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Integrating key functions in product development : a conceptual product development model for the Korean context

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ABSTRACT

INTEGRATING KEY FUNCTIONS IN PRODUCT DEVELOPMENT: A CONCEPTUAL PRODUCT DEVELOPMENT MODEL FOR THE KOREAN CONTEXT

by
Jong-Wook Kim

The high-tech market is characterized by market uncertainty, technology uncertainty and rapid change. To survive in this risky high-tech market, a company must create competitively effective product development practices that meet its own unique needs and circumstances.

One effective practice is cross-functional integration in the product development process. The advantages of integration include a shortened time to market, successful transformation of research results to production, productivity improvement, innovation project success, and high-quality problem solutions. However, these advantages are rarely obtained in the current product development practices of Korean companies. Their product development efforts are generally characterized by time consuming sequential processes, hierarchical organization, and indirect marketing following OEM exports. These are disadvantages for Korean high-tech companies competing with foreign advanced companies in the international markets.

To meet the competitive challenges of the global high-tech market, Korean companies must improve their product development practices with new product development tools, cross-functional integration, product development process overlap, and new company cultures.

INTEGRATING KEY FUNCTIONS IN PRODUCT DEVELOPMENT: A CONCEPTUAL PRODUCT DEVELOPMENT MODEL FOR THE KOREAN CONTEXT

by
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This thesis is dedicated to my mother
who taught me the preciousness of challenge in life.

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CHAPTER 1

INTRODUCTION

Korea has experienced phenomenal economic growth rates, ranging from an average of about 9% from 1962-1971, 10% from 1972-1979, and up to 12.2-12.3% in 1986-1988. This high growth rate has continued into 1995. The gross national product in 1995 is expected to grow 10%. Largely due to the growth of Korean companies, especially the *Chaebols* *, which play a very major role. The top three *Chaebols* alone accounted for 36% of the gross national product in 1984, and the top10 accounted for 80% of the gross national product in 1985 (11). With relatively low labor cost and various supports from government, *Chaebols* have had success in the labor and capital-intensive industries such as textile, ship building and steel industries. On the other hand, the contribution of technology to economic growth has been about 14 % (1966-1982) (as compared with 63% in Japan and 52% in US) while that of labor and capital has been about 86 % (11).

Recently, two significant changes have been observed in the Korean companies' business environment in the international market. The competitive advantage of Korean companies in the labor and capital intensive industries has decreased because of rapid wage increases in recent years. For instance, in 1985 the average wage of Korean manufacturing workers was the lowest among Asia's fastest-growing economies: $1.39 an hour. vs. $1.67 in Taiwan, $ 2.23 in Singapore, and $ 9.50 in Japan (in the U.S. it was $13.09) (53). By 1994 Korean manufacturing workers' wages have increased to $6.25

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* A business group consisting of large companies which are owned and managed by family members in many diversified business area.

an hour, which is relatively high among Asia's newly industrialized economies: $ 4.80 in Hongkong, $5.55 in Taiwan, $ 6.29 in Singapore and $ 21.45 in Japan (U.S's $17.10). This has resulted in the decline of labor-intensive Korean industries in the international market, such as shoes, textiles, and ship building. The second change was observed in the high-tech sector. From the early 1980s, major *Chaebols* such as Samsung, Hyundai, and Lucky Goldstar entered the semiconductor industry and experienced success. Samsung's rapid growth in the international market for memory chips was especially remarkable. After a relatively late start in the semiconductor industry compared with U.S. and Japanese companies, Samsung, Hyundai, and Lucky Goldstar have experienced rapid growth due to highly educated workers, innovative entrepreneurs, various government support programs and low costs. Samsung is already No.1 in the world in 4-megabit DRAMS (29).

No longer low-cost producers, Korean high-tech companies have tried to maintain their competitive advantage through technology innovation and product differentiation. "The Chaebol themselves see the need to become more competitive overseas, inpart because their protected home market is become slowly open" (38). Korean government planners also aim for one third of all exports to be high-tech by the year 2000: computers, software, semiconductor, communications equipment, and biotechnology product (37). At present, they are in the midst of a restructuring to compete with overseas companies in both international and domestic markets. This will not be easy, as Korean companies, long focused on their home market, also lack the established brand names and marketing skills in international markets. Furthermore, they have few indigenous technology for inducing technology innovation. This difficulty stems from Korean high-tech companies (including *Chaebols*) past development and international marketing practices. Korean companies have long purchased technologies from overseas companies and focused on manufacturing for OEM export. Hyundai motors, Kia motors, Lucky Goldstar electronics, and Daewoo motors, for example, purchased needed technologies from Mitzubish, Mazda, Hitachi, and General Motors respectively. Samsung electronics manufactured laser beam printers for Hewlett-Packared, LGE manufactured TV and VCRs (Video Cassette Recorders) for Zenith and facsimile machines for XEROX, and Kia motors manufactured autos for General Motors.

It is true that this OEM export policy using purchased technologies has played an important role to gain success in the labor and capital intensive industries in the Korean context. However, the result is serious concern about Korea's long-term continued growth and particularly about ability to develop indigenous technology. During the OEM export period, Korean companies have concentrated their efforts on production efficiencies rather than on technology innovation. In this situation, indigenous technology innovation or marketing practices have hardly occurred in the Korean companies.

The purpose of this thesis is to study a conceptual product-development model for inducing product development innovation in Korean high-tech companies. Chapter 1 introduces currently changing business environments of Korean companies' domestic and international markets. Chapter 2 defines the meaning and characteristics of the term "high-tech" to make clear the differences between the high-tech and the low-tech markets. Chapter 3 describes how to integrate R&D and marketing as a strategy for high-tech product development success. Various product development team structures and tools are discussed in Chapter 4, for effective functional integration. Chapter 5 contains examples of world-class companies' product-development practices. Japanese and U.S. companies product development practices are discussed as models. Chapter 6 contains three product development projects by two Korean electronics companies in order to understand their current product development practices. In Chapter 7, a conceptual product-development model including four dimensions for effective product-development is discussed to induce technological and product innovation in the Korean context. The focal point of this chapter is that how to integrate functions in the product development process. Chapter 8 explains a road map for implementing the suggested models. Four phases of cross-functional integration development are discussed. Finally, Chapter 9 contains conclusions and recommendations.

CHAPTER 2

HIGH-TECH PRODUCT DEVELOPMENT ENVIRONMENT

2.1 What is High - Tech?

Technology has been defined as "the practical knowledge, know how, skills, and artifacts that can be used to develop a new product or service and/or a new product, delivery system. Technology can be embodied in people, materials, cognitive and physical processes, plant equipment, and tools" (35). This definition includes both product technology and process technology. It also includes "management technology", the knowledge of how to design, make and market a product and a business (12). If we define technology as knowledge, skills, and artifacts, it becomes clear that every organization uses a variety of technologies to create and deliver products of value.

What makes high-tech marketing unique? There seems to be no consensus among the experts. The U.S bureau of labor statistics labels any industry having twice the number of technical employees and double the R&D outlays of the U.S. average as high-tech. McKenna (32) asserts that high-tech industries are characterized by complex products, large numbers of entrepreneurial competitors, customer confusion, and rapid change. Shanklin and Ryans (43), apply the high-tech label to "any company that participates in a business with high-tech characteristics; the business requires a strong scientific/technical basis; new technology can obsolete technology rapidly; and as new technologies come on stream their applications create or revolutionize markets and demand". Consequently, the high in high-technology depends on the time of the technology evolution.

2.2 High -Tech Market and Low - Tech Market

Two underling dimensions distinguish high-tech from low-tech marketing situations. The first dimension is market uncertainty and ambiguity about the type and extent of customer needs that can be satisfied by the technology (44), (57). Confronted with a radically new technology, customers may not understand what needs the technology could satisfy. Customer needs, once known may be subject to rapid and unpredictable changes as the environment evolves. There may be questions about whether the market will eventually establish technical standards with which the products must be compatible if the buyer hopes to use them with other products, people organizations. Furthermore, predicting the diffusing rate of a high-tech innovation is difficult. All the preceding questions make it difficult to determine the size of the potential market. The second dimension that distinguishes high-tech marketing is technological uncertainty. Which is higher when technology is new or rapidly changing. Five sources can be considered as technical uncertainty in high-tech marketing (35):

- Lack of information about a product's functional performance whether it will do what the seller promises.
- The company supplying the technology may not have an established track record for delivery.
- There is uncertainty about whether the supplier of a high-tech product will be able to provide prompt, effective service.
- The technology may have unanticipated side effect.
- Technological uncertainty may arise because of questions about technological

uncertainty may arise because of questions about technological obsolescence whether and when the market will turn to another technology to replace the current generation of products.

Figure 2.1 shows the shape of an ideal product life cycle. In this case the product development period is short, and therefore the product development costs are low. The introduction / growth period is short, and therefore sales reach their peak quite soon, which means early maximum revenue. The maturity period lasts quite long, which means that profits fall gradually. In contrast to the life cycle of the ideal product, the shape of the life cycle of high-tech products (Figure 2.2) shows, long development time, and steep development cost; the introduction / growth time is long, short maturity period, and fast decline. Many high-tech firms must invest a great amount of time and cost to develop their product. They find that it takes a long time to introduce it, and that the market does not last long. The decline is steep, owing to the rapid technological change. This shows why many high-tech firms fail.

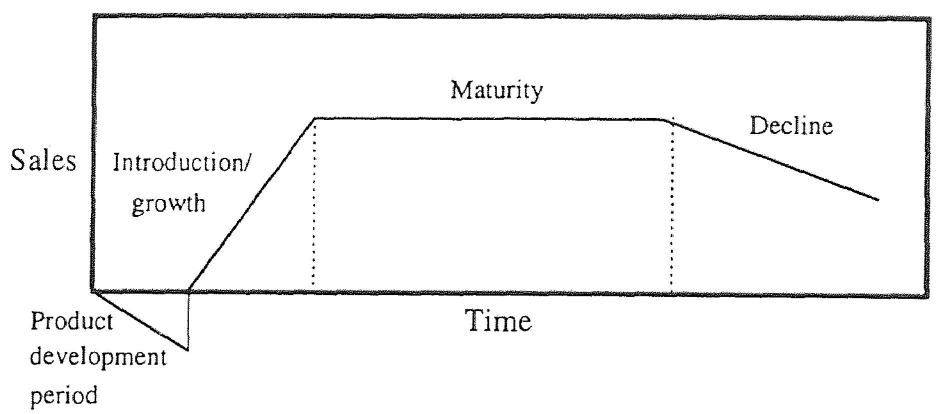


Figure 2.1 Product life cycle of the ideal product.

Rearranged from *Marketing management,* Philip Kotler, 7th. ed., Prentice-Hall Englewood Cliffs, NJ, (1991):353.

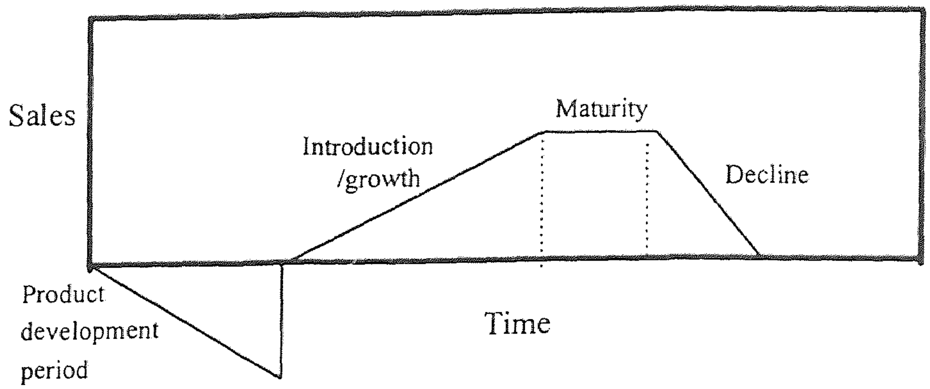


Figure 2.2 Product life cycle of the high-tech product.

Rearranged from *Marketing management*, Philip Kotler, 7th ed., Prentice-Hall Englewood Cliffs, NJ, (1991):353.

2.3 Strategy Alternatives in High - Tech Markets

There are two generic strategy choices to the high tech market each with variations depending on the market characteristics and the companies resources for entering a market. These are the pioneer strategy and the second-but-better strategy. The pioneer strategy of an organization may be based on a R&D effort to develop technical superior products. Pioneers are innovators. They are the first to identify new market opportunities, possessing the technological capability to develop products that address those opportunities. They are also willing to invest the substantial resources in R&D, manufacturing capacity, distribution and promotion that are necessary to bring the product to market before the competition. While the second-but-better focuses on modifying and changing the pioneer's innovative new products. Their objective is to make incremental improvements that allow to reduce costs and obtain niche market. It greatly reduces financial risks. The second-but-better almost starts with lower costs than those incurred by pioneering firms and they have the opportunity to assess how effectively the pioneer has positioned itself with respect to market needs and can then make appropriate adjustments (5).

There are advantages and disadvantages to both strategies. Pioneer is a high risk strategy, but, for survivors it results in higher market share and greater profitability (28), (57).

2.4 Issues Facing High - Tech Marketers

If increased technological and market uncertainty are the major differences between high-tech and low-tech marketing setting, what issues must be addressed to succeed in the high-tech market ? First, high-tech marketing and sales professionals must have the expertise in the key technologies necessary to understand their market potential and thereby establishing credibility with their counterparts in engineering and R&D. Thus the minimum acceptable breath and depth of knowledge is greater in high-tech markets. Second, when the market's needs are under, marketing, sales, manufacturing and R&D functions should maintain strong relationship for new products. One of the most difficult tasks for the high-tech marketers is to correctly identify new market opportunities. This difficulty is shown in the Sony Walkman development story. After performing the traditional market research on the Walkman, results indicated little demand for the product. Akio Morita, the president of Sony, did not believe those results and introduced the Walkman based on his instincts. The Walkman became one of the great new product success stories of the 1980s. This example demonstrate the shortcomings of traditional market research techniques in high-tech markets.

When product technology is complex and fast-changing, R&D, manufacturing, sales, and service units work together on aspects of marketing plans and programs. In addition they must maintain distinct expertise in product development and sales. Introducing a sales engineer position in a company may be a good practice for coordinating technology and sales. Sales engineers locate at headquaters and focus on interactions between product development and field sales and field service units in developing marketing plans and during the introduction phase of product programs. Marketing must be equally willing and able to give advice and to be involved in the technical development. They need to overcome their reluctance to get deeply involved in the technical detail. They must be willing to take the time to let the R&D personnel educate them in the technology. And they must be willing to share their thoughts and subject their opinions to test by R&D. Moreover, R&D and marketing must act as a team, and collaborate in order to move their product into routine customer applications.

2.5 Marketing's Role in the High - Tech Product Development Process

Shanklin et al., (43) have argued that marketing in high-tech firms is different from customer products marketing. They asserted that "the role of high-tech marketing management is to apply technology in the marketplace so that the firm gains a competitive advantage. In many high-tech firms, marketing's role may be more subtle and indirect than is traditionally prescribed (61). In rapidly changing markets, it may not be possible to use traditional market research methods to determine which products to develop. In these cases, the key role of senior managers may be to develop an environment that allows many options to be pursued. Among them, introducing sales engineer positions, facilitating organizational learning, and helping the organization to rapidly respond to trends once apparent are the focal points of their role. In particular, the rapid change of high-tech industries calls for creative approaches to product and to organization design over the product development environment.

It may be done by integrating the two functions; information of the marketplace, and technical knowledge. Together the two form a powerful team. Takeuchi and Nonaka (55) described how well-managed companies have organized the development of new products to enhance cross-functional communication, and reduce the time between conceiving and launching a new product. This approach requires a great of interaction among marketing, sales, field services, R&D and manufacturing throughout the process. This degree of interaction contrasts with traditional approaches to product development, in which one function dominates the process for one phase, and then passes the baton to another function at a later phase.

CHAPTER 3

PROBLEMS IN NEW PRODUCT DEVELOPMENT

As explained in the previous chapter, the high-tech market is characterized by ambiguity, complexity, and uncertainty. To survive in such a risky market, high-tech companies should know how to integrate resources and functions within the product development processes. "Integration has been found to be an overwhelmingly positive contributor to the success of development project, especially for companies that operate in dynamic and highly competitive market" (3). Since time is an important factor in the high-tech product development, any unnecessary conflict among functions and process delay should be avoided. Therefore integrating the activities of research, development, manufacturing, and marketing is essential for optimizing product development efficiency.

The integration can to be various forms, depending on market situation, technology complexity, or company policy. Among the forms, two key levels of integration in the product development process are between marketing and R&D and between manufacturing and R&D. If the project's objective is being "first in" with new technologies and products, it is likely to require a greater degree of R&D and marketing integration. A project that venture into totally new and unfamiliar markets and technologies requires a great deal of new information to reduce the risk of new product failure. Obtaining this knowledge is likely to necessitate a highly integrated effort between marketing and R&D.

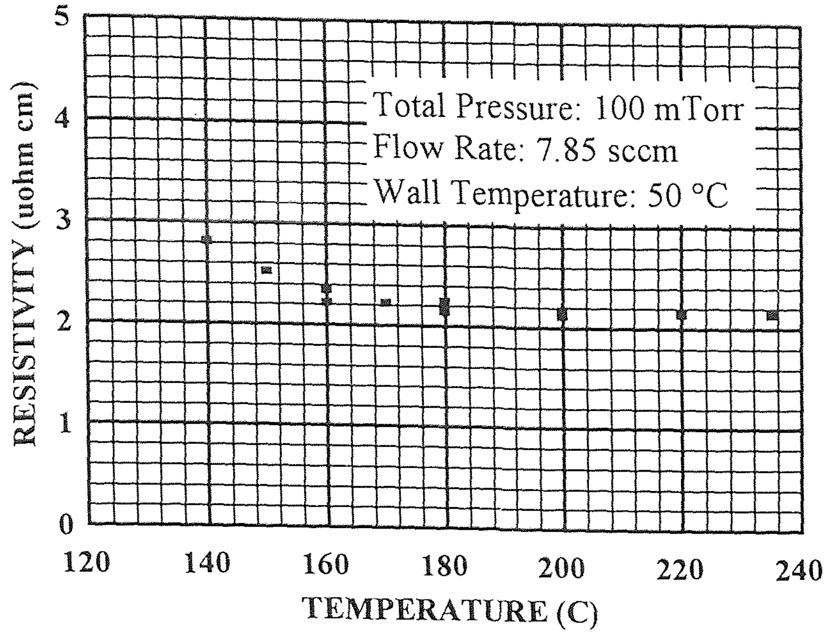


Figure 3.16 The dependent behavior of resistivity of CVD Cu on temperature.

3.2.3 Surface Morphology

Scanning electron microscopy (SEM), atomic force microscopy (AFM), transmission electron microscopy (TEM) were used to study the effects of deposited film surface morphology (brightness, surface roughness) and the variation of surface morphology with film thickness. The AFM and SEM photos as shown in Figure 3.17 and Figure 3.18 demonstrate the average and maximum of surface roughness of deposited copper films with the same deposition condition but different thickness. These results are reinforced in a comparison between the AFM and SEM measurements, establishing that the surface roughness is proportional to film thickness. During these AFM and SEM experiments, a very interesting phenomenon was observed. The thin deposited films appeared to be very bright, but the thick films even with the same deposition condition were not bright. This reasons. These studies imply that the factors which cause conflict among organizational subunits are: mutual task dependency, task related asymmetry, differences in criteria for reward, functional specialization, dependence on common resources, and ambiguities in role descriptions and expectations for these units. In this problem R&D and marketing personnel often purposely avoid each other. Each has negative emotional feelings about the other that stand in the way of collaboration.

Organizational forms for assisting in the process of bringing innovations more quickly to market which have been described in the literature (55) include emphasizing the parallel efforts of the "rugby team" rather than the sequential performance of the "relay" approach to managing the different activities, and in particular those in which different functions need to be involved. To achieve this the two important integration that between R&D and marketing and between R&D and manufacturing must occur at the same time to avoid delays in introducing the product in the market. The parallel approach argues for close cooperation between people from different functional areas, so that the "innovation" can be carried forward by a team moving together, rather than by individuals who pass on their information from hand to hand with all the possibilities this provides for misinterpretation or "dropping the baton".

3.1.2 Problems between R&D and Marketing

The difficulties in integration between R&D and marketing people are a function of their roles and the different personalities which characterize these two groups. With respect to products, the R&D engineers may be more concerned with engineering goal achievement and functional features than the marketing person who may stress quality only as perceived by the customer and product characteristics which are salable (6).

