
Title: Barriers to Excellence In A Highly Competitive Marketplace - An Exploration Of Proactive Engineering Management Method

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# BARRIERS TO EXCELLENCE IN A HIGHLY COMPETITIVE MARKETPLACE- AN EXPLORATION OF PROACTIVE ENGINEERING MANAGEMENT METHODS

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**To:** Dundar Kocaoglu

**From:** ProjectTeam 3

**Subject:** Title of Group Project

In our proposal and early status reports, our team had identified the title of our project to be "Barriers to Excellence in a Highly Competitive Marketplace - A Study of Reactive vs. Proactive Engineering Management Methods." As we performed our literature search we found no information linking reactive behavior and the ability to compete favorably in a highly competitive marketplace. All information linked behaviors we classify as proactive with competitiveness. As a consequence, we have retitled our paper "Barriers to Excellence in a Highly Competitive Marketplace - Exploration of Proactive Engineering Management Methods."

Regards,

Tim Bennington-Davis, Tim Golik, Ramazan Guven, Anthony Piwinski, Donna Street, and Arnold Wolf

# Barriers to Excellence in a Highly Competitive Marketplace -

# An Exploration of Proactive Engineering Management Methods

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***Abstract*** **- This paper explores the impact of a proactive approach to job responsibilities for an engineering organization. A definition of reactive and proactive engineering behavior is offered, then the organizational, human, life cycle and management aspects are examined with respect to a competitive marketplace. With few exceptions, proactive behavior was found to be more desirable for organizations who were seeking growth, increased competitiveness, shorter product introduction times, or participation on a global level.**

## I. Introduction

In recent literature concerning the management of technical personnel, there has been much talk about the need for engineering groups to behave in new and non-traditional ways. Faster times to market, higher quality products, better relationships between functions, and increased efficiencies have all been cited as reasons for change. From these discussions has come the model of an engineering team that is on top of every challenge, is able to foresee problems coming, is innovative, and is constantly improving the relationships with other functional areas. "Proactive" is the term coined to describe this behavior. This paper studies the effects of proactive and reactive behavior in various aspects of the corporate arena.

Before a discussion of proactive and reactive management methods can occur, definitions are needed. For the purposes of this study of reactive versus proactive engineering management methods, the following definitions of proactive and reactive are used. They are a compilation and summary of research material which defines proactive and reactive management.

Proactive Behavior - Proactive behavior is exhibited in organizations and individuals who take the initiative to establish goals and objectives through both long term and short term planning. [7][20][44][47] They appear to be decisive, firm and communicative. [20] They tend to self-initiate contacts both inside and outside of their organization/work group in order to meet the goals of the organization/individuals. [3] [9] The goals of the individual must align with the goals of the organizations for the actions taken by the individual to be appropriate.

Reactive Behavior - Reactive behavior is exhibited in organizations or individuals who find their goals arising out of necessities rather than through short and/or long term planning. While they may appear to do short term planning, it is in response to another organization's or individual's action which requires them to react. [7] [47] They appear to be indecisive, weak and uncommunicative. [20] They tend to wait for contacts from others both inside and outside of their work group before taking action. [20]

It must be noted that an organization's or individual's behavior will be governed by the environment in which they are allowed to operate. The uncontrollable external elements may make a normally proactive individual to appear to be reactive. Studies indicate that an individual may be proactive in setting up an

organization then appear reactive in the normal operation; however, the individual still spends the necessary time in both short and long term planning in order to establish goals and objectives for the organization. In essence the organization or individual has been very proactive in establishing both long and short term goals for his/her organization or his/her individual life and can appear to be reacting to other reactions to their proactive initial actions. [20][37] [44]

This paper will now explore the proactive and reactive management methods from an organizational, human, life cycle, and overall management aspects of engineering organization. Throughout, we also look at how proactive and reactive management methods are utilized or demonstrated in foreign environments as well as in the United States. Since the world is becoming smaller in terms of communications and in the interactions between both the governments of other nations and the economic forces which work within these countries, it is useful to compare and contrast the different methods to see where the United States is in this arena.

## II. Organizational Aspects

The structure of an engineering organization is influenced by the environment under which it operates. This changing environment is forcing the development of a new type of engineering organization. This new organization is more proactive than traditional organizations, focuses on long term strategies, and is aware of the effects of time on product development. The structure of this organization is flexible to allow for fast response to a changing environment.

