the form of licensing agreements between companies where one firm manufactures the product and the other markets it. This approach utilizes the strengths of both organizations. This allows an R&D organization to concentrate on new technology or product development without having to worry about how it will be marketed. On the other hand, the marketing organization can focus on what it does best and that is to utilize its channels to sell the product.

Perhaps the fastest growing trend is outsourcing arrangements. Technologies, processes, components, subassemblies, and even entire finished products are obtained from alliance partners. These partners can be either domestic or foreign with the trend heavily favoring foreign relationships. This is done for many reasons including cost savings, efficiency, and simply ability. The product is manufactured in the partner's facility and labeled with the outsourcing organization's brand for sale. In fact, the outsourcing firm may not have had anything to do with the actual design, development, and manufacturing of the product. They simply bought it and labeled it with their name for distribution and sale. Unfortunately there is a downside to this type of alliance and it relates to jobs lost at the outsourcing organization. This is a pressing issue that has huge ramifications both now and in the near future.

These trends indicate that the collaborative engineering management effort between organizations is rapidly expanding in order to keep ahead of, or at least up with, the competition. However, increased global competition is only one of the reasons for creating collaborative engineering management arrangements. The primary reasons for forming collaborative agreements include resource sharing, risk sharing, and competence sharing. Whatever the rationale for establishing the collaborative effort, the results are in most cases very rewarding for all organizations involved. But this is not always the case.

Collaboration has actually produced other new challenges, primarily of a legal nature for organizations tied to intellectual property rights and possible misconduct. Basically the overriding issue reduces to who owns what. The belief is that as long as the rights of each party are clearly defined in the contract, the alliances should be allowed. However, reality is often quite different, raising a number of difficult legal issues. It is best to enter into these types of agreements with caution outlining in grave detail each party's responsibilities, duties, and outcomes. With all of these details determined right from the start, the likelihood of disagreements and surprises are greatly reduced. Despite the potential for legal, financial, and political ramifications, many collaborative engineering management projects have resulted in success. Whenever an organization enters into a collaborative effort to design and develop an innovation or invention, it must enable additional precautions to guard and defend its intellectual property.
Implementation

Implementing any type of organizational change is always a difficult process. Typically there are two groups, those promoting the change and those opposing the change. The challenge is to win over those opposing the change. This resistance to change can be found in any organization and it is based on a number of factors. First, change brings along with it fear of the unknown. This is compounded by rumors and worst case scenarios that tend to feed on themselves and grow with time. Second, uncertainty always accompanies change. Individuals have a need to understand their status and uncertainty is difficult to deal with. Third, a loss of control sensation is often triggered by change. There is a tendency for change to threaten the sense of security felt by individuals leading to a view that they are losing control of their lives, responsibilities, and jobs. Finally, change may lead to more work, at least initially. This often takes the form of learning and developing new skills directly related to the change. As a result additional hours of work may be required for an unspecified period of time. Depending upon the unique circumstances surrounding the change other factors may also lead to resistance.

Facilitating organizational change requires implementing strategies that directly incorporate the concerns of the individuals. Among these strategies are “involve potential resistors …, avoid surprises …, move slowly at first …, start small and be flexible …, create a positive environment …, incorporate the change …, respond quickly and positively …, work with established leaders …, treat people with dignity and respect …, [and] be constructive” (Goetsch & Davis, 2003, p. 201-203). The change process must involve every affected business unit or department in both the planning aspects and executing activities. This helps to overcome the emotional aspects of the transition and leads to successful implementations.

In addition, specific steps can be taken by engineering managers to aid in this process. The first and perhaps most important is training. Extensive training or retraining may be required in order to utilize new tools and techniques. This can lead directly to reduced cycle time, improved quality, and higher customer value perception. For example, new quantitative methods are available to aid in improving the design, development, and manufacturing processes. These include Statistical Process Control (SPC) along with other statistical tools that can be used to maintain consistency and improvements in processes.