As the first step to integration, top management should initiate the organization design and prepare the new value systems. A number of organizational and personality factors are likely to influence how much integration is actually achieved between R&D and marketing. These factors may be placed into the following categories (21):

- Effect of organizational structure
- Senior management's attitude toward R&D and marketing integration and the actions it takes to facilitate it
- Cultural differences between the R&D and marketing managers involved in the new product development process

The effective management of the R&D and marketing interface is a complex problem. A variety of methods and their combinations are available for managing this interface. According to Souder's study (49) on 150 randomly selected R&D projects at firms, there are four distinct types of R&D and marketing interface problems:

- *Lack of communication*

  In this type of problem the R&D and marketing parties maintained verbal, attitudenal and physical distances between each other. These feelings and behaviors are fostered by the normal time pressures and work deadlines.

- *Lack of appreciation*

  Top management has allowed personality conflicts to exist for long periods of time. Top management has permitted imbalances of power and prestige to arise between the R&D and marketing personnel.

- *Too good friends*

  The parties have much regard for each other and do not challenge each other's

- *Too good friends*

  The parties have much regard for each other and do not challenge each other's judgments. Thus, important information and subtle observations were overlooked.

- *Distrust*

  Many of the distrust cases were characterized by personality conflicts that top management had allowed to exist for long period of time.

Young (65) in investigating 16 manufacturing firms in the Chicago metropolitan area, found the following four major interface problems between R&D and Marketing:

- The most common reason reported by the respondents for the delay of a developing product was improper or incomplete market specification. Many successful products suffered long delays caused by the need for specification changes and additional retests before the final product introduction.
- The research members were angry with their marketing counterpart because of what the researcher considered excessive product specification changes.
- The marketer normally had no product-development experience and often less work experience than the research member. The marketers often commented with awe on the researchers' experience, education and status within the firm.

One serious problem dealt with the company orientation of the marketers vs. the professional or technical orientation of the researchers. Researchers had no idea about the ultimate market or potential use of the product they were working on or how the product fit into the firm's economy.

3.1.3 Guidelines to Overcome R&D and Marketing Interface Problems

When marketing and R&D work in an integrated team, the team as a whole shares the responsibility and the authority for resolving system level issues. However, the team will not be able to act in this way unless all the formal and informal actions and communications eminating from senior management support it. Souder (49), based on his study of 38 Industrial Research Institute member firms, suggested the following guidelines to improve integration between R&D and marketing.

- Break large projects into smaller ones

  The large projects often experienced severe problems, while the smaller projects usually experienced only mild problems.

- Take a pro-active stance toward interface problems

  The R&D and marketing parties were strongly motivated to make repeated periodic inquiries into the health of their relationships. They openly critiqued each other's behaviors and talked freely about their evaluations of each other.

- Eliminate any problems before they grow into severe problems

  Attempts to eliminate severe problems usually involved some major reorganizations, personnel transfers or other radical changes. These changes often did not completely eliminate the problems.

- Make open communication an explicit responsibility of everyone. "Open door policy" may be good for communication. An example of this is quarterly information meetings between R&D and marketing, periodic gripe-sessions, and constant encouragement of marketing personnel to visit the labs to "see what we do down here."

- Promote dyadic relationships between R&D and marketing

  A dyadic relationship is a strong, one-on-one, interpersonal alliance. Dyads are promoted when persons with complementary skills and personalities are assigned to work together and given some autonomy.

- Use new product committees to steer and guide the efforts

  The new product committee structure characteristically consists of some standing taskforces that coordinate the R&D and marketing efforts. Adhoc taskforces of R&D and marketing personnel are constituted as needed by the top-level taskforce. The top level taskforce can consist of : the company president, the vice presidents of R&D, marketing and finance; the project coordinator; the R&D taskforce leader and the marketing taskforce leader. They meet monthly or as otherwise called to decide on strategic matters, policy items and unsolved conflicts.

- Appoint only highly qualified individuals as project managers

  Project managers are familiar with the technology, and well known by both the R&D and marketing personnel who would be involved.

- Involve both parties, early on

  In general, when R&D and marketing are joint participants to all the decisions, from the start of the project to its completion, lack of appreciation and distrust are lessened.

3.2 The R&D and Manufacturing Relationship

3.2.1 Problems between R&D and Manufacturing

An important integration in the product development process is the effective integration between R&D and manufacturing (42), (60). If research results are not effectively transferred to manufacturing, the company will not obtain the desired return on its investment in product development. Vasconcellos (58), in a survey of 60 R&D division managers and 58 production managers from 61 companies in Brazil, found that lack of a communication systems between the two groups is the strongest barrier among the following:

- The communication system between R&D and Production is not efficient (48%).
- Production cannot stop to test new products and processes (47%).
- Production is routine oriented, and resistant to innovation (34%).
- R&D goals are not known by the production managers (30%).
- Different technical levels between R&D and production (21%).
- R&D does not know enough about the needs and capability of production (20%).
- R&D is distant from "reality" (16%).
- Production does not trust R&D (7%).

He asserted that the communication problems between R&D and manufacturing were more serious in high-tech companies or large R&D division. Souder and Padmanabhan (50), based on their experiences of 12 firms in transferring 34 new process control technologies from R&D to manufacturing in America, presented five statistically significant (95% degree of confidence level) barriers.

These are:

- inadequate staffing by the manufacturing department
- the technology was perceived as too fragile.
- the technology was perceived as too complex.
- manufacturing management feared disruption of plant schedule.
- manufacturing management was preoccupied with other problems.

The most severe problem to the integration of R&D and production is *interfunctional communication*. Interestingly, the most severe integrating problem is same as the problem between R&D and marketing.

3.2.2 Suggestions for Integrating R&D and Manufacturing

The studies of problems between R&D and manufacturing suggest the following conditions for the integration of this two functions.

- *Manufacturing involvement at the design stage*

  Communication problems should be significantly reduced if manufacturing engineers are involved from the product design stage. Early involvement by manufacturing engineers will foster strong relationship between R&D and manufacturing.

- *R&D and manufacturing jointly select the vendors*

  R&D is in the best position to select the most technically competent vendor. While, manufacturing is in the best position to select the most responsive and experienced vendor. Thus, joint agreement on the most satisfactory vendor ensures both the long-term integrity of the technology and its continued successful use.

- *End-to-end involvement product team members*

  R&D, manufacturing, and other functional areas, e.g., marketing and administration, should be involved jointly from beginning to the end of project. If new persons take over the project when a project gets into its later phase, the enthusiasm for the product that was developed by the original team cannot be transferred to successors.

- *Supplier involvement at the product development team*

  Suppliers particularly need to be included as team members when the new product involves critical technologies in which the buying company is not expert. It may be advantageous to all suppliers to the team for total integration of R&D and manufacturing.

- *Conducting design reviews*

  In order to improve design quality and completeness, R&D engineers must conduct design reviews early with representatives of manufacturing and marketing before the designs are frozen. This will helpful to improve manufacturability in the mass production phase and marketability of the produced product.

Effective methods for preventing, or coping with, problems of coordination and communication in a rapidly changing product development environment will be found in a new arrangement of people and tasks; an arrangement which breaks the bureaucratic organization structure and production and marketing systems.

CHAPTER 4

BUILDING CROSS-FUNCTIONAL INTEGRATION INTO THE PRODUCT DEVELOPMENT PROCESS

Having the "right" organization structure may not be sufficient to induce behaviors that achieve innovation. However, structures that cannot stimulate employees motives will discourage innovation. In this chapter, based on literature reviews, various organizational structures are discussed for functional integration.

4.1 Functional Integration and Its Advantages

4.1.1 Meaning of Integration

"Integration in its best form implies a significant transfer of information and development of mutual understanding through informal processes. Integrating strategies is insufficient. Integrating purposes, objectives, and strategies is insufficient. Integrating research with manufacturing and marketing is insufficient. Integration must be viewed in comprehensive terms" (16). Integration requires an intellectual perspective with regard to product and process development. Specialization and professionalism are essential, but integrating such factions remains a managerial and organizational challenge. Companies must link all organizational levels, develop unified strategies and understand their interdependency, link the strategic and operational levels, shrink the number of levels in the organizational structures, develop cross-functional literacy, and change the current approach from skill fragmentation to multiskilled involvement. Several of the dominant requirements of successful integration then have the possibility of being satisfied: the linkage of levels; the mutuality of interest and understanding; the consistency of technology and organizational structure; the real involvement of real operative. Ultimately, this calls for a rejection of overspecialization in favor of wider multifunctional skills and much greater reliance on multidisciplinary and interdisciplinary education and training.

Specialization tends to be a major problem. Specialization fosters the development the jargons, conceptual frameworks, and values unique to specific disciplines. Jargon and idiosyncratic norms are useful for they establish a shared semantic space in which communication within a group can be more efficient and reliable, specialized semantics and behavior become severe obstacles in sharing information between groups. Severe specialization becomes a serious disadvantage in an uncertain and fast changing market.

4.1.2 Literature Review

Integration has been the subject of many studies over the years. Research which throws light on the issues involved is of a variety of types. For example, Souder (49), Lantos (30), Monteleone (34) report on research studies of integrating R&D and marketing in the product development process. These studies stress strong integration between R&D and marketing for product development success. Norton et al., (39), Gerstenfeld et al., (19) reported differences in the marketing and R&D relationships between Japanese companies and American companies. Whitson (59), in a series of four articles published in *Technovation,* considers the policy issues and organizational questions related to education, behavioral practices, and need for a critical mass. He illustrates the micro-dependencies influencing integration which cites Voss, who subdivided integrating into a hierarchy consisting of five facets; strategy, material flow, technology, information and organization. Wolff (60), the editor of *Research, Technology Management*, calls attention to the dual interface -- transfer of technology from R&D to manufacturing -- in an interview with Keith McHenry, at the time (1985), vice present for R&D at Amoco Oil Co. Wolff states that at Amoco manufacturing has an effective interface with R&D because:

- researchers work on a project basis and every project has a sponsor either in manufacturing or marketing.
- research required for technical support is financed from the manufacturing budget.
- research people are encouraged to participate in plant start-up activities and to counsel with manufacturing.
- a solid communication network exists between the technical specialists in engineering, R&D and the line organization in the plants.

The interfaces between design and manufacturing are considered by Dierdonck (13). There is little argument among scholars that the interface must be mediated because of its impact on time-to-market, but Dierdonck raises issues about the limits of integration when major or radical innovation is involved. Innovations with close linkage may of necessity be treated differently. Rosenthal in "Bridging the Cultures of Engineers: challenges in organizing for Manufacturable Product Design." (By J.E Ettie and H.W. Stoll, McGraw-Hill, NY, 1991) suggests that organizational structure determines the culture of manufacturing. If no specialists are formally assigned to investigate the manufacturability of a new design, then manufacturing personnel only focus attention on improving the existing processes. Rosenthal considers another scenario that includes an independent group of "producibility engineers." He describes producibility them as: engineers who use designs from design engineering and capabilities observed in the factory, then converts those designs and capabilities into workable designs so they can be made in the factory. The producibility engineer, then, is a compiler of information, an optimizer of factory input and design input into a producible scheme. Rosenthal goes on to suggest that the primary function of the producibility engineer is to initiate the design reviews at the time that a design engineer is ready to present drawings of a part or an assembly. Souder et al., (50) and Vasconcellos (58) studied integrating between R&D and manufacturing and suggested managerial implications. The above studies show two implications for effective integration of functions. One is that the two key functional integrations in product development are between marketing and R&D and between R&D and manufacturing. The other is that the fundamental understanding of technology, company strategy, and cultural differences among functions are critical for achieving integration.

4.1.3 The advantages of Integration

An integrated process causes team members to anticipate and manage problems, and to actively exploit opportunities for progress that exist at the interfaces between different technologies, subsystems and value-added activities. The advantages of an integrated effort is a *shortened time to market* (59), (33), *successful transportation of research results to production* (58), *productivity improvement* (34), *innovation project success* (51), and *high quality of problem solutions* (9). These advantages are critical to the achievement of highly ambitious goals of performance and quality that require pushing the limits of multiple technologies and organizational boundaries simultaneously. Strong integration between design and manufacturing enables new products to be brought to market almost immediately.

4.1.4 Integrating at the Project Level

As a concept, integration might be seen as a set of formal systems, in which all team members understand the same design, execution and performance goals, use the same timing charts, and follow routine processes to manage the handoffs between upstream and downstream activities and the interfaces between functional groups. Integration within the individual new-product project, however, requires much more. It depends on several factors; way work gets done, with perceived rewards and career paths, with the tools, methodologies, and organizational culture that support a disciplined approach to problem solving, and with the role senior management is willing to play (3). When product design reflects how the product will be manufactured and takes advantage of existing or developing process and support capabilities, and when the design of new processes and new field services are considered to new product plans in the design process, the firm is likely to capture truly superior performance, quality, and cost advantages. Differences in the project's performance measures are also related to differences in the project management structure. In the automotive industry one of the major differences between the European, American and Japanese approaches to design is the dominant use of separate nonintegrated functional structures in European design processes (10). The coordination is done by senior management, by rules and procedures, and check-off procedures when the product moves from one stage of development to another. In Japan the more effective projects both in terms of time and quality of design, tend to be characterized much more by multifunctional teams including people from manufacturing engineering.

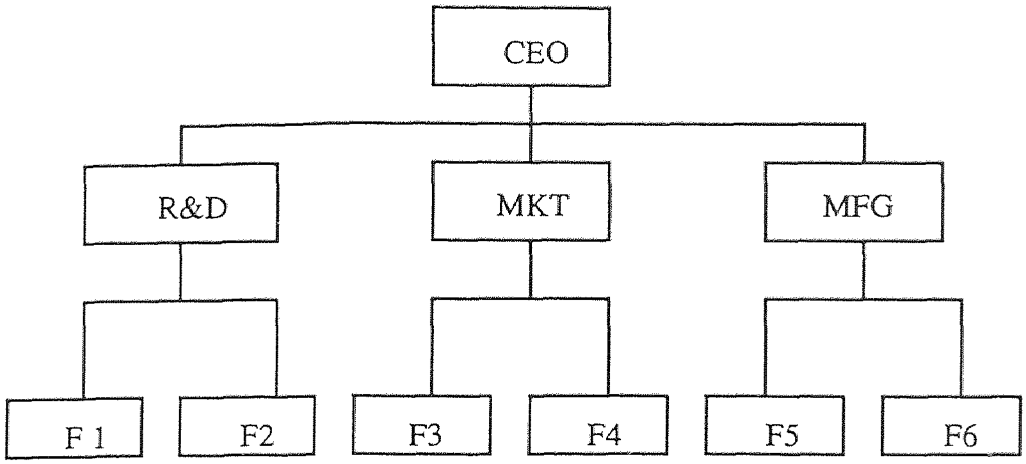
4.2 Organizing Project Team

4.2.1 Functional Organization

The classical functional organization (Figure 4.1) emphasizes specialized behaviors and rational economic decision making. "Functional organizations are identified with sequential one way information flows. The sequential model has established itself primarily because of its compatibility with the bureaucratic command and control concept of management in complex organization" (4). Traditional functional organizations worked fine for businesses with limited or well defined product lines and stable market environments, but industries that place a high premium on inventiveness, hybrid technologies, and quick expansion or new product development often find the strict functional structure of organization too confining (62).

Because objectives and projects are not managed by a project manager with cross-functional responsibility and authority, each function is primarily concerned with its own departmental goals and objectives. The specialization in a function is a typical aspect of the functional organization and it is still important to the product development process. The functional organization, however, prevents organizations from making effective use of their full information resources. The functional organization is well suited to smaller or simple mass production company, but with growth in sales and an increase in products and in lines, many firms eventually reach a cross-over point at which symptoms of needed organizational change must be recognized. Functional organization is criticized because of following reasons (26) :

- no one individual is directly responsible for the total project.
- it does not provide the project-oriented emphasis necessary to accomplish the project



CEO: Chief Executive Officer MKT: Marketing MFG: Manufacturing
F1 - F6: Functional Departments

Figure 4.1 Functional organization.

tasks.

- coordination becomes complex, and additional lead time is required for approval of decisions.
- decisions normally favor the strongest functional groups.
- there is no customer focal point.
- response to customer needs is slow.
- there is difficulty in pinpointing responsibility.
- ideas tend to be functionally oriented with little regard for ongoing projects.

Many companies have looked for various new product development team organizations which can increase communications and stimulate creative team activity. These teams have been called "cross-functional teams", "task force teams", "project teams", "skunk teams". and "multi-discipline teams." Whaever they are called, the objective is focused on inducing horizontal integration among different functions. A variety of companies have adopted matrix forms of organization for vertically and horizontally well balanced organization.

4.2.2 Matrix Organization

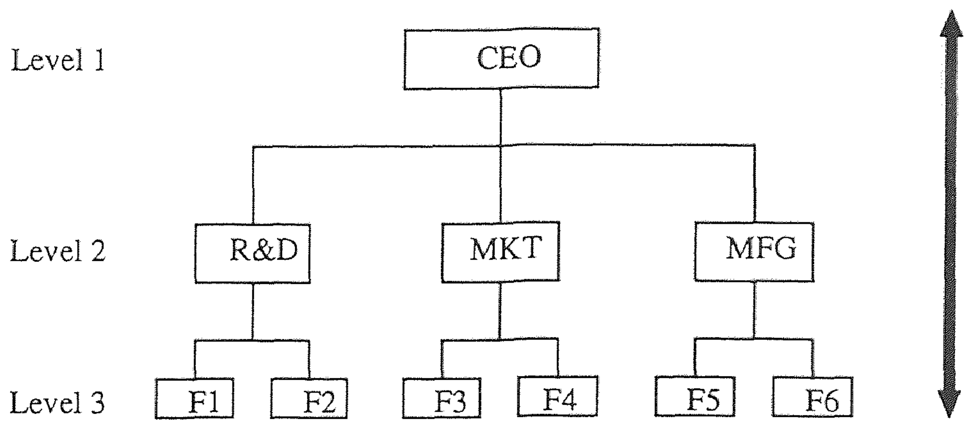
Matrix organization is designed to constructively blend the program orientation of project staffs with the speciality orientation of functional personnel in a new and synergestic relationship. In this organizational setting, two forms of organization-related management integration occur. The first is a vertical integration that occurs naturally in functional organizations due to chain-of-command relationships. This form of integration occurs vertically in each individual functional department and assures that functional organization objectives are given proper recognition. The second form of integration is a horizontal integration that is induced in the matrix by project organization. This process stems from the intensive management associated with project management and focuses on integration of functional activities associated with achievement of project objectives.

- **Vertical integration**

Vertical integration is, in effect, a process of "hierarchic referral" (26) with upper management concerned with tactical values, and first-line management concerned with operational values. Figure 4.2 portrays the concept of vertical integration in the functional elements of the matrix. It may be seen that the vertical integration hierarchy is related to the organization hierarchy and that the concept is a closed-loop.

- **Horizontal integration**

Horizontal organization must be induced in the matrix by the project office, for it does not occur naturally. It is related to the work flow of the project across major organizational boundaries and is horizontal in its effect, paralleling the horizontal orientation of project emphasis in a matrix organization.

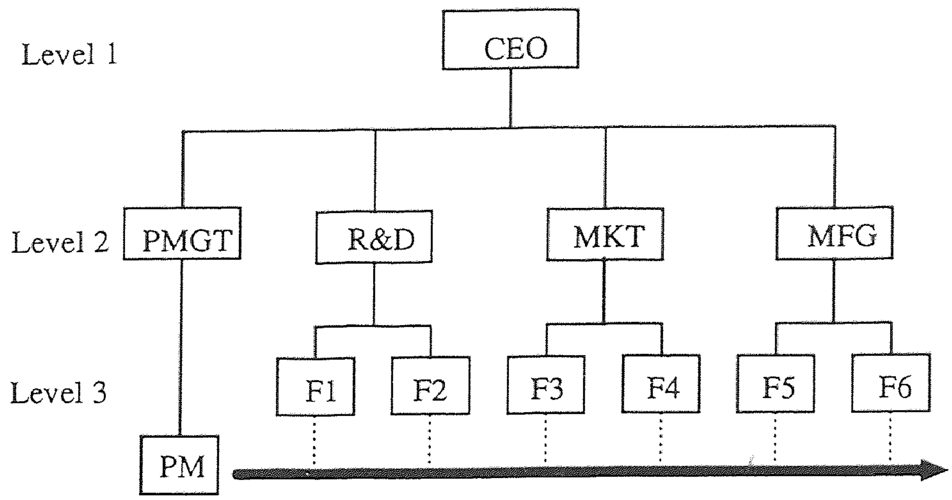


CEO: Chief Executive Officer MKT: Marketing MFG: Manufacturing
F1 - F6: Functional Department

Figure 4.2 Vertical integration.

Figure 4.3 shows the concept of horizontal integration. A project manager is assigned with complete cross-functional authority and responsibility for a given project. He works for his project in the name of the president and has full authority for his decisions and actions. The project manager reports to the top level engineering manager, and his position is equivalent to department manager level. Personnel under this organizational structure are assigned to the project by the functional manager with the project manager's concurrence. The matrix organization introduces a "horizontal" layer of responsibility to the "vertically" structured functional organization.