### a. Government Environment

The financial system of a technologically oriented company in the United States must overcome shortcomings in American accounting standards. These standards have created short-term metrics that pressure mangers to produce short-term results. The emphasis placed on quarterly profits comes at the expense of long term investment. Japan's financial system has almost completely bypassed short-term income pressures in favor of focusing on market share, growth, and total sales. [28]

In the United Kingdom, corporations emphasize short-term profitability to the detriment of long term strategic planning, research and development, and training due to pressure from the stockholders. [11] U.K. corporate managers look at short-term profitability while West German and Japanese corporations can adopt long-term strategies because of closer relationship with their banks. Traditionally, the West German and Japanese banks are prepared to take a long view. Low inflation in Germany and Japan is another key for their success. Fluctuation in inflation rates makes it hard for U.K. corporations to plan ahead. [11]

The Japanese government's role in shaping a long-term, proactive environment is provided by the Ministry of International Trade and Industry (MITI). The primary goal of the MITI is to develop a coherent industrial policy that focuses on international trade. [28] Corporations in other far east countries also collaborate with their governments to increase communication, share knowledge, and become industry leaders. There is no counterpart to the MITI in the U.S.

### b. Global Competitive Environment

As world trade increases and national borders become less important to the flow of goods and ideas, American engineers must be cognizant of global changes. Engineers who are unable to anticipate the effects of the global marketplace may design products with limited appeal to the rest of the world.

The potential of a single European market by 1992 and the opening of markets in many Eastern European nations will have an effect on US corporate strategy. U.S. corporations that desire to maintain a competitive advantage have four major market strategies available to them; international marketing, geographic-niche marketing, pan-european marketing, and marketing differentiated goods [5] Engineers must design products that will fit into these different strategies. Even this can be a challenge, such as in Turkey, where even well-managed companies are finding it difficult to acquire the capital that they need in order to prepare for international competition. [1]

Some of the eastern European corporations are collaborating with western corporations. Russian machine tool manufacturers are becoming more competitive and increasingly interested in obtaining western technology. [18] The Soviet managers are seeking to find pragmatic and realistic solutions for problems they face in bringing about a market economy. [38] Proactive organizations from all countries are taking advantage of the removal of barriers to increase their global competitiveness.

### c. Technology Environment

Rapid technological change has created a dynamic business environment in which management must anticipate rather than react. More emphasis must be placed on strategic management.[12] Strategic management is focusing the organization on strategic thinking, implementation, monitoring, control, and re-adjustment. The strategic perspective of the organization must emphasize a total systems view of the organization, interaction with the environment, and anticipatory control. [13]

U.S. corporations are still making technological breakthroughs, but are missing opportunities to bring those products that use these breakthroughs to the market. This is caused by the functional separation of R&D and manufacturing. U.S. corporations are also missing to opportunities to upgrade their products by not making modest but continuous improvements. [14]

From the aspect of technology, it is important for the engineering team to be proactive in identifying and incorporating new technologies into products and manufacturing lines. The ability to incorporate new technology into a product can provide a significant cost, competitive, or strategic advantage in the marketplace. The importance of close connections to technological forefront is heightened by the increasing accessibility of technology. [15] Close communication is important in such efforts, however, since introduction of a technology that does not match corporate strategies and company capabilities can cause great waste and infighting. [32]

d. Tradition vs. Nontradition

The traditional engineering organizations that are currently being used by most U.S. firms have evolved since World War II. These organization tend to be larger in size then the new nontraditional organization. In fact, most Japanese firms tends to decentralize their organization as it grows to between 300 to 500 employees.[35] Traditional organizations tend to be structured by function, procedure driven, and slow to respond. The following table, which contrasts the two, was developed from various articles. [2][13][35]

| Traditional Engineering | Strategic (non-traditional) Engineering |
|---|---|
| Solution to problem | Base for strategic advantage |
| Design elegance | Commercial importance |
| Start with technology | Start with customer needs |
| Timing depends upon rate of technological progress | Timing depends upon progress, customer needs and actions of competitors |
| Judged by peers in profession | Judged by organizational needs |
| Extend current trends and technologies | Break trends, shift and abandon technologies |
| Depth and breadth of knowledge | Flexibility of reponse |

## III. Human Aspects

### a. Managerial Behavior

To facilitate proactive behavior, an organization must develop proactive management teams that are capable of nurturing and developing proactive employees. Leaders see themselves as part of a team, balancing organizational goals with the needs of their employees. Participatory leaders strive to know their employees in every department and at every level. They come to know the responsibilities and expectations of each employee as well as the barriers each individual faces. By becoming participatory, leaders are better able to match available skills to required tasks, anticipate problems that could hinder productivity, and recognize barriers that might restrict an employee's ability to excel. In this way, participatory leaders are proactive rather than reactive. [9]

Organizations striving to develop proactive management teams should first identify candidates that exhibit team ideals and organizational goals. Once the appropriate top-level candidates have been identified the next challenge is to develop their potential. The most successful development efforts have three aims that take them well beyond the skill building objectives of classic training programs. These aims focus on cultivating a common vision and shared values (organization cohesion), broadening management perspectives and capabilities (teaching people how to manage complexity instead of merely to make room for it), and developing contacts that shape management relations.