One of the most useful practices that can be implemented to design products and processes in response to customer needs is Quality Function Deployment (QFD). It is a technique that strives to utilize the voice of the customer directly into the development process for new products or services. The customers’ perceptions can be identified and translated into the products designed, developed, and manufactured to fulfill those requirements. Customer needs are prioritized, innovative responses are determined, and processes maximized to improve effectiveness. Basically, QFD is a methodology that enables an organization to continually improve and exceed the customers’ expectations. In this way, effective organizations can align their processes to meet or exceed their customers’ needs the first time and every time. By using QFD techniques to drive changes in the way business is done, processes, products, and services can be modified to better meet the customers’ needs.
Another very useful implementation tool is the design for X (DFX) methodology. The term was originally derived from the design for manufacture process that required a product be more than just manufacturable, it also must be simple to assemble. The expression has evolved into design for X which now includes a wide variety of approaches to product design utilizing a diverse assortment of philosophies, techniques, and tools. The objective is to continually review the design during the entire development cycle to determine ways to improve every aspect of the process. The result is typically a linkage between the requirements of the customer and some quality criteria. Today there are dozens of different design for X methodologies. A few of them are design for assembly, cost, disassembly, ease of use, environment, installation, maintenance, manufacture, quality, redesign, reliability, reuse, safety, serviceability, simplicity, speed, and test. The advantages resulting from using these techniques include simpler designs, shorter production times, fewer parts, more standardized parts, fewer production steps, and reduced cost.

Remaining competitive in a rapidly changing global economy offers many challenges for the engineering manager. The organization’s core competencies must continually be enhanced to enable the development of products with the features that customers’ want. Managers must be continually aware of new emerging technologies in order to be able to utilize them to improve the organization’s products or services. Operations must be streamlined by introducing new Web-based tools for product design, project management, operations, maintenance, and knowledge management. New or next generation products must be released in a timely manner to ensure profitability and viability for the organization. Engineering managers must determine the best way to utilize all of their available resources in order to attain the organization’s objectives. Global economies of scale must be realized to obtain cost and technology advantages. A global mindset must be acquired and nurtured allowing them to lead their organization in the quest to remain competitive in the global business market. This rapidly changing environment offers many challenges as well as many opportunities for the engineering manager.

**Conclusions, Reflections, and the Future**

It is very challenging for an organization to remain competitive in a rapidly changing global environment. It requires speed and scale in every aspect of the business from research, design, and development to marketing, production, and distribution. The overall objective is to offer products cheaper, faster, and better than the competition. In order to accomplish this goal organizations have implemented new engineering management techniques intended to streamline product development. Functional areas within organizations are working much closer together and coordinating their efforts. Alliances have even been formed between organizations to utilize their strengths and overcome their weaknesses.

In order to counteract these global challenges new tools and techniques have been developed to aid the engineering manager. Quality Function Deployment (QFD) techniques can be used to identify customer preferences and perceptions. Quantitative methods and statistical tools can be used to maintain reliability and improve processes. Design for X methodologies can be used to enhance quality, lower cost, and attain a host of other objectives. However, the burden still rests on the engineering manager to make the right decisions at the right time allowing the organization to successfully compete.
Essentially this all leads to change. Organizational change is necessary to keep pace with the rapidly evolving business climate. Those organizations that recognized the need for change and welcomed it survive. They remain competitive today. Those organizations that rejected change and continue to conduct business the same old way have either become a shell of their former self or ceased to exist. They are no longer viable players in today’s competitive business environment.

However, those organizations that have adapted to the new highly competitive global environment cannot relax. Change is continuing. The business climate will surely be far different tomorrow than it is today. Organizations must continue to change and evolve in order to meet the challenges that tomorrow will bring. This task becomes either the principal difficulty or foremost opportunity for today’s business and engineering managers to resolve.

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