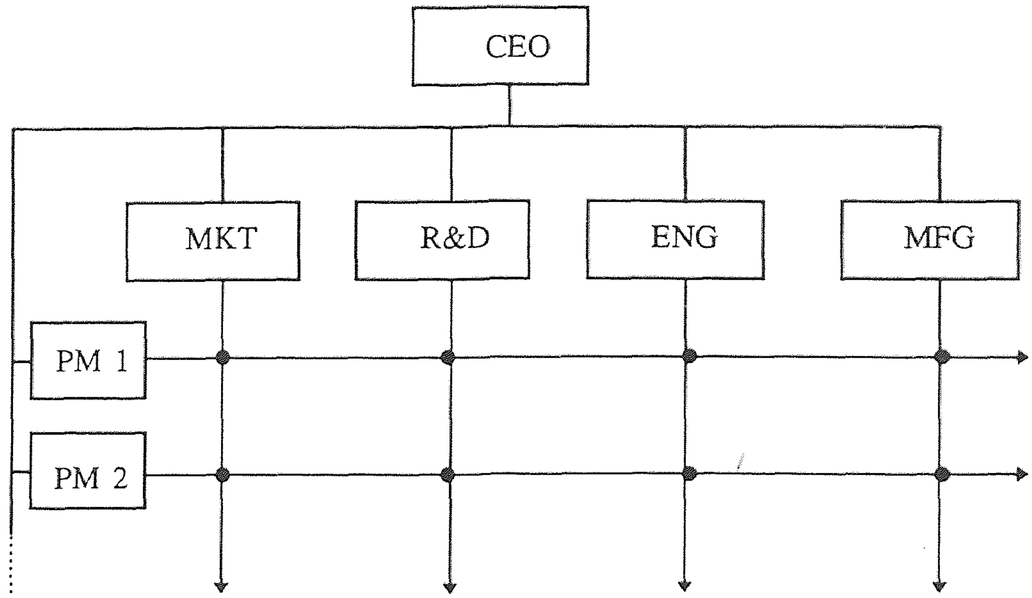
In effect it divides the total company business into subsets which are project or program oriented. Project team members report on all project matters to the project manager, and on administrative matters to their functional managers. One of the most important ground rule is making clear the unique roles of the project manager and functional manager. The project manager has responsibility for what will be done (product), why it will be done (company justification), when it will be done (schedule),



CEO: Chief Executive Officer MKT: Marketing MFG: Manufacturing
PMGT: Project Management PM: Project Manager
F1-F6: Functional Department

Figure 4.3 Horizontal integration.

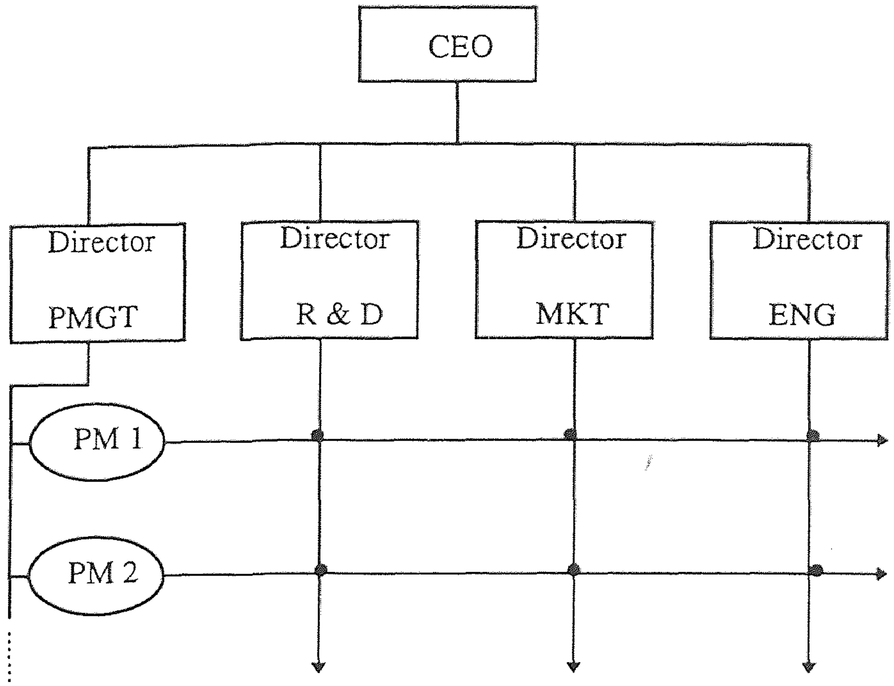
budget, and based on his skills as negotiator, how it will be done (technical judgment). While the functional manager determines who will do it and how it will be done (negotiated technical judgment). They provide adequate tools, equipment and facility, carry out normal managerial functions, such as career planning, salary review, personnel engineering, resolution of inter-department conflicts, respond to sustaining engineering requirements from the rest of the company (1). Matrix implementation requires:
in matrix operations; training in how to maintain open communications; training in problem-solving; compatible reward systems and role definitions; team building skills. Figure 4.4 shows a typical matrix organization. It contains three critical roles: project managers, functional managers and project team members. Each project manager reports directly to the CEO. The project manager has total responsibility and accountability for project success. The functional departments, on the other hand, have functional responsibility to maintain technical excellence on the project. Each functional unit is



CEO: Chief executive officer   MKT: Marketing   ENG: Engineering
MFG: Manufacturing   PM: Project Manager

Figure 4.4 Typical matrix organization

headed by a department manager whose responsibility is to ensure that a unified technical base is maintained and that all available information can be exchanged for each project. One of the major differences compared to functional organization is that individuals frequently find themselves working for three or four project leaders simultaneously. In addition, they retain a continuous reporting responsibility to the head of their functional disciplines (20). Another difference is the role of the functional managers and project managers. Functional managers control departmental resources, such as people, facilities and time etc. This poses a problem because, although the project manager maintains the maximum control (through the functional managers) over all project resources including cost and personnel, the functional manager must provide staffs for the project's requirements. It is almost therefore inevitable that conflicts occur between functional and project managers. This type of matrix organization works best or small companies that



CEO: Chief Executive Office PMGT: Project Management
MKT: Marketing ENG: Engineering PM: Project Manager

Figure 4.5 Development of a director of project management.

have a minimum number of projects, and assumes that the general manager has sufficient time to coordinate activities between his project managers.

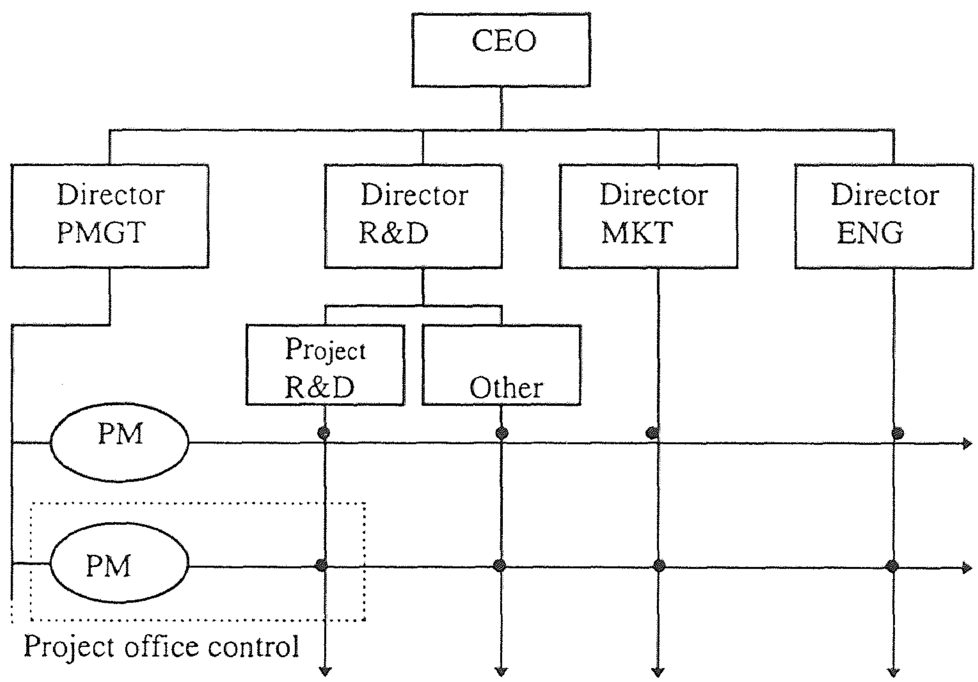
4.2.3 Modification of Matrix Organization

a) Director of project management

As companies grow in size and the number of projects, the general manager finds it increasingly difficult to act as the focal point for all projects. A new position can be created as shown in Figure 4.5. A director of programs or manager of projects can be introduced to free general manager from the daily routine of having to monitor all programs himself.

b) Project engineering in the project office

When projects grows so large that the project manager becomes unable to handle both the management and engineering functions. Then, as shown in Figure 4-6, a chief project engineers is assigned to each project as deputy project manager, but remained functionally assigned to the director of R&D. The project manager is now responsible for time and cost considerations, whereas the project engineer is concerned with technical performance. Very important to making this matrix work is that the two matrix managers (project and functional) have to share a great deal of information, and they have to have confidence in and respect each other's special skills regardless of the matrix form (typical matrix or modified matrix), then the whole organization loses. This happens, of course, if the two matrix managers (project manager and functional manager)



PM: Project manager PMGT: Project Management MKT: Marketing
ENG: Engineering

Figure 4-6 Placing project engineering in the project office.

are not working together effectively and one becomes much stronger than the managers are not working together effectively and one becomes much stronger than the other. Since the project managers and functional managers share some degree of authority, responsibility, and accountability on each project, they must continuously negotiate.

Although matrix organization requires much effort, it has the following advantages (26):

- The project manager maintains maximum project control (through the functional managers) over all project resources, including cost and personnel.
- Rapid responses to changes, to conflict resolution, and to project needs are possible.
- The functional organizations exist primarily as support for the project.
- Because key people can be shared, the program cost is minimized.
- Each person can be shown a career path in either a functional area or as in project management.

CHAPTER 5

REVIEWS OF CONTRAST SUCCESSFUL PRODUCT DEVELOPMENT PRACTICES

Product development practices vary depending on companies' product development policy and cultural differences. Therefore, the idiosyncratic product development procedures of a given company might not be copied well by other companies. A company, however, can improve its product development practices with careful investigation and adaptation of the advanced companies' product development practices. In this way, the Japanese companies' successful product development practices might be helpful to the Korean high-tech companies, which have followed an incremental product development model.

From literature reviews regarding the product development practices of Japanese companies in recent years, seven advantages are found compared to the practices of U.S. and European companies. These are multifunctional teamwork, incremental innovations, job experience, time-based product development, R&D-dominated and market-oriented product development, continuous improvement, and early problem detection using product prototypes.

5.1 Multifunctional Teamwork

One reason Japanese companies are successful in introducing new products is that they use a team approach, which involves more horizontal communication across functions (10). Multifunctional teamwork stimulates inventions through cross-fertilization of ideas. In contrast to Japan, many American firms attempt to develop new products using a bureaucratically programmed approach (45). In this bureaucratical organization, each specialist performs a discrete function before passing work down stream to another as though running a relay race. The Japanese approach relies more on the group; the American depends on individual specialists with professional training and experience.

5.2 Incremental and Market-Pull Innovations

An important characteristic of Japanese industry has been continuous streams of minor product improvements and incremental process improvements based on market demand (market-pull). For example, the strategy of many Japanese electronics firms, such as Hitachi and Matsushita, has been to quickly develop cheaper, more functional, higher-quality versions of existing products in order to participate in new growth markets. While Japanese companies may produce few breakthrough technologies, they can develop new products quickly by combining existing state-of-the-art. In contrast, many U.S. technology giants, such as Xerox and Dupont, have sought to develop a long term competitive advantage through advanced technology (technology-push). R&D in these companies builds the technological base for successful product offerings five and ten years into the future (45). It is true, however, that for major innovations, as differentiated from incremental innovations, that technology-push can be successful, but with higher risk. Gerstenfeld (17), found similar results in his study of 22 projects (successful project 11, failed projects 11) in Germany automobile, electronics and chemical industries, concluding that the high number of successful innovations start from market-pull, while the high number of unsuccessful projects starts from technology-push.

5.3 Job Experience

The individual Japanese tends to stay in each assignment for a long period of time. Promotions are relatively few and take place over long time spans. The individual, as a result, tend to remain in the same business environment for an extent period. During this time, he builds up a solid base of knowledge and experience about the business that helps him avoid mistakes and reduces the probability of reworks. Compared this with the American experience where the reassignments are very frequent. Americans are very mobile and easily move from one company to another company, from one function to another function (41). Between Japanese and American organizations the level and type of experience that is built up is very different.

5.4 Time-Based Product Development

Strategies based on the speed of flexible manufacturing, rapid response, expanding variety, and increasing innovation are time based. Japanese organization structures enable fast responses rather than low costs and control. It is well known that Japanese have responded to market demands with incremental and rapid product development. They managed structural changes that enabled their operations to execute their processes much faster. Stalk (54) asserts that Japanese time-based manufacturing practice has a competitive advantage in the world markets, and Japanese manufacturers have competitive advantages over their western competition:

- In projection television, Japanese producers can develop a new television in one-third the time required by U.S. manufacturers.
- In custom plastic-injection molds, Japanese producers can develop the molds in one third the time of U.S. competitors and at one-third the cost.

- In autos, Japanese companies can develop new products in half the time-and with half as many people as the U.S. and German competition.

Stalk added that introducing a series of new organizational techniques, such as JIT continuous improvement, for their flexible manufacturing led fast-paced innovations Japanese flexible manufacturing practices include the followings:

- In manufacturing, the Japanese stress short production runs and small lot sizes. In innovation, they favor smaller increments of improvement in new products, but introduce them more often-versus the Western approach of more significant improvements made less often.
- In the organization of product development work, the Japanese use the factory cells that are cross-functional teams.
- In the scheduling of work, Japanese factories stress local responsibility, just as product development scheduling is decentralized. The western approach to both requires plodding centralized scheduling, plotting, and tracking.

5.5 R&D Dominated and Market-Oriented Product Development

According to Norton et al., (39) studies in the Japanese and American chemical companies shows that Japanese firms have a relatively narrow definition of "marketing". It is viewed as a practical information resource on continuous improvement, rather than as a new product concept generator. Marketing's roles in new product development have an asymmetric relationship with R&D having a dominant role. Johanson and Nonaka (24) asserted that Japanese-style market research relies heavily on two kinds of information: "soft data" which informally obtained qualitative product information from visits to dealers and other channel members, and "hard data" which quantitative product information such as shipments, inventory levels, and retail sales. After analyzing both hard and soft data on their channels, Japanese make small, incremental changes inproduct features, packaging, and promotional efforts.

5.6 Continuous Improvement

Kamath and Liker (25) found that Japanese practices in supplier handling include using fewer suppliers and forging longer-term relationship with them, prodding suppliers to improve continually, and involving suppliers in the design and development of products. Cusumano (12) found that Japanese product development practices in automobile industry focused on continuous improvement, leading to competitive advantages, the results of which by 1980 U.S. and European companies lagged so far behind in productivity and quality that they were no longer competitive.

5.7 Early Problem Detection Using Prototypes

Clark and Fujimoto (10) on the studies of car development practices in U.S., Europe, and Japanese companies, found that early problem detector paradigm of Japanese car makers led to reduced time to market and unnecessary design changes. European engineers view the engineering prototype as a master to be copied by the production model. In this "master model" paradigms, no time or expense is spared in ensuring the completeness and quality of the prototype. Japanese engineer regards the prototype as a tool for finding and solving manufacturing design problems at early stages of product development. The early problem detector might be regards as a "draft" of the production model, rather than the fully matured master of the model paradigm.

CHAPTER 6

CURRENT PRODUCT DEVELOPMENT PRACTICES OF KOREAN HIGH-TECH COMPANIES

Although horizontal integration is important for product development success, project managers or cross functional-teams are hardly found in Korean companies. "This stems from the idiosyncratic nature of Korean companies which have grown up in a relatively stable business environment under government incentives for emerging business, and government policy on trade and technology acquisition with advanced overseas companies" (31). In the stable environments, hierarchical structure has been an effective method to do repetitive tasks. Efficiency was maximized and conflict was minimized by keeping functions independent and non overlapping. However, the Korean companies business environment is no longer stable. Their competitive advantage in low labor cost has been eroded because of the high rise of labor cost in recent years. To make matters worse, their protected domestic market is becoming slowly more open to overseas companies. Now, Korean companies must compete with advanced overseas companies even in the domestic market. Facing these changes, Korean manufacturing companies have tried to induce technology innovations. However, these hardly occur in the Korean companies' functionally separated hierarchical organization and time consuming product development practice.

The information source of this chapter is the author's working experience for 6.5 years in LG Electronics Co., LTD - a leading electronics product manufacturer in Korea - and interviews with a former project leader of Sambo - Trigem Co., LTD - a computer hardware and software supplier in Korea. In 1993, as a concurrent engineering practitioner of a business unit of LGE (there were seven business units that had different product groups and target markets) the author visited other business units to investigate their product development practices. At that time (1993), concurrent engineering methodology had been implemented in several business units with the help of Japanese consultants.

Three product development projects of two Korean electronic companies are presented to understand the *Korean high-tech companies'* * current product development practices. The first case study includes a project of the LGE Laundry Machine Business Unit of LG Electronics. This project was successful in terms of technology breakthrough and cross-functional team activity. The second case study shows the ineffectiveness of the conventional product development process (sequential process) with the LGE Information and Systems Business Unit. The third contains a cross-functional product development team of Sambo-Trigem Co.

6.1 Case Study 1: Task-Force Team of Laundry Machine SBU

Lucky Goldstar electronics (LGE) (formerly Goldstar Co., Ltd) one of the leading electronics product suppliers in Korea, has for a long time experienced severe competition from Samsung electronics and Daewoo electronics in the domestic home electronics product market. In 1993, LGE launched the "Hit Product Development Committee (HPDC) " at each strategic business unit (SBU). Goals for product development has been set by the product development team and approved by the committee. HPDC was chaired by the vice president or director of the SBU, and included R&D general managers, project leaders, and functional managers. HPDC was powerful in that it planed and choreographed the details of the major product introduction events including go / no-go decision. At HPDC, the project leader reported monthly product development status and follow ups to ensure closure of all outstanding action items. Detail action items were then discussed for next month.

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* : A Korean company which competes or intends to compete with overseas advanced companies with technology.

The most successful project was the laundry machine development project. The project team was designed to induce cross-functional integration among the various departments and to improve the introduction of products into the manufacturing. As shown in Figure 6.1, the task-force team includes one project leader who was a section leader of mechanic design, and functional representatives including down-stream functions. In this cross-functional team, functional representatives who will return to their functional department when the project completed, were worked together in a place and maintained strong relationships with the project leader but weak relationships with their functional managers.

From the beginning of the project, marketing personnel surveyed customers' complaints on the conventional laundry machine using interviews and a focus group to catch ideas for product improvement. Then the project team analyzed the marketing results and discussed widely and in depth the ideas. During the idea generation meeting, the team discovered that a major user complaint regarding the conventional laundry machines was twisted and entangled laundry. This complaint was also observed in the competitors' laundry machines. Although laundry-machine manufacturers have experienced the problems when they developed the conventional laundry machine, they could not correct the technical problem completely due to its difficulty. Tangling of laundry occurred as a result of complicated water streams during the laundry machine cycle. The most difficult problem to the team was in finding the relationship between the water streams and the rotation panel located on the bottom of the machine and rotates to make water streams when the laundry machine is operating. Manufacturing and engineering staffs with trouble-shooting experience on the production floors supplied

R&D with various types of hand-made rotation panels to conduct experiments. With this cooperative environments, researchers and manufacturing engineers could determine the optimal design configurations of the rotation panel. Completed designs were distributed to the members to the project team and their functional departments for design review before the designs were frozen. These activities were included in engineering sample (ES) phase.