Organizational cohesion should not be developed in an attempt to devise the most ingenious and well-coordinated plan but rather to build the most viable and flexible strategic process. In addition, the key organizational task is not to design the most elegant structure but to capture individual capabilities and motivate the entire organization to respond to a complicated and dynamic environment in a cooperative manner.

The shared strategic objective should be visible to all and in the form of clear and concise statements. This should describe in detail the objectives of the organization and responsibilities to the industry, fellow employees, and society. These "mission statements" assist in developing organizational cohesion. They provide guidelines which make it easier to recognize actions and attitudes that deviate from or support the objectives of the organization. The actions of individuals should be contained beneath the umbrella of the goals if the organization is to remain focused and productive.

It should be understood that objective statements alone will not lead an organization away from the reactive trap. These statements merely dictate the goals of the organization and results expected of the employee. Once stated, the organization must continually challenge all departments to identify and remove barriers which impede the achievement of said objectives. These barriers can take many shapes and forms such as hardware and software

deficiencies, inappropriate strategies, and conflicts which can become stumbling-blocks for employees. Hardware and software deficiencies are easily corrected as both problem and solution are usually apparent. Inappropriate strategies, on the other hand, are often difficult to identify. Though sometimes limited by the available hardware and software, strategic solutions are rarely a product of capital expenditures for equipment. The solution to these problems lies in the beliefs, actions, and words of the managers.

The most successful companies are those with top level executives who recognize the need to manage environmental and competitive demands. They focus less on the quest for an ideal structure and more on developing the abilities, behavior, and performance of individual managers. The challenge is not so much to build a matrix structure as it is to create a matrix in the minds of managers. The built-in conflict in a matrix structure pulls managers in several directions at once. Developing a matrix of flexible perspectives and relationships within each manager's mind, however, achieves an entirely different result. It lets individuals make the judgements and negotiate the trade-offs that drive the organization toward a shared strategic objective. [1]

Individuals must commit to occupational excellence for both themselves and the organization. Getting people to commit is at the heart of the "take action " process. Commitment to new behaviors is often overwhelming but always rewarding. Leaders who have committed themselves to the success of the organization are valuable assets.

b. Conflict Identification and Classification

One of the key challenges of a leader is to recognize and correct conflicts that exist between employees. By fully understanding the department and its personnel, participatory leaders are able to intervene when necessary to circumvent conflict situations - i.e. "One can stand outside the forest, and if need be, zoom down into the forest and look among the trees". [19] Conflicts between employees can be dealt with through employee separation, reassignment, or dismissal however the most creative solution involves changing the behavior and beliefs of the employees. [16][21] Once it has been decided that a behavioral change is needed, there are 3 managerial factors that must be considered: the type of situation that exists, the type of behavioral change desired, and the type of leadership necessary to perpetuate said change.

If change is necessary, a leader should allow a certain amount of employee participation. This builds team spirit and self worth. Participation does not mean allowing employees to implement change without regard to the resultant impact. The organization should encourage and respond to employee input, and strive to include employees in the change process. [16][21]

### c. Behavior Management

Leaders must cope with 3 basic types of situations: anticipatory, reactive, and crisis situations. Anticipatory situations are products of proactive thinking and short and long term planning. Examples of anticipatory situations include forecasting, market studies, and manpower projections.

Successful responses to reactive situations, i.e. situations that arise out of necessity rather than through planning, require quick and accurate pairing of individual abilities to situational action items. Proactive leaders seek to anticipate situations and hence avoid surprises that require reactive solutions. The irony is that proactive leaders prove their worth by displaying their ability to successfully respond reactively. It is easy to see that participatory leaders, those who thoroughly understand their employees, are best equipped to succeed in reactive situations. [20]

A crisis is a breakdown within an organization. A breakdown may involve equipment, products, employees, company strategies, or the organization as a whole. Solutions to crisis situations usually take the form of temporary "fixes" designed to allow the organization to continue to function while better solutions are examined. Crisis situations, though inevitable in any organization, can be reduced in number by developing improved communication linkages between top executives, departmental managers, engineers, and support staff. Once the burden of crisis and/or reaction management is overcome, change can occur from a procession of small proactive wins. [23]

Education and/or training is a key to employee success. By providing your employees the skills and tools to act proactively you allow them the opportunity to be successful on a daily basis. Proper and continuous training is expensive but will accomplish three objectives: it will refocus the employees efforts to match the overall needs of the organization, reinforce an employees' sense of self-worth and valve to the organization, and communicate to the employee a high level of commitment by the organization to the success of the individual. [21]

Traditional firms facing more competitive and economic demands on improving their products and services invariably attempt to do so through some form of reorganization. For them, reorganization is an attempt to regain order through relocation of personnel accountability. A reposition of personnel on the organization chart takes the form of new functions, downsized functions, and/or modified functions representing newly installed work concepts of the times. [48]

Although a certain amount of structure is necessary to maintain any organization, steps should be taken to identify and remove routines that may be redundant. Overlapping responsibilities, not to be confused with functional cross-training, can reduce the overall productivity of an organization and create conflict between individuals. Employee conflict can significantly decrease the ability for an organization to be proactive.

Leaders should look for barriers, such as language, that can hinder an organizations proactivity. Such barriers can be overcome through short-term and long-term fixes. A repositioning of personnel is an example of a short-term fix to a language barrier. By reacting in this way a manager is responding to the immediate needs of the organization. A proactive manager will attempt to remove this barrier to success by encouraging educational programs. Taking proactive measures such as educating personnel helps to avoid employee segregation. Segregated employees tend to feel as though they do not fit in and are unimportant. These feelings are a product of poor communication linkages which leave an employee out of touch with the rest of the organization. [33]

### d. International Trends

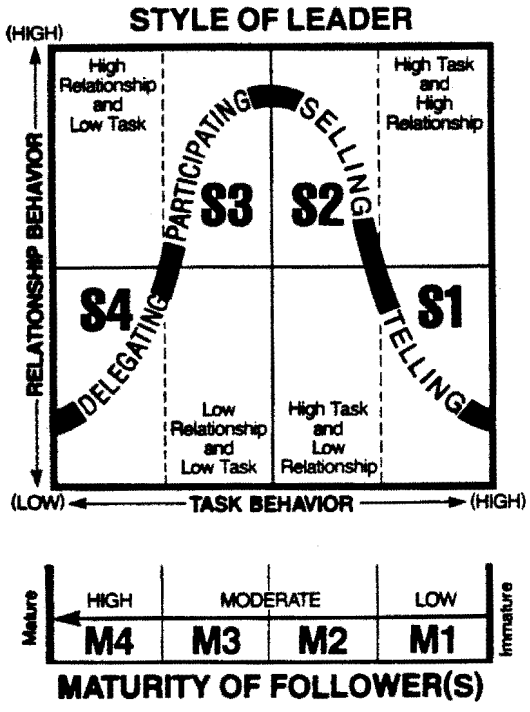
Companies in the Far East are maintaining corporate culture by ensuring compatibility of workers. For example, conglomerate groups in South Korea place importance on corporate culture and values. As a result they spent a great deal of time and effort in ensuring that job candidates are compatible with the corporate culture. [22]

Corporations of Africa are trying to reduce barriers of conventional management by increasing training programs, privatization of state owned enterprises, and increasing external and internal communication. South African companies are implementing a participatory approach to management to ensure company-wide quality improvement. [12]

In Spain, the government encourages their corporations to handle the barriers of effective management by training their staff [8], while corporations in the U.K. are committed to Management Training and Development (MTD) programs by moving from procedural, function-specific skills to knowledge-based entrepreneurial skills. [30] Despite these efforts, questions remain as to how to develop truly effective MTD programs.

### e. Leadership

Numerous leadership theories have been developed over the years including the first four-style model with an effectiveness dimension developed by Reddin in 1964. This model has since come to be called a situational leadership model. The following two concepts are central to the understanding and use of the situational leadership model: (1) Task behavior is the extent to which the leader engages in directive behavior when spelling out the duties and responsibilities of an individual or group. These behaviors include telling people what to do, how to do it, where to do it, and who is to do it; and (2) relationship behavior is the extent to which the leader engages in two-way or multi-way communication. Relationship behavior includes listening, facilitating, and being supportive. These two behaviors, task (direction) and relationship (support), are separate and distinct. [34] When placed on separate axes of a two- dimensional graph they form the following four style grid:

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When determining the appropriate leadership style to use (S1, S2, S3, or S4), the leader must consider both the task-specific ability and willingness of the follower(s). If the employee has little knowledge of the task to be performed, that individual is relatively immature with regard to the task. On the other hand, if the employee knows what, where, when, and how to do the task, that individual is considered to be relatively mature with regard to that specific task.