In the pilot phase the complete product was produced in low volume and tested under various conditions that approximated the full range of typical customer usage environment. One of the critical paths in this phase is die development for volume production. Die development begins with the first release of drawings and continues through the phase until the try out for production completed. Since all components

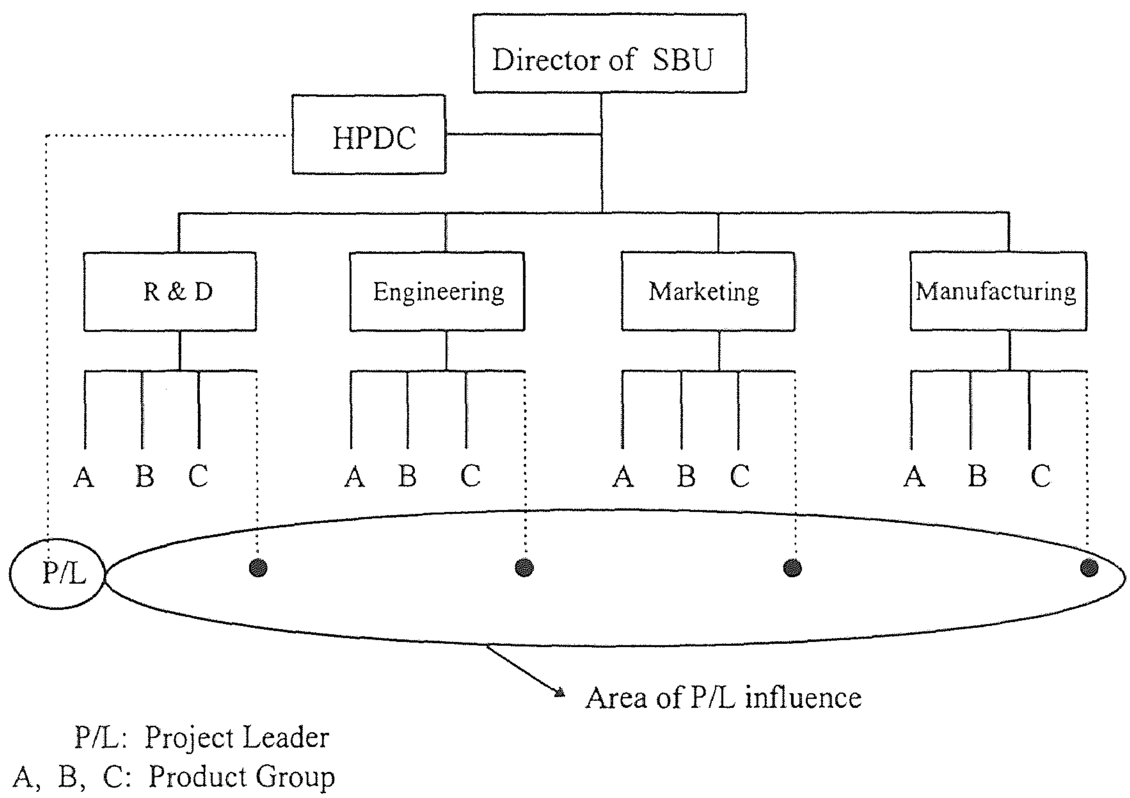

Figure 6.1 Task force team organization of Laundry SBU.

supplied by an outsider, design engineers visited the suppliers with purchasing people to explain the functions of a component and to prepare die development schedules. When a product design changes during the dies building, design engineers go immediately to the die suppliers and instruct the die manufacturers about the changes, instead of waiting for paperwork. After die building, pilot building engineers assembled pilot samples on the manufacturing floors with plastic molds and sheet metals delivered from vendors. This practice was newly applied compared to the conventional process. In the conventional product development process, pilot samples had been assembled at the pilot job-shop because of the poor components quality. Many components could be assembled after cutting, bending or grinding at the pilot job shop.

The advantages of cross-functional team activity in pilot phase was that during pilot sample building at the factory floor, process engineers concurrently designed production processes, jigs, tools and service manuals for mass production. In the conventional product development process, process designs had been conducted subsequently after pilot building. Another advantage was found in design reliability. Design changes were remarkably decreased compared with the conventional product development process (sequential process), in which many design changes occurred during the pilot phase due to low level of completeness of the product design. Another advantage was that the team could reduce the product development time. As shows in Figure 6.2, the down-stream engineers early participation to the team resulted in product development process overlapping and it led to concurrent work.

With the cross-functional efforts Laundry SBU achieved the followings:

- Reduced time to market by 3 months compared to conventional product practice

- Technology breakthrough achieved with cooperative working environment.
- Design changes were decreased in the pilot phase with design review meetings.
- Informal communications increased among team members.
- Communication between project leader and top management increased.

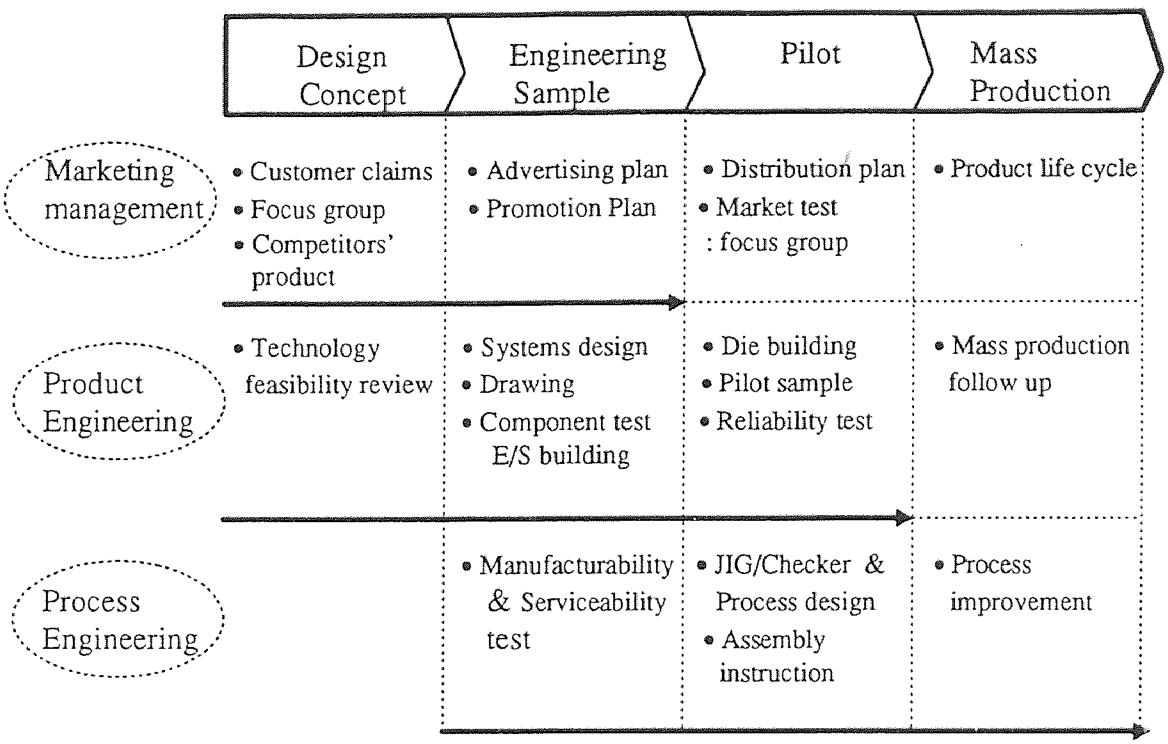

Figure 6.2 Parallel activities during the stages of product development by the Laundry SBU.

6.2 Case Study 2: LG Electronics Information and Systems (LGEI&S)

Based on business success in home electronics products, LG Electronics (LGE) launched a new business unit. In 1985, the Information and Systems SBU was created to enter the office automation (OA) market. From the beginning of this new business, LGE manufactured facsimiles, dot-matrix printers and plain paper copiers with technical help from Japanese companies. LGEI&S manufactured OA peripherals for OEM customers (e.g., Brother in Japan and Xerox in USA). At the same time, LGEI&S entered facsimile and dot-matrix printer domestic markets. In the first two years of operations, the revenue of LGEI&S dropped rapidly due to the decline of the dot-matrix printer market. The printer market had moved to high-end products, such as ink-jet printers and laser beam printers (LBP).

In 1988 LGEI&S launched a LBP development project in response to changes in the printer market. Entering new market was a significant challenge for LGEI&S. Having done little empirical research on LBP development, LGEI&S made an attempt to get technical help from LBP manufacturers in Japan, without success. LBP production technology was one of the most advanced technologies at that time, and no company was willing to transfer state-of the-art LBP manufacturing technology. LGEI&S had no choice but to develop this technology by itself. LGEI&S hired Japanese engineers who had experience in LBP development in Japanese companies, and let them work together with LGE engineers to develop LBP technologies in the LGE Japan R&D center in Tokyo. Another product development team was organized in the LGEI&S R&D lab in Seoul. Its responsibility was component design and engineering samples building. Core sub-assemblies such as the electrophotography process and system designs were developed at the LGE Japan R&D center.

The project was formally launched with the marketing group's presentation regarding product specifications, target material cost, and market entry schedule at the annual product development planning meeting, chaired by the director of the office automation (OA) business. This was the only formal presentation of market information to the product development team. The project leader--with a Masters degree in mechanical engineering, 8 years experience in machine design including, and two years as a project team leader--prepared detail development schedules based on the marketing input. As shown in Figure 6.3, the product development process followed a sequential process. For example, after major system designs and electrophotography process were developed at the LGE R&D center in Japan, then component design and engineering sample building were finished by LGEI&S R&D lab in Seoul. Late pilot sample building and process design were conducted by the engineering department at Pyungtack Plant, located 60 km away from Seoul.

Although they were physically separated each other, there were no communication problems between LGEI&S R&D lab in Seoul and LGE R&D center in Japan. The engineers in Tokyo used to visit Seoul every month to consul on engineering sample building at LGEI&S R&D lab. However, the communication with other functional departments such as marketing and manufacturing was poor. Marketing managers and manufacturing managers seldomly met together with the project leader. Marketing and manufacturing personnel were occupied by their functional activities. This communication problem with marketing and manufacturing resulted from its sequential product development process and a strict hierarchical organization. As illustrated in Figure 6.3, each phase was dominated by one function and therefor no process overlapping was observed throughout the product development process. The project leader, who had no cross-functional team members, concentrated on engineering rather than project planning or functional coordination with other groups, because his only responsibility was in achieving engineering targets. He spent all his days in the lab with design engineers building engineering samples. Meanwhile, the engineers in LGEI&S R&D lab in Seoul

, could have finished systems design and engineering sample building with the help of the LGE Japan R&D center. Later, the engineers in Seoul R&D lab distributed the first drawings for die building and visited die suppliers to give technical assistance. However, die building could not be finished as schedule, because of serious quality problems in the engineering samples after the first designs were released. Engineers in Seoul R&D lab redesigned and reassembled engineering samples for testing but quality problems occurre continuously. This time consuming design change and retesting were repeated througho the die building phase.

Pilot phase started with delivering the engineering samples and drawings to the engineering department located in Pyungtack plant. The basic purpose of pilot phase was to discover any defects in design and manufacturing that could be modified before volum production. However, since the product design phase was finished by one department (R&D department in Seoul), the pilot engineers could not have known detailed product information until they received engineering samples and product designs from the R&D department. This was a major cause of delay because pilot engineers had to spend time t understand the software and physical configurations. Another serious problem of LGEI&S' product development practice was observed in component quality. Many components could be assembled after grinding or bending at the pilot job shop. ECOs were issued again by the pilot engineers to improve component quality. These repetitive design changes in the engineering sample (E/S) and pilot phase had a very negative impac not only on time-to-market but also on quality of that earlier product. The results were s serious that mass production first lot was launched more than 8 months later than the scheduled target.

Inspite of LGEI&S engineers' and managers' efforts, the LBP development project was not successful. When the LBP was introduced to the domestic market, it had no competitive advantages in terms of quality, price, and design compared to competitors' products. Many service calls and product returns were reported from customers due to quality problems. Furthermore, the printing speed was lower than the competitors'. The machine was designed to print 3 pages per minute (PPM) but the market was dominated by the 5 PPM machine when the new product was shipped. The laser beam printer market had already been moved to high speed and small size machines. As a results LGEI&S lost the 3 PPM machine market.

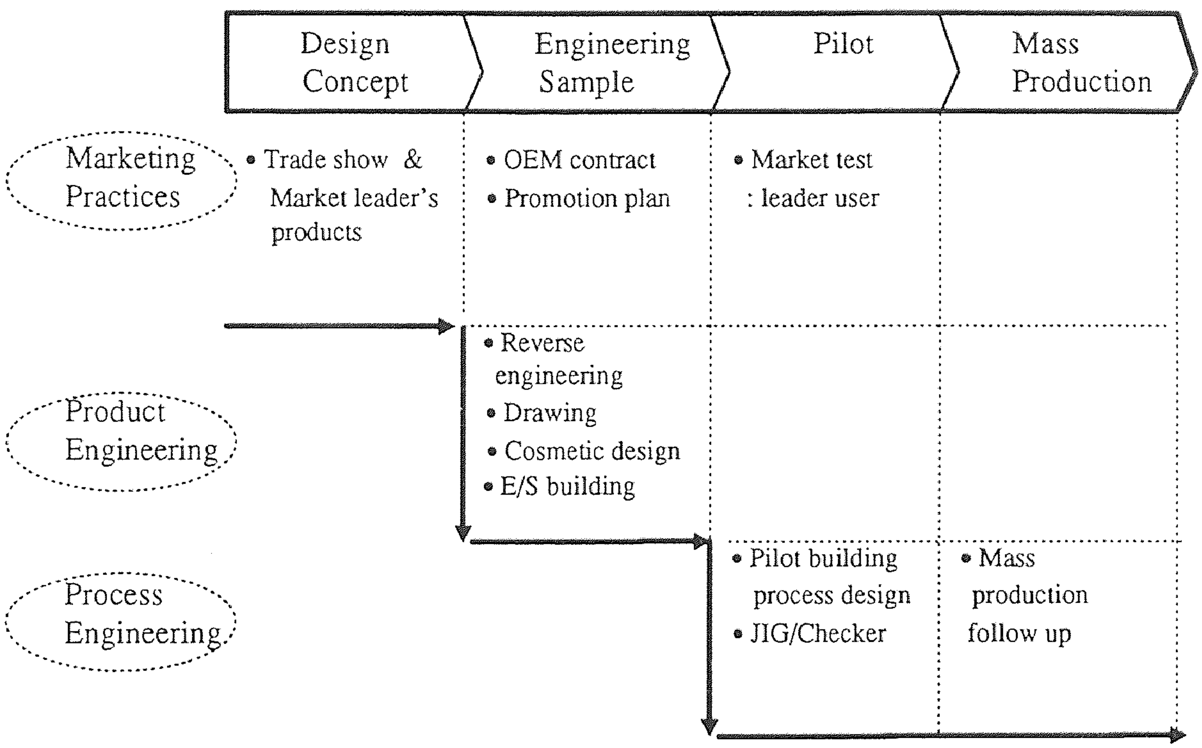

Figure 6.3 Sequential product development flow of LGEI&S.

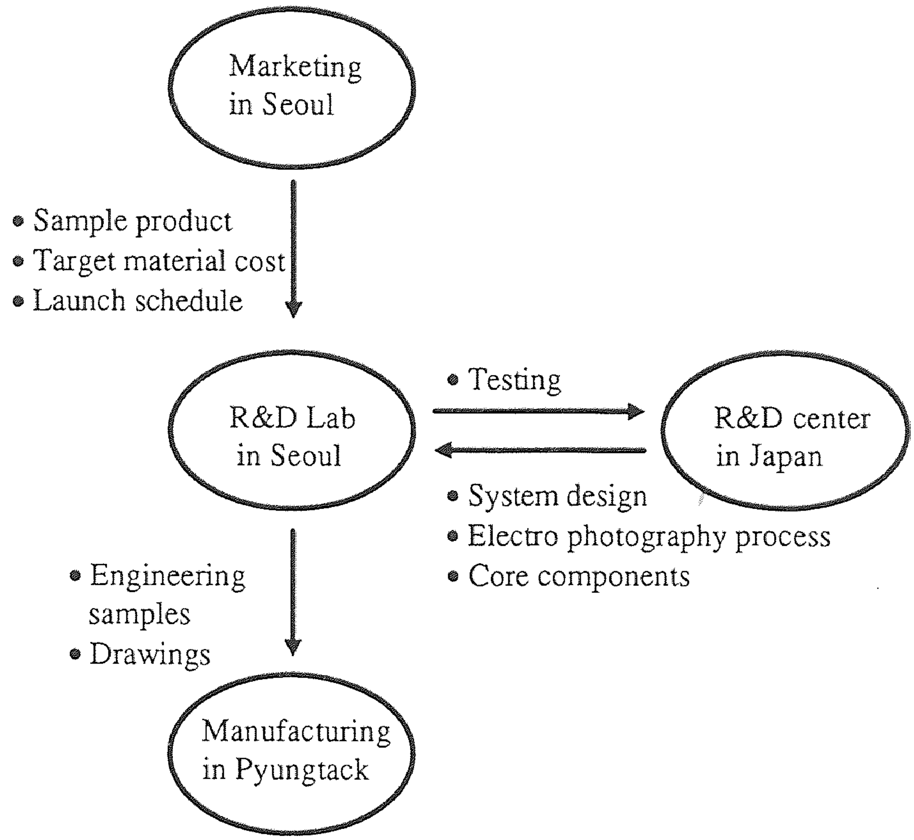

Figure 6.4 Actual communication process of LGEI&S.

6.2.1 What was Wrong with LGEI&S ?

- *one of the major causes of product development failure of LGEI&S stems from their time consuming product development practice.*

As illustrated in Figure 6.3, in the sequential product development process, each phase is dominated by one department (e.g., R&D department dominates the engineering sample phase, engineering department dominates the pilot phase) and down stream functions such as manufacturing and engineering department cannot prepare anything until they received the engineering samples and product designs from R&D department.

- a *second problem was due to the many design changes throughout the product development process (especially in die building phase).*

  Design changes had a very negative impact on the time-to-market and product quality.

- *a third problem was poor communication among functional departments.*

  As shown in Figure 6.4, four major functions were geographically separated, for example, the marketing department in Seoul, LGEI&S R&D lab in Seoul (in different building then marketing) LGE R&D center in Japan and manufacturing department in Pyungtack. Communication between the project team in Seoul and engineers in Japan LGEI&S R&D center had no problems, as they communicated well with facsimile, mail, and telephone. They shared their functional goal achieving engineering functions. Communication with other departments such as marketing, engineering and manufacturing was poor. The project leader just concentrated on achieving his functional department's product to development team without detail marketing information. This means that they used current market leader's product specifications for product which would not be introduced to the market for two years. Marketing had ignored the subtle changes of the market. Although LGEI&S was successful in meeting engineering goals, they failed to develop a marketable and manufacturable product.

- *a fourth problem was misunderstanding of the future market.*

  Marketing people choose the low-end market regardless of the communality of 3 PPM machine in the LBP market because they thought that 5PPM machine development was too risky in terms of capital investment and technology success.

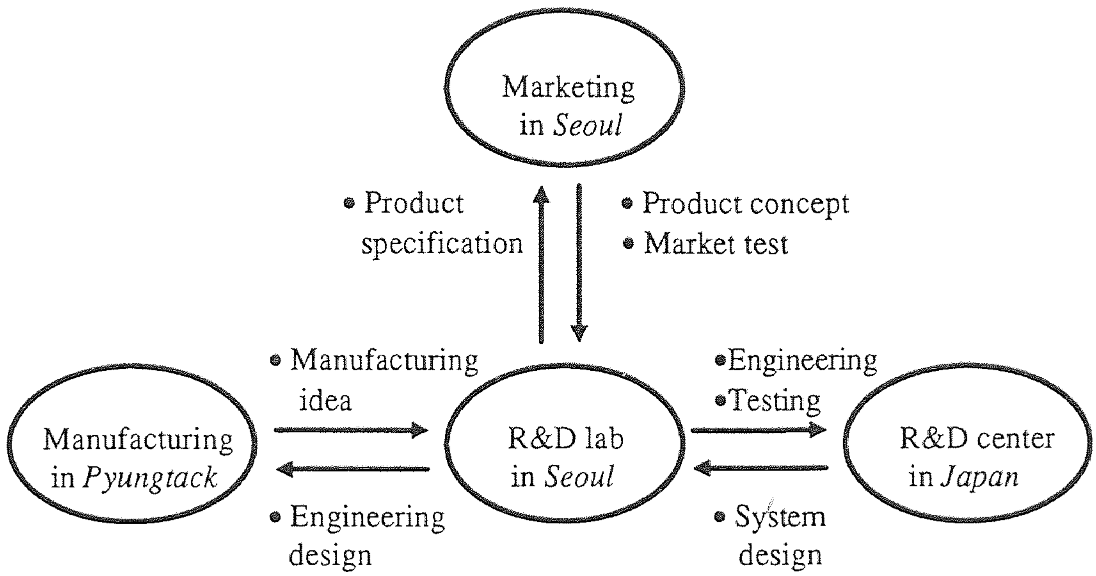

Figure 6.5 A desirable communication process for LGEI&S.

When they set the target market, marketing people considered the project risk but did not understand the product life cycle.

6.2.2 Suggestions for LGEI&S

Cross-functional communication is critical to achieve product development goals. Project leader should concentrate on maintaining communication among functions throughout the product development process. First, as shown in Figure 6.5 *the project leader should located in the center of the communication process*. Second, *product design engineers should have get the early involvement of manufacturing experts* to eliminate the design changes in the down stream functions. Third, *LGEI&S could have set a drastic goal for the future demand.* Marketing staffs might consider high-end product (5 PPM) market instead of low-end product (3 PPM) market when they set a target market. The product development failure of LGEI&S shows not only the importance of communication among functions but also the ineffectiveness of sequential product development process in the changeable market.

6.3 Case Study 3: Cross - Functional Team of Sambo - Trigem

Sambo - Trigem, one of the most successful technology-based venture companies in Korea, has enjoyed rapid growth in the domestic personal computer market. Despite the relatively high price, customers preferred the Sambo - Trigem label because of its advanced technology and high quality. In the late 1980s, many computer manufacturers including foreign companies, entered the Korean personal computer market with low price and high quality. For instance, Taiwanese computer companies' market share had rapidly increased in the Korean personal computer market. With these changes in technology and competitive environments, Sambo - Trigem planned a product development project to create a new domestic market. For product ideas, planning people visited major world trade shows and bought a sample of a pen personal computer (PC) for reverse engineering. The pen PC was a new computer on which the characters or drawings could be input directly with an electronic pen through the monitor screen. Planning people expected that the pen PC would be a lucrative business due to its newness in the domestic market. At that time there were no pen PC makers in Korea. After brief reviews on the sample machine, the planning department reported product development team organization, material cost, target market, and product launch schedule to the vice president at the product development committee meeting. A functional team leader of hardware design group in R&D department, was assigned as the cross-functional team leader. The project team was restructured to the cross-functional team. This included R&D, engineering, purchasing, planning and marketing groups. However, manufacturing engineers were not included in the team because of the geographical distance. The cross-functional team was the first use of organized horizontal integration in Sambo - Trigem's product development history. In the past product development, product development was conducted by one functional department (R&D department) and followed sequential product development process.

After the project team was formed, Sambo - Trigem dispatched the hardware and software design engineers to a pen PC manufacturing company in England. There, Sambo - Trigem engineers learned how to design the systems and components with the technical help of the English company.

Although the cross-functional concept was a step in the right direction, the integration and coordination were problems because there were no specified authority relationships between the cross-functional team leader and the functional managers. As a result the cross-functional team members maintained loyalty to their functional organizations. The report route and the functional managers behavior was the same as the conventional organization (functional organization). For example, the project leader reported only to his boss, R&D manager, and the functional representatives also represented their loyalty to the functional managers because the team leader had no authority of performance grading for promotion or monetary reward of the functional representatives. Functional managers were also reluctant to endow their authority to the project leader. The most severe obstacle to the project team was that functional managers placed nonqualified and inexperienced individuals to the cross-functional team. Functional managers even frequently replaced the team members throughout the long-range projects. This strong vertical integration between functional managers and subordinates, and weak relationship between cross-functional team leader and functional representatives, resulted in poor teamwork. The team members who were placed by the functional managers seldomly participated in the cross-functional team meetings. Functional representatives spent all their days handling the functional work assigned by their functional manager. The engineering sample phase was completed by the sole effort of the R&D members instead of the cross-functional team activities.

The failure of transition to the horizontal integration stemed from senior managers' poor understanding on the nature of cross-functional team activity. The functional managers did not know their roles in the new organization. The project leader did not only misunderstand how to work together with the functional representatives, but also how to coordinate or integrate functional managers.

This case study shows the difficulties of achieving horizontal integration in a strict hierarchical organization. One of the major factors for success in the organization change is the understanding of the fundamentals of managing the conversion period from a organization to another. An effective cross-functional team requires well designed horizontal communication across departments and inter-organizational boundaries at the peer level. However, this may not be achieved without the concurrent involvement of functional specialists. Managers who adopt organizational changes must be prepared for change. Then they must initiate the changes with strong confidence on the advantages of cross-functional integration. Senior managers should try to avoid undesirable outcomes by concentrating its involvement on the role of facilitator. Preparing training programs for executives, functional managers, and employees on cross-functional team management knowledge, skills, and attitude is critical to a successful transition to the new product development practice.

CHAPTER 7

A CONCEPTUAL PRODUCT DEVELOPMENT MODEL FOR THE KOREAN CONTEXT

In the previous chapter, three product development projects were reviewed to gain an understanding of Korean companies' current product development practices. Product development inefficiences and ineffectiveness were rooted in the time consuming sequential product development process, functionally isolated product development organizations, lack of product life cycle understanding, and OEM-oriented indirect marketing practices. These conditions result in critical disadvantages for Korean companies competing with advanced foreign companies in the international market.

Over the last three decades, Korean companies have had success under government-directed growth policies. In such a stable environment, exploiting short term "economies of scale" using low labor costs was their best policy for entering international market. Thus, Korean companies have long concentrated their efforts on purchasing advanced technology from foreign companies and have manufactured with the purchased technologies for OEM export. However, since OEM export, by its nature, does not require risk-taking on technology development or sophisticated marketing strategies, indigenous technology innovation and marketing practices have rarely occurred in Korean companies. These are disadvantages for Korean high-tech companies to compete with advanced foreign companies in the world market. As shown in Figure 7.1, their current product development practice should be changed to be a more flexible organization. That utilizes parallel product development processes, incremental or creative product development, and aggressive international marketing to compete in the risky, fast changing, and high competitive environment. In this means, a conceptual product development model for the Korean context is discussed in this chapter.

7.1 Literature Review

Many studies of product development organization have been described in the literature. Based on the relationship between the nature of the market and the nature of technology, Souder (49), suggested the organization structure for integrating R&D and marketing. Monteleone (34) explained the business board approach: a profit center, chaired by a business manager and having as members such as marketing manager, commercial development manager, manufacturing manager, finance and planning manager and a research manager. This approach is a cross-functional integration at senior managers level. Young (65), suggested the technical-marketing dyad, a team consisting of a researcher and a marketer who jointly work on a developing product. Souder (52), In his study on fifty successful and fifty failure outcome products, found that the *commercial project manager approach* * was the most successful among the 9 product development approaches.

Although these approaches make sense in specific organizational environments, a basic question arises -- are these approaches developed in advanced foreign countries still valid in the Korean context? Ouchi (40), noted that "tradition and climate make up a company's culture." Ignoring the multiple elements of organization is one of the reasons for failure to change organizational behavior and culture. The organizational

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* A formal project manager who is appointed from marketing department. He is given a budget for the entire project and became the top-level manager for the duration of that project. Project team is formed with functional representatives who will return their home department after the completion of the project.

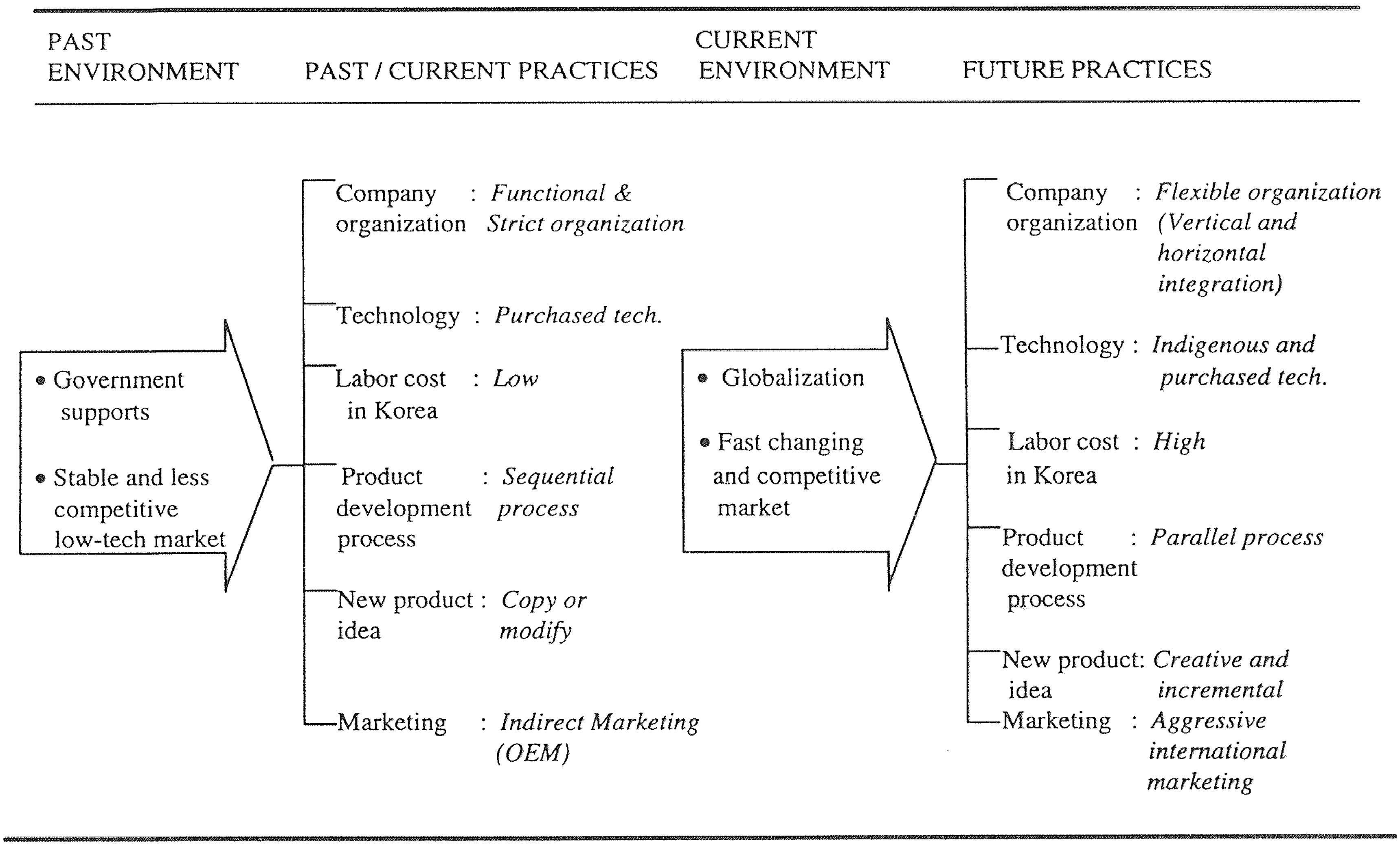


Figure 7.1 The product development environment and practices (past, current, and future) of Korean companies.

arrangements for the future should induce those behaviors that are keys to its success. At the same time, the organizational arrangements contemplated must match the needs and expectations of employees and the social culture of the country in which the company is embedded(2). Obviously, cultural differences should be considered in applying an organizational model to the different countries. Unfortunately, little research on product development practice has been done in Korea. A few exceptions are to noted. Youngbae Kim et al., (63) Linsu Kim et al., (31) and Youngbae Kim (64). Linsu Kim et al., (31), in their studies in 31 manufacturing organizations in Korea, found that the evolutionary pattern of relationships among technology, structure, environment and other contextual variables is different from the type of evolutionin a developed country. They asserted that organization in the early stage of evolution tends to have an organic structure in developed countries, but mechanistic structure in a developing country (Korea). In developed countries, organizations tend to maintain an organic structure in a rapidly changing environment in order to utilize communication capabilities and to stimulate new product ideas. However, in Korea, organizations at the early stage of evolution have a stable predicted environment in terms of both technology and market. They are concerned with the applying of purchased technology. In this relatively certain environment, organizations tend to have a mechanistic structure. Youngbae Kim et al., (63), in the study of 24 innovative and 25 non innovative small firms in Korea, found that the managerial attitudes toward innovation is the most critical factor among four considered factors: environmental, strategic, structural and top management characteristics. Interestingly, Youngbae Kim (64), based on his study on 80 R&D project teams in both government-sponsored research institutes and private R&D centers in Korea, found that autonomy has a significant negative relationship with team efforts currently undertaken in Korea. Most innovation projects performed in Korea largely focus on short-term, incremental, and imitative oriented projects. To successful perform this kind of innovation, the external drive to push R&D members might be more effective than allowing autonomy to them." While, Chan-Jin Lee (9) - founder of Hangul and Computer Co., LTD, the most successful software development company in Korea, which has 280 young software engineers (average 25.5 years) - wrote in his book, *Welcome to Software World,* that the most important factor of their success was the autonomous product development environment. He added that "In our company, young engineers actively suggest their ideas and communicate well with others. As a president, I think of my role as a conflict coordinator and a project supporter." He added that cross-functional communication was critical to project success. According to the book, Hangul and Computer has a significantly flat organization structure with only four vertical levels, with an horizontally integrated project-team organization. All projects are administered by the responsibility and authority of the project team leader. Myun-Woo Lee (36), based on his task-force team experiences for 2 years with both small and large Korean companies, reported that teamwork and the leadership of the company executives are the most important factor for inducing innovation in the Korean context. He also found four obstacles to understanding. These are:

- Copy oriented product development practice: researchers have long copied the overseas company's product and it resulted in unwillingness of risk taking.
- Severe communication problems among functions
- Time consuming decision process

- ineffective committee meetings

From the above literature review several guide lines for a product development model are introduced. First, since traditional organization structure of Korean companies is highly bureaucratic, a step-by-step approach to cross-functional integration is desirable. Rapid changes in the strict hierarchical organization structure may induce severe resistance. Second, product innovation models may vary depending on company size and technology. Third, risk taking of senior managers and researchers is important to accomplish technology innovation. Fourth, senior-management leadership is a critical factor for success in the Korean context. Senior-management leadership is particularly important for transform structure in the Confucianism-based culture--which emphasize loyalty, order, and seniority—into a more creative and spontaneous work climate in R&D organization in Korea. Lastly, new product development tools are required to improve current development practices.

7.2 A Conceptual Product Development Model

The three project case studies of the Korean companies in the previous chapter and above five guide lines lead to a product development model for the Korean context (Figure 7.2). The objective of this model is to stimulate product innovation by changing Korean companies current product development practices. The model is different from their current product development practices in terms of product development process, product development organization and senior managers role.

As shown in Figure 7.2, this model has four key dimensions. These are organization structure dimension, product development process dimension, company

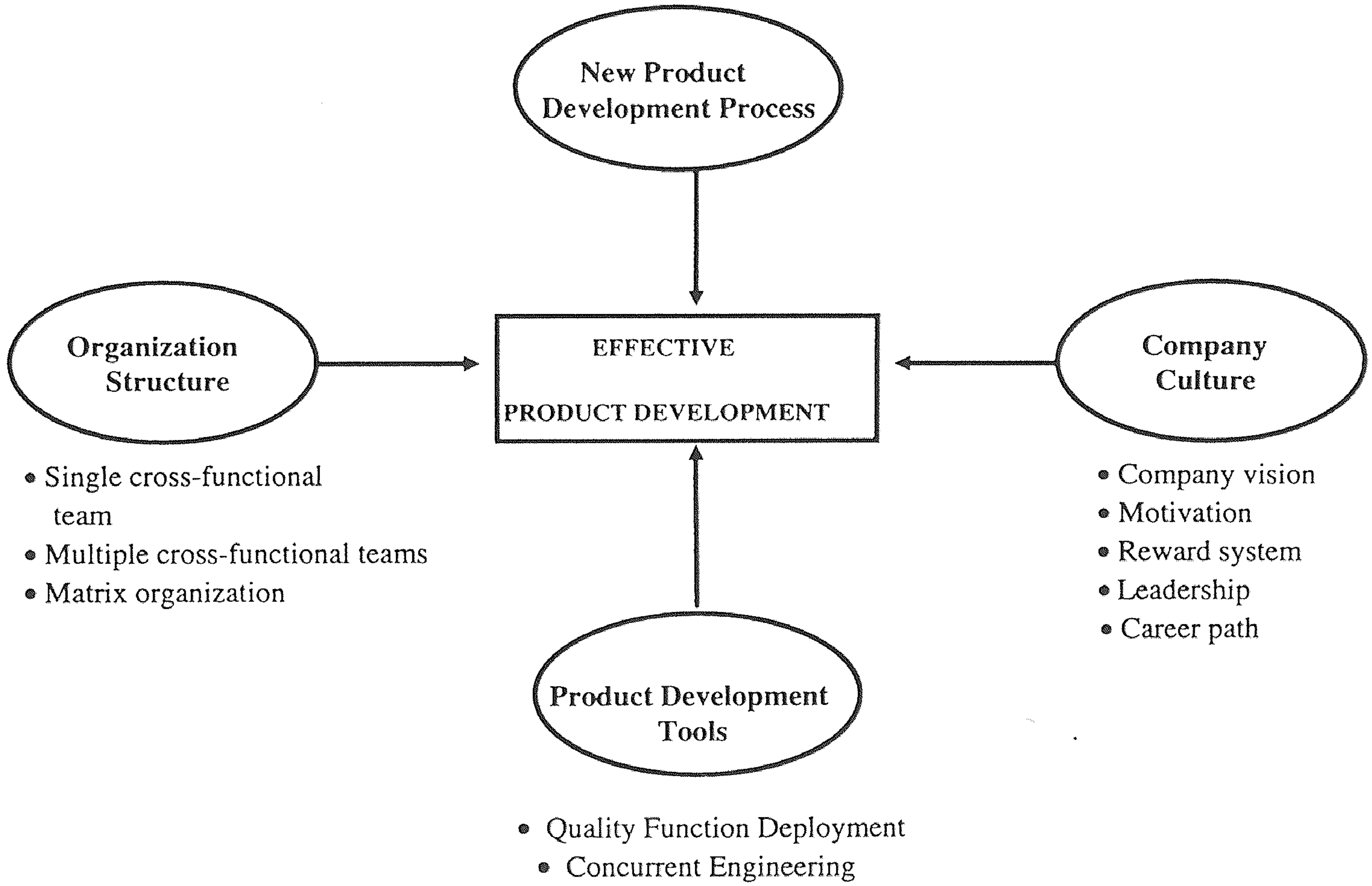


Figure 7.2 A conceptual product development model for the Korean context.

culture dimension, and product development tools dimension. The shape of these dimensions and their relative balance continually shift, depending on products and company policy. If Korean companies can implement these four dimensions effectively, they can change their current product development environment to be more competitive in the international market.

7.2.1 Organization Structure Dimension

The first dimension of the new product development model is that of organization structure. This dimension is expanded widely across the organizational barriers throughout the three steps of cross-functional integration. As a first step to a horizontally integrated organization, the single cross-functional team (SCFT) is explained and then the multiple cross-functional teams (MCFT) is presented as a second phase of the organization structure change process. Finally, as a vertically and horizontally well balanced organization model, the matrix organization is discussed.

a) Cross-functional team

In the days when business was more predictable and stable, Korean companies organized themselves in vertical structures to take advantage of specialized experts. The benefits are obvious: everyone has a place, and everyone understands his or her task. The critical decision making power resides at the top. But while gaining clarity and stability, such organizations make it difficult for anyone to understand the task of the company as a whole and how to relate his or her work to do.