## IV. Life Cycle Aspects

### a. Life Cycle Model

The behavior of an engineering organization is influenced by the point in life at which the product or service exists. Shannon offers a definition of the life cycle of a product as having seven phases: conceptualization, definition, design,development, production and test, operation and support, and phaseout. [33] The life cycle of a product is simply the set of activities that occur from the moment the product idea is conceived to the moment the product is made obsolete. The goal of any profitable organization is to shorten time spent and waste incurred during the first four phases, deliver a product to manufacturing that is robust against manufacturing variations, provides a reasonable profit margin in the face of competition, and can be removed from the marketplace easily. The actions taken by the design team have a large impact on all aspects of the product throughout the life cycle, especially cost.

### b. Early Phases

During product conceptualization and definition it becomes important to insure the mission for the product is connected to a need in the marketplace to avoid wasting precious resources, and that action can be identified and taken at the earliest possible opportunity. Cases of remarkable product introductions have involved the creation of multi-functional teams, organized around the needs of the customers, and empowered to take action. [2] Characteristic of such teams is the close communication between the functions represented on the team, and rapid common ownership of the product vision. In a specific example at Exxon, an Information Specialist saved an estimated two years of research time by contributing to an interdisciplinary Research and Development team.[43] This group found that concurrent activity in the areas of patent strategy, development strategy, and commercialization strategy was required to create a tenable vision. As engineering takes an active role in understanding the marketplace and customer needs, they can begin to identify opportunities to shorten development times, apply creativity and innovation, and remove unnecessary steps. A reactive engineering organization will miss such opportunities due to their lack of connectivity.

Minimizing wasted time and money requires having resources, tools, and equipment in place at the proper point in the program. This is achieved through careful planning and action taken as early as possible. Engineering teams lacking a proactive approach will lack information on which to base such action and will be unable to create realistic plans of action. Teams which react to the needs as they arise will be wasting time in getting the product to the successive phases of development, as well as incurring higher costs of developing production capabilities. [24]

In companies capable of shorter times to market, termed "fast-cycle companies" by Bower and Hout, [2] there exist methods for making the needs of all functional organizations visible and understandable to all other team members. Planning can then encompass the needs of all involved areas of the business, minimizing waste and exposing opportunities for streamlining operations. People within such companies come to see themselves as members of a larger, integrated system rather than members of a functional organization disconnected from the whole. Innovation can then be directed toward optimum results for the company, given the tight coupling between functional organizations. [24] Proactive engineering organizations strive to bridge the gaps of communication and understanding.

In contrast, the serial approach of product development in use by less progressive organizations focuses on the needs of the organization as the product progresses. Optimization occurs at a local level, and the product is passed from marketing to engineering, engineering to manufacturing, and manufacturing to service over the life cycle of the product with each addressing the product in accordance with their own needs. Actions taken are not taken with consideration of the best global approach, creating waste when changes

need to be made downstream. Conflict and ill will arises between teams when members begin to believe their work is not appreciated by others, or when they see their efforts being undone.

In some organizations, the attitudes and behaviors of the members of functional teams may accommodate concurrent product development, but the organizational structure and company policies inhibit efficient operation. Starr refers to a "fast-response organization" where a comprehensive information system is available to everyone, and the management is acutely aware of timing as well as time. They are geared to be anticipatory. [35]

### c. Later Phases

Once the product has been released to manufacturing, proactive engineering teams engage themselves in a process of transferring the product smoothly into manufacturing. This not only provides the manufacturing organization additional support during the initial stages of production, but also affords the design team immediate feedback on the quality and manufacturability of the design. The term "closed-loop corrective feedback" is typically used on the manufacturing line when referring to finding assembly errors and returning them to the source of the error for correction. The same principle applies to engineering teams and what they can learn from manufacturing before they begin their next design. Reactive engineering teams wait for the manufacturing organization to call for help, thereby missing opportunities for learning and product improvement.

While the product is being marketed, the engineering team has a opportunity to gauge the usefulness of features and capabilities designed into the product. Tradeoffs made during product developments were based upon marketing data or assumptions, and can be validated once customers have used the product. With the engineering team in a position to receive customer feedback and be apprised of both the benefits and shortcomings of the product for the customer, suitable ideas for better products result. One Austrian study showed that products driven by customer needs are four times more likely to succeed than technology-driven products. [36] A reactive engineering organization that responds to customer feedback only when asked will be missing opportunities to factor current customer dissatisfaction and competitive pressures into new product designs. [6]

Designing for serviceability is similar to designing for manufacturability, but has greater impact on the total life cycle costs of a product. Finding ways to make a product easily serviceable creates the opportunity for higher profits from the service organization, and perhaps a longer life for the product itself. Engineering organizations that develop methods of learning the service issues of products they designed gain the advantage of aiding the long-term profitability of the entire company though decreased warranty expenses and increased margins from service branches. Reactionary engineering

organizations will find out about service problems after they have reached a level where many customers are dissatisfied or the service branch is unprofitable. Either demand fast reaction and indicate damage has already been done, in some cases to the company's reputation.

Being connected to the marketplace and to the other organizations within the company puts the engineering group in a position to aid the marketing and sales organizations in gaining against the competition. Successful organizations are those who gain and keep an advantage against their competition, whether by continually replacing their own products with more desirable ones or by broadening their offerings to encompass the needs of the entire marketplace. [29]

### d. Engineering's Impact on the Business

With an understanding of the type of behavior a proactive engineering group exhibits, it becomes evident that the engineering group has a great impact on the life cycle of the product in terms of time and cost. Emphasis on reduction in time-to-market centers on the deliverables from engineering being correct the first time and on schedule. Engineering has turned to computer-aided tools to gain a more accurate understanding of the design as well as speed the flow of information from engineering to component vendors and manufacturing. As more of the design information is captured electronically in the form of schematics, CAD drawings, bills-of-materials, etc., standards between computer tools being used in different functional areas have become important. These standards work towards insuring that data generated in one function is usable by another without wasted effort. [40]

In an effort to gain indications of product quality earlier in the process, engineering groups have turned to accelerated testing of the products across all disciplines (software, electrical hardware, mechanical, chemical). Subjecting prototypes to tests which simulate worst-case customer use and end-of-life conditions provides insight into the weakest areas of the design. Higher quality and customer satisfaction result from improvements made once problems are discovered. Manufacturing processes which include screens simulating such conditions can help to maintain high quality and indicate changes in the manufacture of the product over time. [46]

An engineering organization who recognizes the importance of the functions performed in other groups can seek to improve the leverage of those groups as well as their own, by helping to generate standards, create and specify tools, and align their activities to better fit into the processes of the other groups. This type of behavior allows engineering innovation to reach further into the organization than does the reactive approach. [24]

The most successful companies are those poised to take action on a new opportunity, whenever it arises. The well-connected, proactive engineering team who recognizes both the possibility and how to capitalize on it with be much more likely to succeed in making the opportunity into a product than it's reactionary counterpart. [10]

## V. Management Aspects

The degree of proactivity or reactivity in an engineering organization is largely dictated by the organizations management methods. Decision making skills, management tools, and management style are significant dimensions of management methods. The success or failure of an engineering group or project is directly related to these management dimensions.

### a. Proactive vs. Reactive Decision Making

Decision making is the heart of an engineering manager's function in an organization. Situations that require a decision can either come with advanced notice, or appear out of the blue with no warning at all. Proactive decision making looks toward the future, anticipating what will need to be done and when. This style of decision making can best be characterized as strategy or strategic planning. Reactive decision making occurs after an event has happened. This style is characterized as tactics. Strategy has an implicit value over tactics, but even the best manager is surprised once in a while. For this reason tactical skills complement strategic decision making skills.

Strategic planning is a requirement for any business to excel, especially a business that focuses on a technology that is rapidly changing. Technologically Oriented Firms (TOFs) need to make a conscious commitment to the use of technology. This requires that management must anticipate the future, and use strategic planning to gain a long term advantage over both competitors and the environment. As the technology evolves, the feedback loop between strategy and engineering grows stronger. Strategy defines the design directions, and

technology limits the strategic options. [13] A recent survey of the executive officers of 12 leading European TOFs identified 6 factors that were common to the companies strategies; [42]

1. Goal clarity as opposed to only a strategic plan.

2. A clear, consistent business definition.

3. Establishment of an inter-organizational network with public agencies, academic organizations, competitors, and clients.

4. A sustained access to external financial resources.

5. Downstream coupling between R&D, marketing, and manufacturing.

6. An organizational climate based on personal commitment, team spirit, and mutual trust and reward.

Strategic planning has parallels in game theory. The object is to "think ahead, then look backward." [26] A manager chooses the best possible outcome, then traces backward to find the strategy that is most likely to achieve that outcome.