Heightened global competition and the ever-increasing speed of technological change have since altered the ways of competition in the world market. Many world-

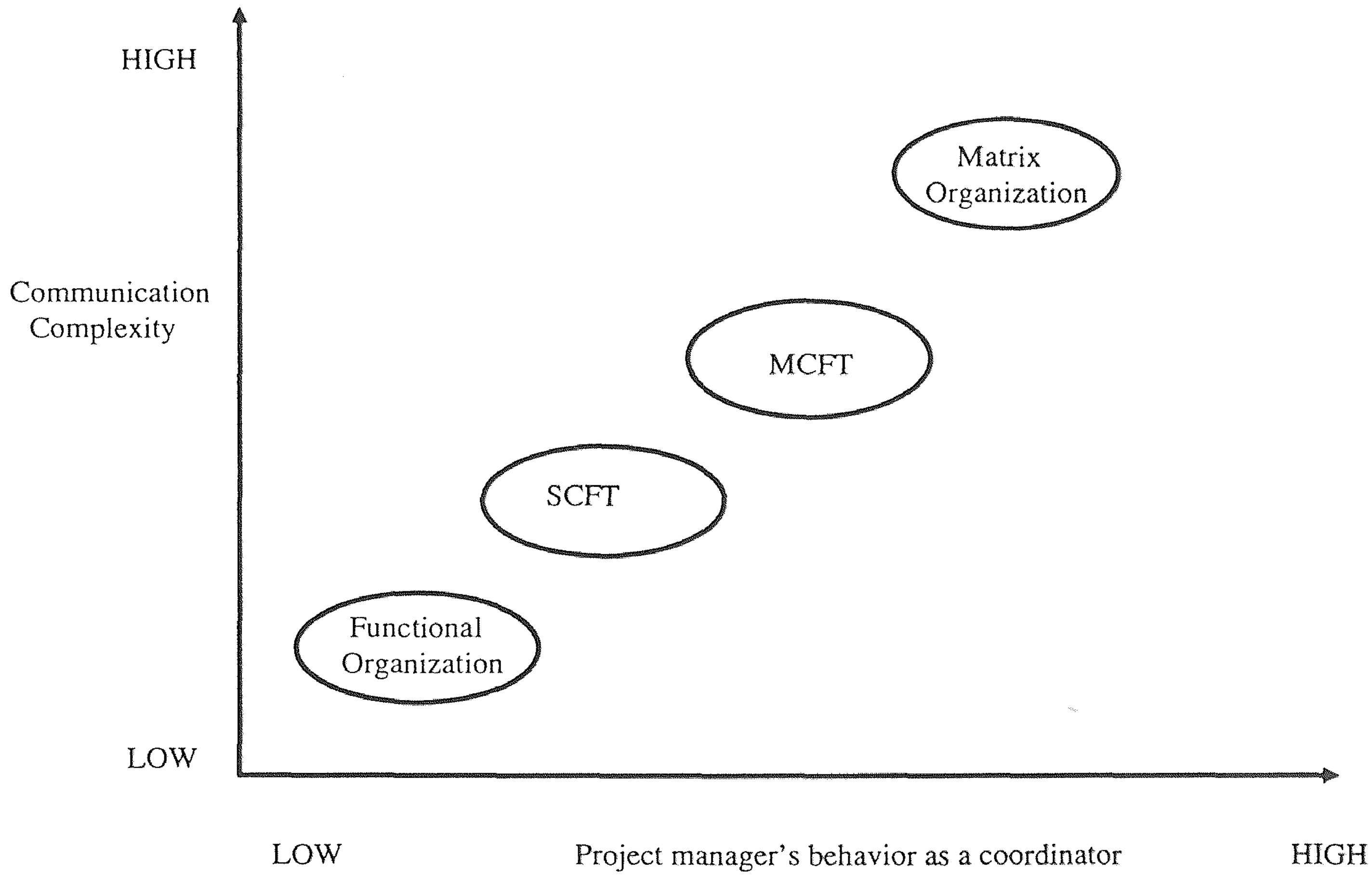


Figure 7.3 Project manager's role and communication complexity of organization structures.

class companies have tried to seek new organizations to respond the environment changes. Although many different organizational concepts have been created, the trend is toward flatter organizations such as cross-functional team, project team, multidiscipline team and task force team. The major objective of the cross-functional team is eliminating the border between functions and projects. There are two types of cross-functional team organization depending on the number of the team in a business unit. These are: the single cross-functional team (SCFT) and the multiple cross-functional teams (MCFT). The major differences between SCFT and MCFT are levels of functional integration and roles of project leader. SCFT consists of a project leader and a cross-functional team. While, MCFT consists of two or more project leaders and cross-functional teams in a business unit. Therefore, its communication complexity is higher than SCFT (Figure 7.3).

b) Single cross-functional team (SCFT)

As a first step to the horizontal integration, the SCFT approach is helpful to Korean high-tech companies. Since SCFT has lower communication complexity level than MCFT, it can be used as a learning phase for changing their product development organization to a horizontally integrated teams. SCFT consists of one project, one cross-functional team and one project leader (Figure 7.4). It involves a whole spectrum of management skills, required to identify and integrate the various functional groups from the functional organization. To successfully start to the cross-functional integration, the project must be publicly recognized and supported as a project by top management so that the project leader has the delegated authority necessary to enforce the polices, procedures, rules, and standards. Project leaders in this mode of organization should know not only how to keep communication with functional managers, but also how to maintain the functional

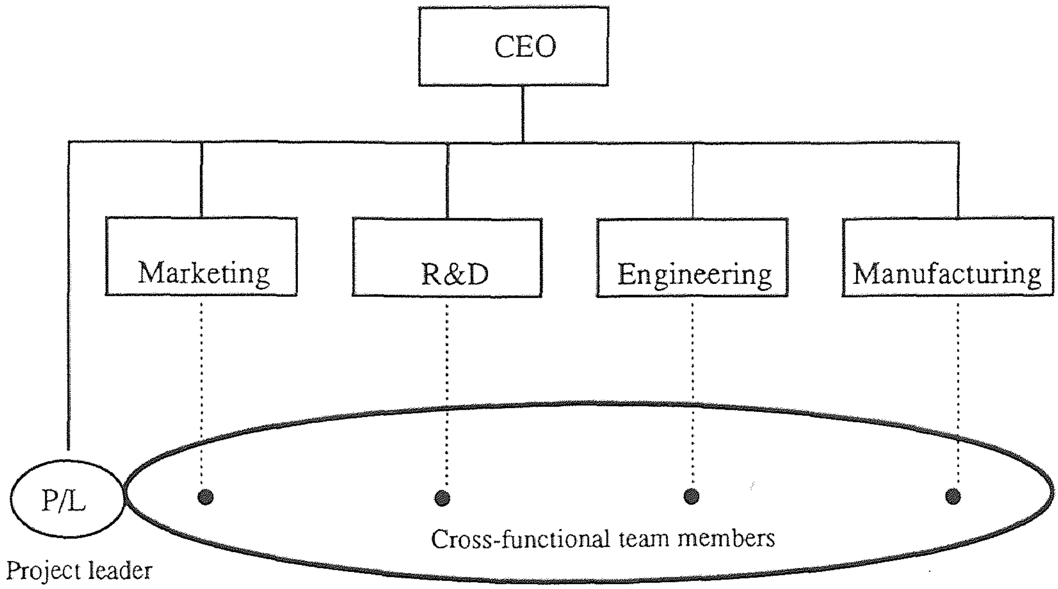


Figure 7.4 The organization of Single Cross-Functional Team.

integration during the product development phases. To be effective, the project leader must provide an environment conducive to teamwork. He must nurture a climate with the following characteristics.

- Good interpersonnel relations and team spirit
- Team members committed to the program
- Clearly defined goals and project objectives
- Involved and supportive top management
- The necessary expertise and resources
- Open communication among team members and supportive organization

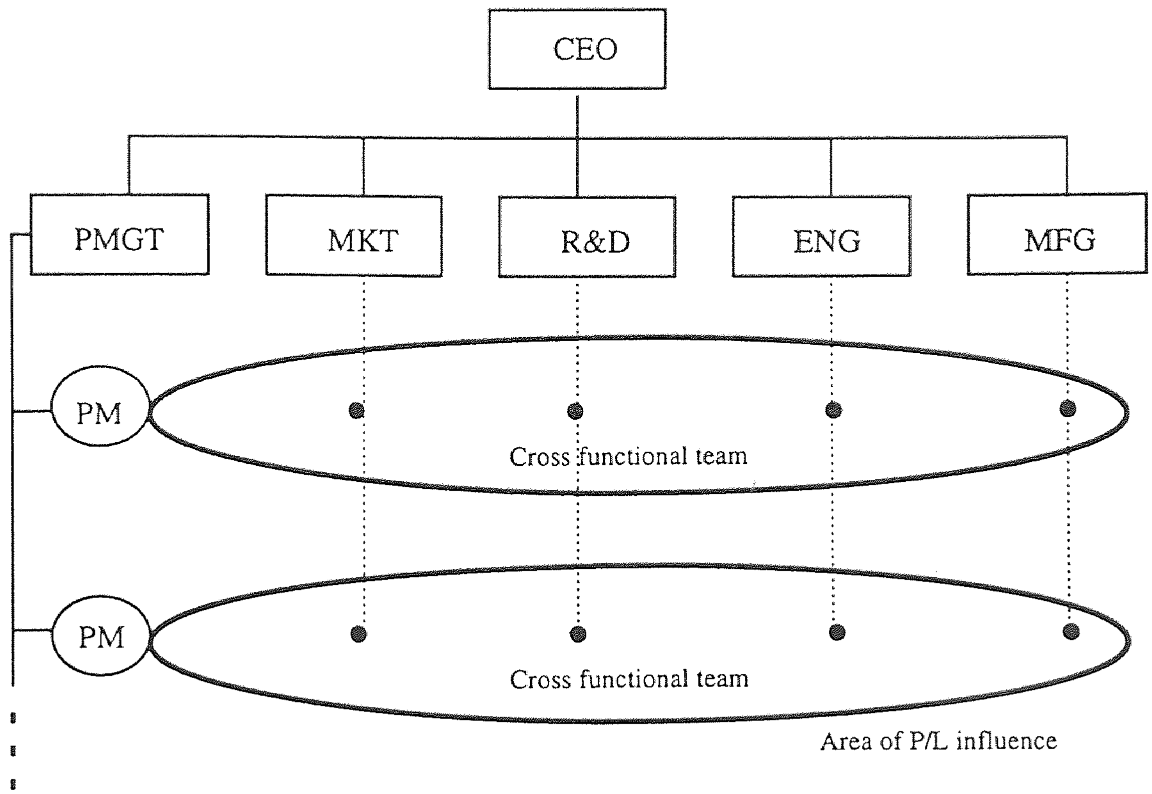
A low degree of detrimental interpersonal and inter group conflict If the project required many functional team members, thus making it difficult to control the cross-functional team, the use of project assistants or liaison people can help the leader. Project assistants or liaison people serve as product planners or project controllers in a cross-functional team and communicator among functional teams. Since the SCFT approach is a first step to the horizontal integration, senior managers' support and directing is critical to success. Senior managers should understand the importance of horizontal integration and initiate necessary changes.

c) Multiple cross-functional teams (MCFT)

The MCFT approach is the second step towards horizontal integration in the Korean context. After a company has accomplished a project using an SCFT, senior managers may organize two or more project teams simultaneously to set up MCFT (Figure 7.5). Since MCFT is a more complicated structure compared to SCFT, senior managers should prepare detailed procedures before they launch MCFT. Reviewing the difficulties and the problems of previous projects (SCFT) will be help them initiate the second step. The major differences between SCFT and MCFT lay in the communication complexity between project leader and functional manager, and in the role of project leaders. If preparation is not sufficient, functional managers or cross-functional team members may resist the change and not understand their new roles in the new organization. If these potential problems are not avoided by the senior managers, many conflicts (c.f., project priority or resource management) may occur between project leaders and functional managers throughout the product development process.

d) Matrix organization

A matrix organization consists of project managers and the product development teams. In a matrix organization the roles of functional manager and project manager are differ.



CEO: Chief executive office PMGT: Project management MKT: marketing ENG: Engineering
MFG: Manufacturing PM: project manager

Figure 7.5 Organization of Multiple Cross-Functional Teams.

The project manager has *total responsibility and accountability for project success.* While the functional managers have *functional responsibility to maintain technical excellence and provide the project team with resources.* Project management in a matrix organization is not an one-function operation: In a matrix organization, project team consists of: a project manager, an assistant project manager, and a project office. Generally on large project, project office personnel are assigned full-time to the project and work out of the project office, whereas the project team members work out of the functional units and some members may spend only a small percentage of their time on the project. Kerzner (26) pointed out problem areas in staffing.

- Part time vs. full-time assignments
- Several projects assigned to functional managers
- The project manager role retained by the general manager

The first problem is generally related to the size of the project. If the project is small (in time duration or cost), a part time project manager may be selected. If the project is a high-technology effort that requires specialization and can be performed by one department, then it is not unusual for the functional manager to take on a dual role and act as project manager as well. Project managers should have both business management skills and technical expertise. They must understand the fundamental principals of management, especially those involving the rapid development of temporary communication channels. Project managers must understand the technical implications of a problem, since they are ultimately responsible for all decision-making. They may have a staff of professionals to assist them.

7.2.2 New Product Development Process Dimension

a) Product development phase overlap

One way to reduce the time to market is by overlapping functional talent and cross-functional interaction at all levels of control (10), (23), (45), (55). This can be accomplished with full time staffing from various disciplines. The phase overlapping in the product development changes following product development cycle (Figure 7.6). For example, during the design stage, design engineers in the related product design will be the most active participants. In the early stages, though, marketing must provide sufficient input and effort to assure that the directions taken by the product design engineers will meet the market requirements. During this stage, engineering and manufacturing must become informed about the details of the research in order to plan their own activities and also to guide the researchers towards solutions that can be implemented within the scope of the business unit resources. During the development stage, researchers must be involved continuously. Development includes design, prototype or pilot buildings, and product testing. It involves solving all the product problems before going to the mass-production stage. Changes in direction by individuals without concurrence by the other functions cannot be permitted. During the manufacturing stage, researchers play a minor roles, development personnel continue to be involved to assure that the designs will be manufactured a designed, manufacturing engineers becomes a full-time participant, and marketing personnel increase their activity according to the needs. Marketing involves introducing the product to the market.

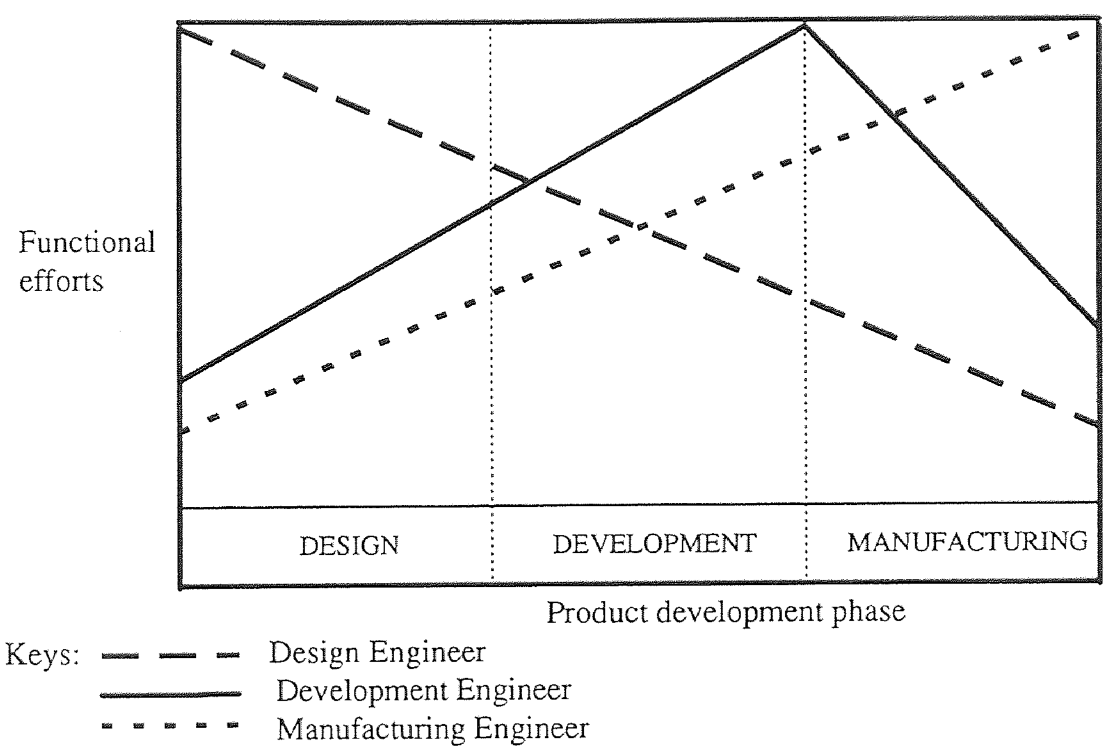


Figure 7.6 Product development phase overlap.

Research and development need feedback from manufacturing and marketing. That feedback is essential to learn about product performance and the future needs of the customer.

b) Two types of product development process overlap

Product development process overlap can be categorized by the market situations and technology levels. Figure 7.7 shows a process overlapping in the market uncertainty and new technology. In this case greater integration between marketing and R&D needed. Research, study and inspection into the users' environments are needed. It may be necessary to observe the users' environments for long periods of time to ascertain their needs. Close collaboration between marketing and R&D may be needed to fully understand the users' technical environments and describe the users' feelings and motives. Figure 7.8 shows a process overlapping in a market-certainty and conventional technology project. In this case, product development time is critical for project success. More integrating among technical process needed than marketing to reduce time to market. In major projects, it is important to get functional personnel involved as early as possible so that there is some overlap of commitment before the project is transferred from R&D to engineering, manufacturing, and marketing.

7.2.3 Product Development Tool Dimension

In a company, the change of overall product-development practices can not be completed in a short time. However, if a company can learn effective product development tools quickly and apply then, significant changes can occur in their product development environment. One of the changes is that the use of new tools stimulates

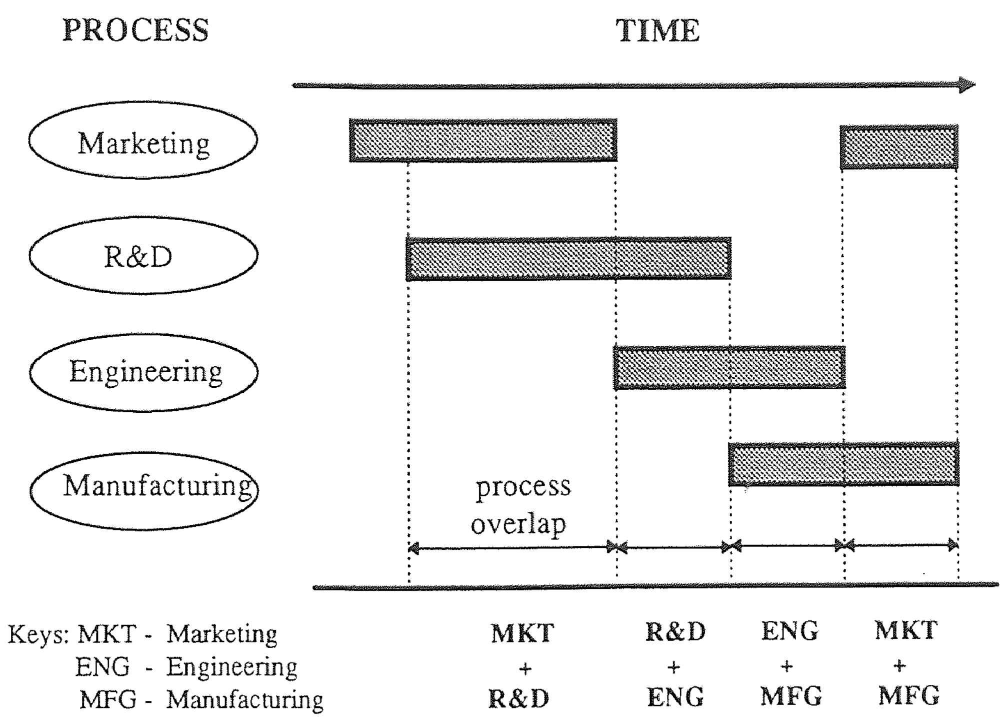


Figure 7.7 Process overlapping in the market uncertainty and new technology.

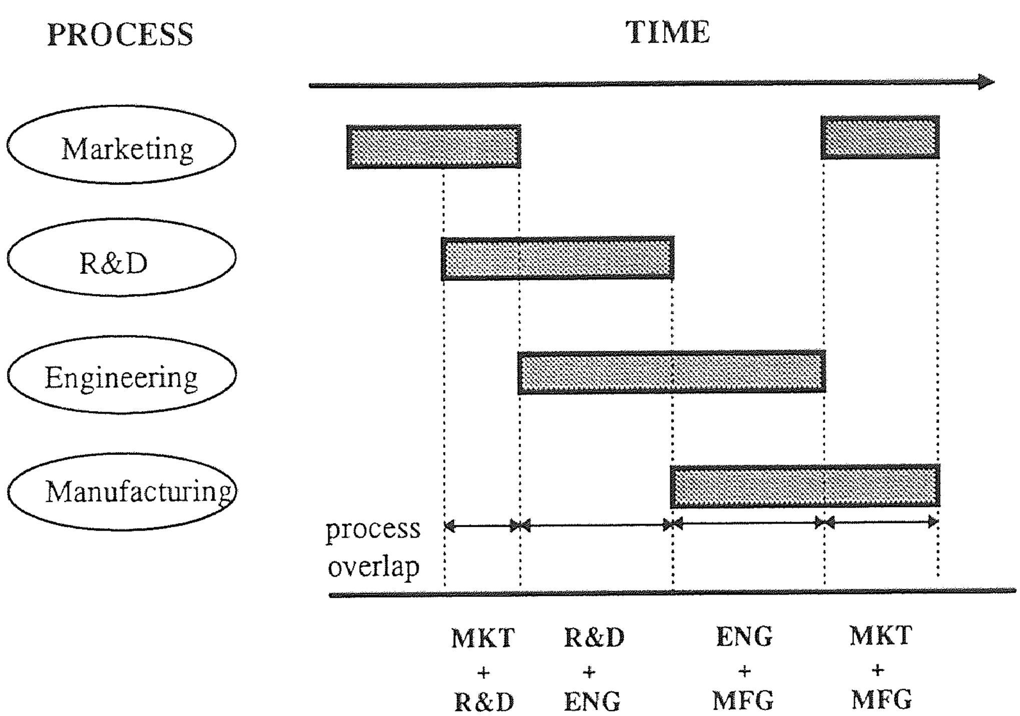
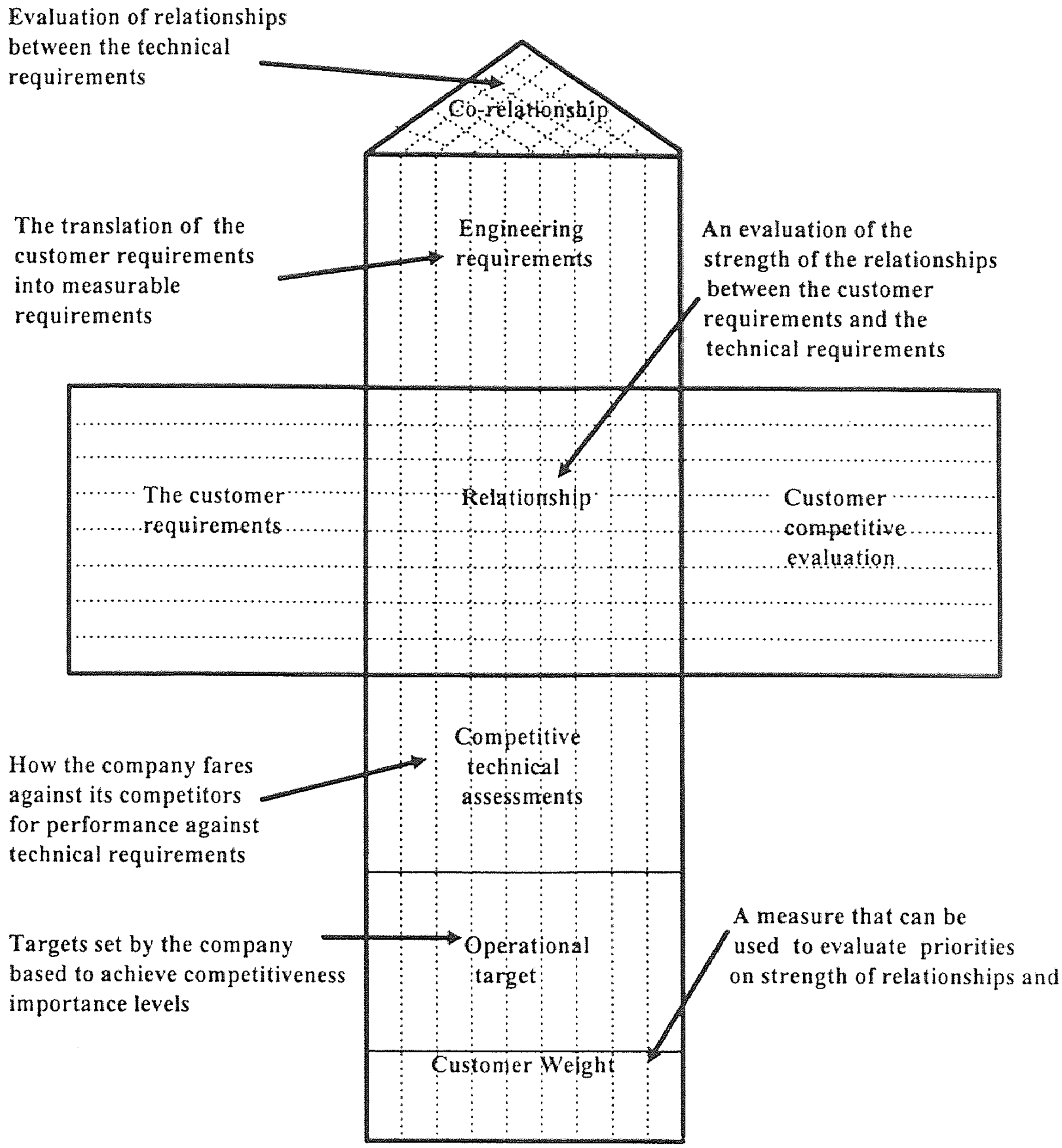


Figure 7.8 Process overlapping in the market certainty and conventional technology.

project team personnel and motivates during the product development. In the new product development model, two tools are discussed for inducing effective product development practices in the Korean context. These tools are Concurrent Engineering (CE), and Quality Function Deployment (QFD). QFD helps to increase communication among functions when the design concept is being defined and the product is specified CE is a powerful product development tool which helps the product development team reduce time to market.

a) Quality function deployment (QFD)

As a tool for integrating key functions in a product development process, QFD has advantages on transferring marketing information to the product design. "A set of planning and communication routines, QFD focuses and coordinates skills within an organization, first to design, then to manufacturing and market goods that customers want to purchase and will continue to purchase. The foundation of QFD is the belief that products should be designed to reflect customers' desires and tastes - so marketing people, design engineers, and manufacturing staff must work closely together from the time a product is first conceived" (23). QFD is also a planning process, as opposed to a tool for problem solving or analysis. The marketing data - customers' requirements - are the inputs to the QFD matrix (see Figure 7.9) . The process cannot begin without these inputs. QFD essential forces an organization to get in touch with the people who use its products. The basic concept of QFD is that It use a matrix to display information vital to the project in brief outline format. This collection of information in the matrix format facilitates examination, cross - checking, and analysis. It also helps an organization set competitive targets and determine the priority action issues.



Source: Ronald G. Day, *Quality Function Deployment,* (Wisconsin: ASQC Quality press, 1993): 20.

Figure 7.9 The basic ingredients of the QFD matrix.

The output resulting from analysis of the QFD matrix is twofold; competitive targets are established for key action items related to the customers' voice and certain priority issues are selected for special emphasis. QFD uses a matrix format to capture a number of issues that are both pertinent and vital to the planning process. The matrix presents issues in an outline that permits the organization to examine the information in a multidimensional manner. This increases the ability to make effective decisions based on a team's examination and integration of the pertinent data.

(1) The primary parts of the QFD matrix

QFD uses a matrix format to capture a number of issues pertinent and vital to the planning process. The QFD matrix has two principal parts (Figure 7.10). The horizontal portion of the matrix contains information relative to the customer. The vertical portion of the matrix contains technical information that responds to the customer inputs. While

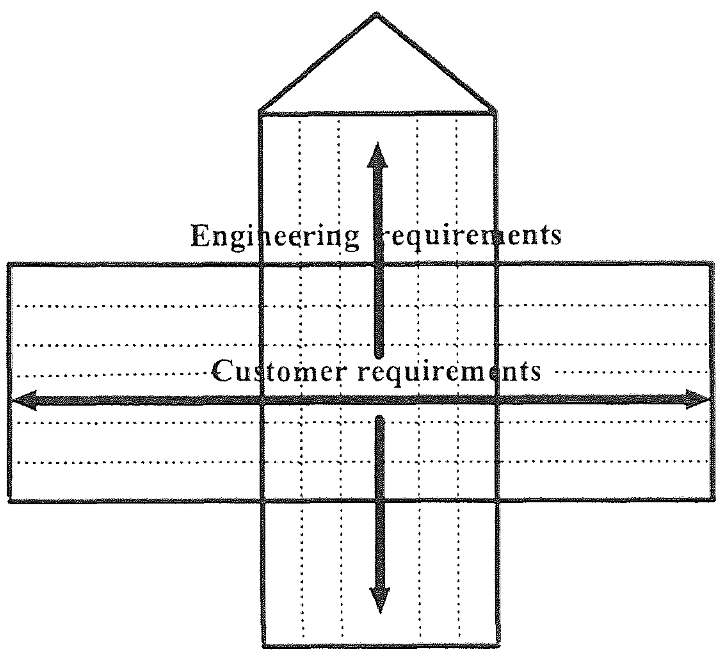


Figure 7.10 Two principal parts of QFD.

the horizontal portion contains customers' requirements. QFD starts from the customer portion of a matrix (horizontal portion) and the next step is to develop the technical information portion (vertical portion) of the matrix (Figure 7.9). The matrix represents these issues in an outline that permits the organization to examine the information in a multidimensional manner. This encourages effective decisions based on a team's examination and integration of the pertinent data (Figure 7.11). The engineering requirements that the company will use to describe the customer's voice are across the top of the matrix. Marketing people tell what to do and engineering people tell how to do it. Engineering characteristics should describe the product in measurable terms and should directly affect customer perceptions.

(2) Customer requirements

Identifying customer requirements is the first step in the QFD process. Customer requirements are descriptions in the customers own words of the benefits they want the product or service to provide. Various marketing survey methods such as, personal interview, focus group, and mail survey are used to identify customers' requirements. In working with a QFD matrix, it is helpful if items of a similar nature are grouped together. For grouping the requirements, affinity diagram process is used. To begin, put each voice on a card. Then, have one team member place the cards one at a time on a table in groups that seem natural to the member. Other members can move cards to other groups if they feel they fit better with that group. Once the cards are grouped and the team members are satisfied with the groups, category titles can be developed for each group. Once the group titles are completed for the voices, the next step should be to see of these can be grouped into larger groups. In this way the requirements can be consolidated according to degree of affinity among requirements. Once the voices have been determined, the customers' level of importance and their competitive evaluation are undertaken.

(3) Translating customer requirements into engineering requirements

The first step in beginning the engineering portion of the matrix is the translation of the customers' voice into engineering requirements. The customers' requirements must be translated into the type of language that the company uses to describe its product for design, processing, and manufacturing. The objective is to translate each requirements into one or more technical requirements. To translate various or ambiguous customers' requirements to quantitative engineering requirements, cross-functional efforts are required. All functions in product development process such as marketing, R&D, engineering, quality control and manufacturing etc., should participate in this phase of QFD process.

(4) Determining relationships

After determine customers' requirements and engineering requirements, the relationships between the two requirements are determined. The purpose of determining relationships is to highlight those technical requirements that have major relationships to customers' requirements. The degree of relationships are measured symbols such as, strong relationship (⊗), moderate relationship (o), and weak relationship (Δ).

(5) Direction of improvement

It is helpful for a team to record its decisions about each technical requirement to show the direction that customers prefer. For every technical requirement, there is a direction that is most favorable for customers, one that will maximize their satisfaction. For example, an arrow pointing up (↑) is used to indicate a technical requirement that the customer would prefer to be larger, bigger, heavier, or in general, increased in some manner. Likewise, an arrow pointing down (↓) indicates that the customer would prefer the technical requirement to be less, slower, smaller, lighter, or shorter.

(6) Competitive technical assessment

As soon as the technical requirements have been established, the QFD team begin the process of arranging for testing. And then the team should select the number of competitors for the comparative tests that represents a balance between the total test time and cost and the need for information. The technical competitive assessment data can be plotted and the target values can be separated as another topic.

b) Concurrent engineering (CE)

The pressure for increased speed to market for new products has been a main cause for considering concurrent work during product development. The narrow view of CE is simple but powerful: manufacturing engineers, design engineers and marketing specialist are work together from the start of project with a combined objective of developing better products than would emerge from their traditional modes of partial isolation from each other. CE has provided important time savings by improving communication, achieving better design trade-off, reducing design rework, and allowing process development to take place parallel to product development. All these work to reduce the length of the development cycle. Sequential development often involves expensive iterations of the design process, due to the low degree of communication between different stages. CE does not change the technological precedence relationship between

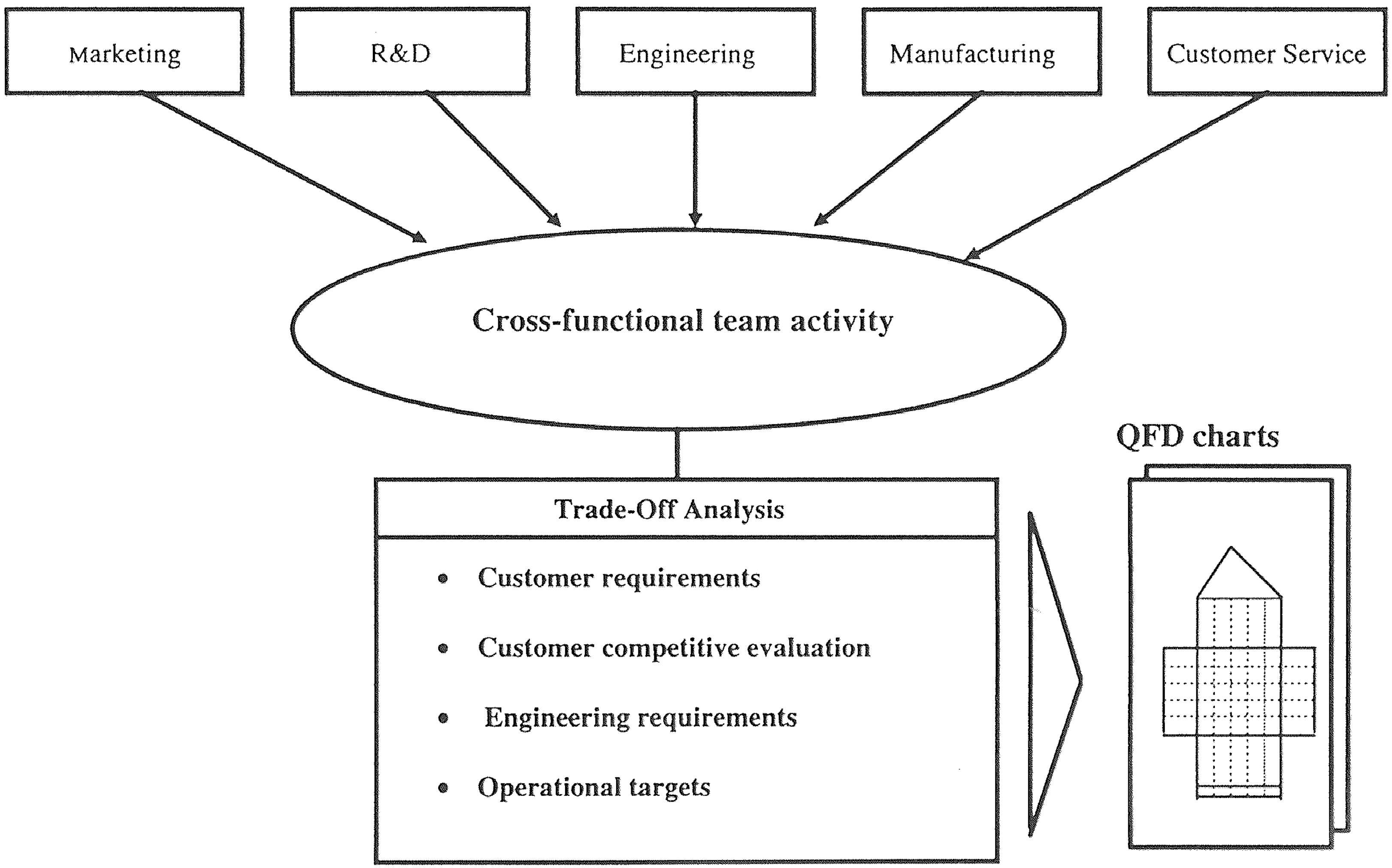


Figure 7.11 QFD process as a cross-functional team activity.

any of the design tasks, but benefits accrue because of the increased communication among all the departments, reduction of iterations, and improved learning processes (14). Justification for a CE program comes from reducing direct labor cost, cycle time, inventory, scrap and rework, and engineering changes.

(1) History of concurrent engineering

One of the most significant events in the CE time line took place in 1982, when the Defense Advanced Research Projects Agency (DARPA) of America began a study to look for ways to improve concurrence in the design process. In the summer of 1986, the Institute for Defense Analyses (IDA) Report R-338 coined the term CE to explain the systematic method of concurrently designing both the product and its downstream production and support processes. The IDA Report provide the first definition of CE (7).

(2) How to implement CE

Two different approaches can be considered to implement CE : these are

- Using information technologies and computer aided design (CAD)
- Using engineering samples (prototypes)

(3) CE using information technology

The two vital areas of CE using information technology are computer aided design (CAD) and information network. As Figure 7.12 shows, communication between functions and team members are processed through a well established computer information systems. Carter and Baker (7), described a concept of concurrent engineering environment: "Using powerful computer two or more tools may reside on the same computer at the same time and present their information in windows, which allows the user to copy data from the window of one tool and paste it into the windows of another tool. These tools can reside both on single computers and be shared through a network." Individuals in a concurrent engineering environment can work together with computer terminals in a single location or separate. For example, if a design engineer want to know the manufacturability of his component design while he designs a component, the design engineer can send the drawing through a workstation to the manufacturing engineer who works in the concurrent engineering environment. When the manufacturing engineers receive the message from the design engineer, they can easily check all the information about the specific design features-including what was problematic in manufacturing. It is not difficult for the manufacturing engineer to retrieve the component if the information system has interactive browsing capability. After the test, the manufacturing engineer can feed back the component design to the design engineer with the results of the test. In this CE component designs and product modeling are conducted with the various tools in a computerized information systems. Since the drawing, the product sample modeling, and the function testing are conducted with various tools in a computerized information system, physical prototype building for manufaturability test and serviceability test are not necessary. Marketing people can also bring a computer file to customers instead of a physical engineering sample. In this computerized information system, the product development team can simulate the product designs or the functions when the customers' requirements are changed. Although start up costs for training, coordinating efforts, and computer hardware and software are high, long-run costs are lower because product designs are simpler and safer to make. Garrett (15), suggested appraisal guide lines to implementing a CE program. These are:

- Operating environment: This means the company's culture, quality programs, continuous improvement programs, customer and supplier involvement, and training and recruiting practices.
- Current practices: Engineering and manufacturing standards and other company policies and procedures make up current practices.
- Design reviews: Appraise them according to their purpose, frequency, and perceived effectiveness.
- Computer systems: Key computer systems applicable to CE include computer-aided engineering, CAD, and computer-aided process planning.
- Manufacturability technologies: Such technologies support assessing manufacturability, standardizing product, reducing part count, simplifying designs, establishing robust manufacturing processes and product designs.

(4) Concurrent engineering using engineering samples

Another approach to CE is phase overlapping using engineering samples (Figure 7.13). The major concept in this approach is to participating down stream functions early to the product design and engineering sample building phase. Early involvement means providing a formal mechanism for manufacturing to work with marketing and design from the start. If the manufacturing people join the team full time from the beginning they will either have to work on engineering or marketing tasks or identify opportunities for overlap so they can begin work on manufacturing tasks, even if this must be done with only partial information. Face to face communication is essential, so it is beneficial to have the participants close together or co-located. Early participation of downstream functions to the product development process fosters proactive rather than reactive attitudes toward manufacturability opportunity. The company can respond to customer needs better when downstream functions work with marketing, design and the customer from the beginning of the design cycle. Better transitions to engineering samples or pilot phase can also be made. The engineering samples are very useful to conduct a manufacturability test. The more people aware of problem, the more people available to solve it. Given the right information, design and manufacturing people will devise unanticipated solutions because they know their part of work better than anyone else.

One practical way to overlap product development processes is to make clear that it is the responsibility of the down stream functions to ask for whatever information they need. By making this the standard operating procedure the downstream tasks will naturally get started sooner, compressing the whole development cycle. "To implement CE successfully, engineers down stream should know that having partial information is better than none and that the consequences of waiting for 'perfect' information may be far more severe than moving forward with imperfect data" (47). When implemented successfully the process overlapping, it offers potential for improvements in cost, quality, and delivery because it avoids many of the problems associated with the serial approach. Moreover, time, effort and money required to solve problems late in the project are saved and sub optimal designs and costly fixed, often produced by engineering change performed late in the project or after design release, are avoided.

7.2.4 Company Culture Dimension

The fourth dimension of the product development model (Figure 7.2) is the company culture dimension. "Company culture consists of the shared implicit and explicit assumptions that members make about what is legitimate behavior in the organization

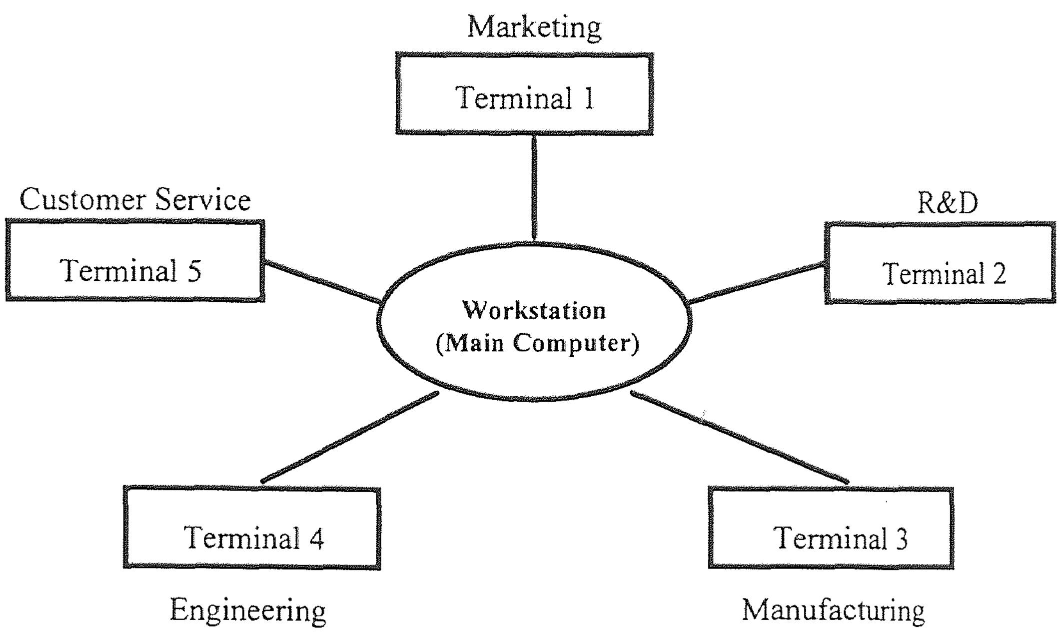


Figure 7.12 Concurrent engineering using information technology.