Tactics are oriented toward short-term objectives. Tactical decisions are typically more structured, detailed, repetitive, functionally oriented, and made at a lower level then strategic decisions. [42] The strategy of a company can be set at a high level, then lower ranks of management are responsible for the tactical implementation. This is seen in the MOGSA ( Mission, Objectives, Goals, Strategy, Action ) hierarchy that typifies effective project oriented engineering teams. Tactical decision making obviously has its place, but large, mature, organizations emphasize tactics and tend to ignore fast response aspects of strategies. [35] An engineering manager needs to know the difference between strategy and tactics, so that tactics aren't substituted for strategy.

### b. Tools for Proactive Management

The degree of proactivity or reactivity in an organization can either be a function of the role the organization fills, or how the organization has evolved. If an organization is reactive as a result of its function, then there may be little need for a swing in management attitudes from reactivity to proactivity. If an organization is reactive mainly because of organizational evolution, a change from a reactive to a more proactive managerial style is in order. The key to major improvements in cost and quality is problem prevention. [4]

The first place to start in the transformation from reactivity to proactivity is in the makeup of the organization. Training is a way to make people more proactive [19] by increasing their awareness of the future effects of present actions. John Deere Harvester Works in Canada emphasizes education and training as ways to help vendors understand John Deeres' needs. [17] Global companies may need to use global scanning seminars and cross cultural training programs [31] to help employees understand their customers future needs.

Proactivity has a different vocabulary than reactivity. Solution, quantification, and automation give way to prevention, reduction, and elimination. Quality is engineered into the product, not added by reworking product or production strategies. [4]

Strategic planning is a tool that helps an organization break out of reactive behaviors by forcing the organization to think about what lies ahead. To cope with rapid change, management must anticipate rather then react, and more emphasis must be placed on the formulation and implementation of a long range strategy. [13] Future engineering solutions will be subject to strategic scrutiny as the feedback loop between strategy and engineering tightens. Strategic planning can be looked at as anticipatory adaptive control for organizations. [12]

Computer software that helps to manage the flow of information in an organization can be an aid to increased proactivity. Computer tools can be broken into two broad categories; software that deals primarily with management information, and software that deals primarily with product information.

Electronic Data Interchange (EDI) and Management Information Systems (MIS) are software tools that operate primarily on management information. EDI allows manufacturers and vendors to share information between company databases. This allows manufacturers to query vendors in almost real-time, enabling companies to assess the effects of potential changes to production schedules. In turn, vendors are able to meet Just In Time (JIT) requirements by seeing the manufacturers' schedule. Through EDI links, changes in production schedules can be quickly and effectively communicated and acted upon with a minimum of disruption for the parties involved. [45]

MIS software is intended to link design, manufacturing, and marketing together so that they can work toward the goal of faster response to customer needs while operating from a common data set. The current challenge for MIS is to link these traditionally disparate functions together when the individual functions themselves do not necessarily want to be part of the system. [45] DuPont U.K. executives increased their knowledge of company operations through four interlinked MIS subsystems; market research, market intelligence, internal accounting, and analytical marketing. [41] In a company where a MIS is working well, business decisions can be made with the "big picture" in mind, allowing the company to take a proactive stance toward change.

Computer Integrated Manufacturing (CIM) allows engineering groups to be electronically integrated with other company functions. CIM is intended to speed the process which converts customer orders into shop orders, enabling goods to be delivered just in time. [45] CIM covers a broad range of tools, from simple production control databases to highly automated factories where Computer Aided Design (CAD) data is sent directly to a Flexible Manufacturing System (FMS). Ideally, CIM includes a method for EDI both inside and outside of a company. [45] The purpose of CIM is to allow companies to make accurate plans of their future activities and then follow their plans, rather then having to react to demands on a daily basis.

Expert Systems are database management programs that try to match a pattern of inputs to a pattern in the database, and then make a response or recommendation if a match occurs. A trend that is helping push the acceptance of Expert Systems is the gradual change from data management to "information management". [39] Expert Systems allow expert technical knowledge to be accumulated and retained in a format where it can be used by others after the source of the knowledge has either left the company or moved into a different area. Expert Systems also make higher levels of expertise available to lower levels of the workforce, increasing their abilities. Expert Systems can assist the evolution from reactivity to proactivity. Instead of only identifying problems and recommending solutions, future expert systems are hoped to have the ability to predict and prevent problems within a heterogeneous software environment. [39]

A counterpoint to the discussion on tools for proactivity is offered by an expert in enterprise modelling who says " The key to success doesn't really depend on the tools. There are lots of good tools. [Success] depends on developing a culture in which they can be [effectively] used." [25]

### e. The Proactive Manager

This paper has discussed proactivity and reactivity in the context of the engineering manager. While a reactive stance is sometimes necessary, increased proactivity seems to have the potential to positively impact an engineering manager and their organization.

The advantage in business goes to organizations that concentrate on project management, as opposed to process management (except on process-changing projects). [35] Project management concentrates on the continuing cycle of design-build-ship over the life of the organization.

The era of an organization being guided by a single leader has all but come to an end. For decades the general manager has served as chief strategic guru and principal organizational architect. As the competitive climate becomes more unstable and unpredictable, it is difficult for one person to serve as the visionary for an entire organization. [1] This puts the responsibility for strategic thinking on the shoulders of others lower down in the organization.

It is recognized that managers may be proactive with certain groups of people and reactive with others. People in senior positions who participate in the formal planning of their operations are pushed toward a position of proactivity. The implications are that managers can be proactive or reactive depending on the nature of their contact with others. [1] Managers who initiate action in key areas - e.g. goal setting, strategy, and climate building - but are reactive in all other areas can still be looked at as proactive based on their future - oriented position. Proactive organizations can be characterized as having a well matched corporate and technology strategy. Top performers have an aggressive technological orientation. They are strongly research and development oriented, are proactive in acquiring new technologies, and have a strong offensive strategy. [32]

As an example of proactive management, we offer the Integrated Technology Management Framework, drawn from R.F. Monger [28]:

1. Accept management's role in technological innovation.

2. Commit equal energies to each and every phase of technology management

3. Create a vision for the technology infrastructure based on general competitive capacity required for long term competition.

4. Build the technology infrastructure to produce quality products and services. Build quality into the infrastructure. Continuously improve quality.

5. Manage technology as an investment, not a cost.

6. Use appropriate standards to measure technologies benefits, not just accepted standards.

7. Work to change the social, educational, political, and economic forces that shape managerial decision making with respect to information technologies.

8. Technology follows the organization, the organization follows the mission.

9. Establish appropriate mechanisms inside and outside the organization to assess new and emerging technologies and to transfer the resulting knowledge into the organization as a whole.

10. Use technology as a positive force in the transformation of work. Prepare the workforce for change.

## VI. Summary

In any company that is facing challenges, a proactive engineering force is desirable, whether the challange is from competition, the global marketplace, financial needs, time to market, or need for increased quality. In the material accessed for this report, there exist no indicators that would suggest an advantage in having a reactive engineering team.

While this is easy to state, a proactive engineering team is very difficult to create and maintain. Many factors work against proactivity, some overt and some subtle. Human behavior, organizational structure and politics, attention to everyday business - all contain scores of issues that make change difficult.

While much attention has been given to organizational structures, it appears that no best structure exists for developing and encouraging proactivity. The degree of proactivity has much more to do with the lack of barriers to progress in the organization and the degree to which multi-functional teams are handled.

An engineering team who works across the organization can be viewed as proactive, or as meddlesome - the difference lies in how appropriate their actions are. If the engineering team has a clear understanding of their impact on other organizations they can work well to support the overall goals. When they do not, they can create frustration and confusion in the entire organization.

The body of literature cited had a common consensus for an engineering organization to prosper in a fast-paced dynamic environment. It had to be intelligent enough to see change coming, and flexible enough to execute the change. Proactive management is not optional, but required to excel.

Finally, the practical limitations of an engineering team need to be recognized as gating factors when moving towards proactivity. A paradigm shift is required in many cases, which is difficult unless the need for change is understood. Even then, the question arises of how the current workload is to be shouldered while long-term planning and action begins. Many of the answers lie in productivity improvements, but usually cost a great deal. Having access to the resources to bring about the productivity improvements is a problem, then implementing those improvements is a large task in itself.

The one remaining element that is required for the practical change to occur is long-term management support and direction. In times of rapid change, this may be the most precious element of all.

## VII. Areas for Further Study

During the research conducted for this paper other related topics were discussed, but found to be outside the scope of this paper. These topics are listed below:

- Reactive/proactive behavior as a function of the maturity of the industry
- Reactive/proactive behavior as a function of the age of the company
- Reactive/proactive behavior as a function of employee age and training
- The natural tendency in engineers toward proactive or reactive behavior
- The effect of proactivity on creativity and innovation (and vice versa)

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