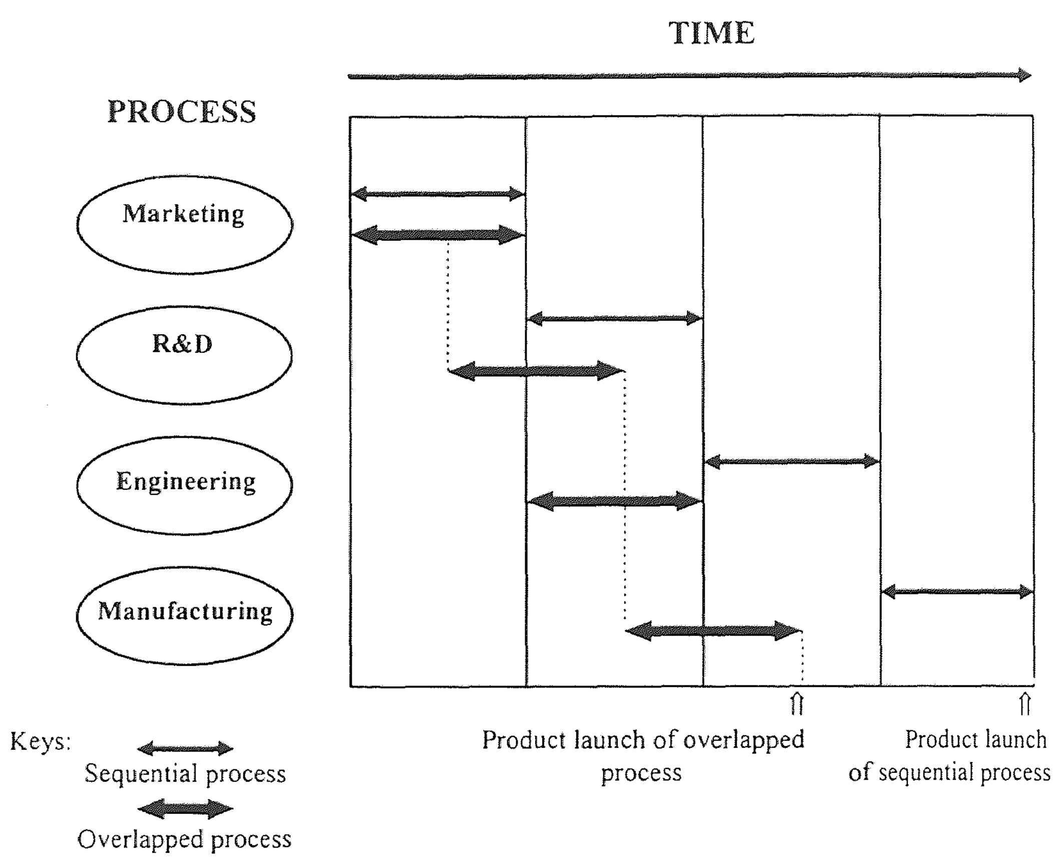


Figure 7.13 Process overlap using engineering sample.

marketing" (56). Since the culture includes not only such norms about how people should behave but also the values they are expected to hold, reorienting the culture must begin at the top. The characteristics of organizations that are believed to foster integration of organization members are organizational structure, leadership of top managers or project managers, reward or incentive systems, organizational culture, physical distances among teams, motivation and career paths. In general, the most innovative firms have clear core values that provide focus in a sea of diversity, and a common objective to which disparate professionals and divisions can agree.

a) Organization and company culture

Over specialization is a common characteristic within groups of design or manufacturing engineers, because each "field" is composed of a number of well-accepted subfields. For example, electrical engineers may be computer, power or printed circuit board (PCB) design engineers. Over-specialization, in turn, is characterized by an exclusive orientation to one's special skills or knowledge apart from the broader goals of the organization. This is the wall between the product design function and manufacturing function. For example, rigid functionally dominated organizational structures naturally lead one group of engineers to feel superior to another group based on the perceived importance of their collective contribution to the company's well being. Therefore, over--specialization and professionalization may negatively affect product development.

b) Reward and recognition

A fair and responsive salary system that reflects job value, capability, and performance is a basic necessity. It is essential that rewards be based on team, not individual, performance because the objective is to encourage teamwork. It may be worth considering a variable reward based on performance. For example, "the firm of Carrier Transicold, used a fast development team for their Phoenix semitrailer refrigeration unit. The team was highly successful, Carrier wrote up the project not just in its newspaper but also helped get in into a national engineering magazine. The parent company, United Technologies, then went further placed a full-page ads of photo with a photograph of the three team leaders in national publications, including the wall street journal" (46). The reward system should not only acknowledge what the team accomplishes but encourage others to do likewise.

c) Leadership

In selecting from the various possible organizational changes, management must understand and consider existing differences in culture among their marketing, R&D and manufacturing people. Bridging or developing new integrated cultures is essential for significantly improving the interface among functions. As within any company, senior managers should play a key role in preparing the culture of the company for changes, including those involved in creating a product development model. Senior managers are the people who must initiate the changes. They must be convinced of its merit to the point that they believe it is the best (however not necessarily the ideal) of all alternative designs. Senior mangers must not only show commitment but must stay involved: they must be very vocal and articulate in developing the concept and visions of the changes. Senior managers must prepare their employees for the culture shock of changing to a new product development model. People are used to doing things the way they've always done them in the past. Therefore, senior managers should motivate people to change and obtain the right resources.

CHAPTER 8

METHOD OF IMPLEMENTING THE NEW MODEL

The focal points of the new model for product development are cross-functional integration and phase overlapping using new product development team structure. Since this model involves new organizational structure and methods, the benefits of new product model will not be achieved until the participants are intellectually prepared for dealing with problems under different operating conditions. In order to build a sustainable, ongoing capability for an efficient product development model, an organization needs to make some fundamental changes in the way it operates, which needs to start at the top. Changes in organizational structure and product development process, changes in the role and responsibilities of every participant, and acquiring new technology, skills and competence will be required to effectively interact with product development team. Therefore, top management should encourage and support cross-functional interaction to keep the changes to the right direction. In the process of the product development practices change, *senior managers have to think of themselves as change agents.* Another critical resources in the new model are project leaders and project managers. They are forerunners and core person of the new model. Without their leadership and devotion to the new model, effective cross-functional integration cannot occur. Therefore, top management should select and motivate them. *Project leaders and project managers should be considered as a key resource in the new product development model by top management.*

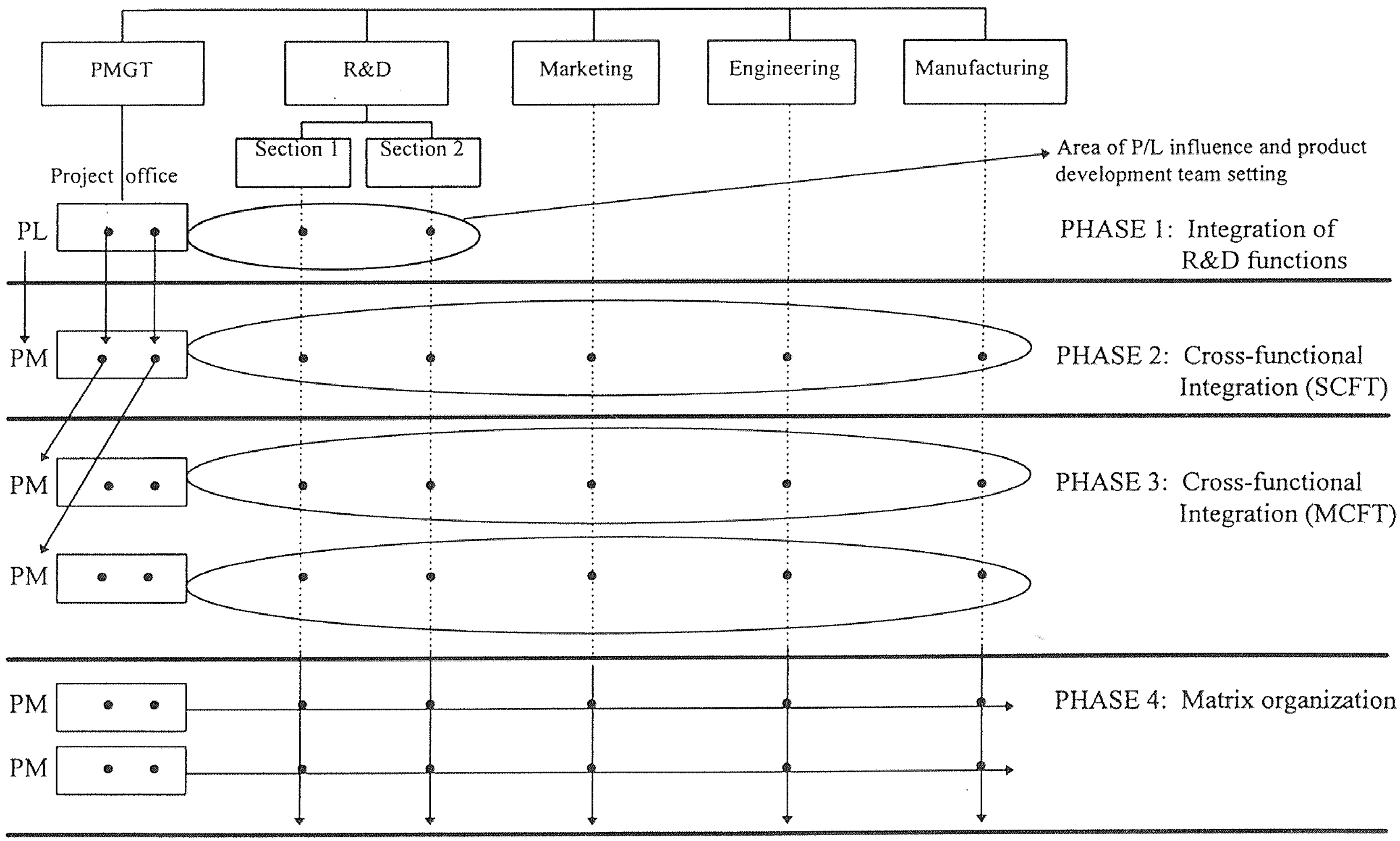
8.1 The Four Phases of Cross-Functional Integration

To implement cross-functional integration so that the product development team can successfully collaborate on the basis of teamwork, senior managers must prepare a step-by-step plan. Because Korean companies have had vertically integrated hierarchy structure, rapid changes to a cross-functional structure might be a cause of resist to adapt new model. There are four phases in the cross-functional integration development (Figure 8.1). To Korean companies, following the four phases is a desirable approach for changing their current hierarchical product development organization to a cross-functional integration.

In the following descriptions of these, Phase 1 concentrates on initiating cross-functional integration, Phase 2 deals with SCFT approach as a first cross-functional team activity, Phase 3 contains expanding cross-functional integration with MCFT, and lastly, Phase 4 contains a matrix organization that a vertically and horizontally well integrated flexible structure.

8.1.1 Phase 1: Project Office Set Up and Integrating of R&D Functions

The first phase of implementing cross-functional integration, involves project office setting, project leader selection, project office member selection and integrating R&D functions. R&D functions can be integrated by the project leaders and members. For example, in a electronic product development project, functionally separated two sections such as a hardware development section and a software development section can be integrated by the product or project base instead of its sectional functions of the company.



Keys : ·········· Weak relationship, ——— Strong relationship, PMGT: Project Management, PL: Project Leader, PM: Project Manager

Figure 8.1 Four phases of cross-functional integration development.

Senior managers should set a major product development project as cross-functional team project, and then must initiate phase one. Without the encouragement of senior management few persons are willing to become a project leader or project office staff. The project leader and project office staffs should be selected carefully by the senior managers. One of the selection criteria should be the commitment to cross-functional integration. Because the project leader and project office staffs are pushing to overcome natural resistance to changes, they often face serious difficulties. Senior management must create a culture of change that guides employees to make needed changes.

Since the goal of Phase 1 is to learn how to achieve effective cross-functional integration while learning new product development tools for the next phase, the authority given to the project leader is limited within the R&D department. This is the major difference of project leader's role compared to project manager's of other phases. On the other hand, the project office has two objective in Phase 1: to establish company vision and short term objectives of cross-functional integration and to handle transactions between functional sections within R&D department. The project office staffs support the project leader with scheduling, reporting and communication with project members. Therefore, members of the staff should be selected in a way that ensures this can work together with the project leader, members must be self-disciplined during this learning phase. Although, down stream functions (e.g., engineering, manufacturing, etc.) are not work together as team members from the beginning of the project, project leader and project office staffs should stimulate them to participate as early in the project as part of this learning process.

8.1.2 Phase 2: Horizontal Integration Using Single Cross-functional Team (SCFT)

In Phase 2, the cross-functional integration extends to the overall company structure with SCFT. As explained in Chapter 7, SCFT is formed as a multifunctional teams with full-time functional representatives. They maintain strong relationships with project manager during the project and return to their functional departments when the project is completed. In Phase two, since maintaining the consistency of the process transition to the cross-functional integration is critical for success, the project manager (former project leader in the Phase 1) and project office staff members should play the same role as they took the position in the phase one. They can then improve their cross-functional management skills and initiate cross-functional integration leadership.

During SCFT activity, the strong relationship between project leader and functional representatives is critical to achieve project goals. If the project manager cannot maintain strong relationship with the representatives of the functional areas, the necessary cohesive teamwork of the project members will not occur. In such a situation cross-functional integration hardly occurs. One way to maintain strong relationship is to locate functional representatives in a place with project office members. If the functional representatives work together with project office members from the beginning of the project, the integration level can be improved. Another way to maintain strong relationships is by having project manager share functional representatives performance and promote evaluation..

Project managers and office members should lead SCFT members with clear team objectives and well designed product development schedule. They also must stimulate down-stream functional areas to participate in product-design phase with new product development tools such as QFD and CE.

8.13 Phase3: Horizontal Integration Using Multiple Cross-Functional Teams (MCFT)

The next step in the evolution of cross-functional integration is MCFT. As explained in Chapter 7, MCFT includes two or more project leaders and project offices. The selection process for project managers is not an easy one. It is senior management responsibility, because the project manager is delegated the authority of the general manager to cut across organizational lines. The selection of project managers is based as much on personal characteristic as on technical qualifications. The desired personal characteristics are (26):

- Flexibility and adaptability
- A generalist rather than a specialist
- Aggressiveness, confidence, persuasiveness, verbal fluency
- Effectiveness as a leader, communicator and integrator

Project nmanagers can be selected from among the project office members who experienced the cross-functional team in the Phase 1 and 2 of process development. During what they work with project leader, they should have gained experience in how to motivate teams and build effective teamwork to accomplish project goals. Conflicts may occur between project managers and functional managers or between project managers as two or more projects are conducted concurrently. Conflict resolution skills are an important factor for cross-functional integration. Project managers in Phase 3, should frequently negotiate with functional managers and cooperate with each other when conflicts occur on resource allocation or project priority.

One good practice for project managers is to maintain effective communication with all organizational levels regarding both project objectives and decisions. Also helpful in managing conflict are effective project planning, contingency planning, securing of commitment, and involving top management. Throughout Phase 3, cross-functional integration extend to all related functions in a business unit.

8.1.4 Phase 4: Matrix Organization

If a company complete Phase 3 successfully, significant changes such as product development process overlapping, cooperative problem solving, and project management practices have already occurred in a product development environment. This learning will lead the company get to establish a successful product development environment.

However, because MCFT dose not share its resources with other project teams, senior managers suddenly recognize resource allocation problems as company's product development projects are diversified. Now the company requires more efficient product development organization that can share company resources. In the matrix organization, each individual may handle more than one projects and report to several project managers and to their functional manager. These are the fundamental differences from SCFT or MCFT where functional representatives engaged in only one project as a full time member and maintain strong relationship with project manager throughout the project.

The goal of matrix organization is not only to share resources but also to lead project teams to a vertically and horizontally balanced organization. However, as shown in Figure 7.3, matrix organization has the highest communication complexity among the cross-functional integration structures. These fundamental aspects of the matrix organization become a cause of severe problem if it is not effectively controlled by the project manager. In a matrix organization, functional managers must share many of the decisions with project managers or other functional managers at his level. A matrix structures require dual sign-offs on subordinater's performance evaluations and related pay and promotion decisions. Even when this is not so, consultation on these matters among managers is essential for the effective functioning of the matrix organization. Thus, for the functional manager, a matrix organization is often experienced as involving a loss of status, authority, and control. They have to segment their work along product lines, not functional lines, and they must willing to establish communication channels with product management units.

8.2 Transitional Management

To achieve success in the new product development model, good transitional management is required. Transitional management is the art and science of managing the conversion period from one organizational design to another. Transitional management necessitates an understanding of the new goals, objectives, roles, expectations, and the change related fears of the employees involved. *It is the responsibility of the top management to overcome such fears and stimulate creativity and the desire to achieve in line with corporate object.*

8.3 Company Vision

A vision of the future of an organization is necessary for change to occur. Such a vision not only serves the purpose of energizing change but also provides a model toward which employees and managers can work. The vision should reflect the multidimensionality of organizations and should specify hard aspects of organization design, strategy, structure, and systems, as well as the soft elements of style, staff, skills, and culture.

8.4 Senior Manager's Role in the Product Development Practice Change

Senior management's leadership and support are crucial to sustaining any significant improvement in product development practice. Unless senior management is truly determined to change the product development organization -- and exhibits this commitment publictly--little can be done by lower-level managers and workers to improve product development process. In a company with an effective product development process, senior managers neither design the product or the process, create the marketing plan, nor solve the technical problems on individual projects. Instead *they identify, educate, and develop leaders and project teams. They establish company strategies and support good product and process ideas.* They connect their individual activities on projects to the challenge of building teams capability in the organization as a whole. In the process of the product development practices change, *senior managers have to think of themselves as leaders in changing.* In order to build a sustainable, ongoing capability for efficient product development model, organizations led by senior management often must make some fundamental changes in the way the operate, which needs to start at the top.

The team and those who interact with them will thus be learning by trying new approaches, which will sometimes result in mistakes. Mistakes unavoidable play an important role in transition to new product development model. Product development is a continual process of learning, and to learn requires making some mistakes. To make quick transition, the goal should be fast mistakes rather than no mistakes. Top management must support and encourage this viewpoint. Once the senior managers are clear on what they are want to achieve with new product development model. This message needs to be spread all the way to the shop floor and the R&D lab. Because the objective is to transform the organization into adopting a new mode of handling development projects, senior managers should watch for and encourage desirable changes in behavior.

8.5 Switching from Engineer to Project Leader or Project Manager

Perhaps the first managerial concerns within the technical hierarchy occur while an engineer is serving as a project leader or project manager on an important company assignment. It is often observed in Korean companies that a young college graduated engineer reaches the position of project leader in 7 or 8 years. Author's experience for several years in R&D department of an electronic product manufacturing company in Korea have convinced him that newly promoted project leaders have experienced difficulties in managing their team members. The engineer is accustomed to basing his decisions on the theorems and principles governing the behavior of the physical world. When it comes to coping with human, nature, however, the engineer often finds few rules to fall back on. The transition from engineering to administration can be made even more difficult by the underdeveloped interpersonal skills of the newly appointed project leader. In the past few resources have been provided by Korean companies to train future project leaders and then realize that their role never will differ from the role of an engineer. As explained in previously, since the leadership of project leader or project manager is critical to implement the new model in the Confucian-based Korean culture, training programs for new project leader or project manager are necessary to introduce accomplish a project in the newly developed structure whether SCFT, MCFT, or matrix organization. Training in basic management functions covers the principals and techniques of supervising, planning, organizing and evaluating and training in administrative and interpersonal skills are appropriate. Training programs based solely on lectures, discussions and readings will not be sufficient. Engineers and scientists must have an opportunity to test the management practices under realistic conditions before making a final commitment to management as a career. Project assignments with significant managerial responsibilities, membership in venture teams, rotational assignments, and participation in task leadership groups are examples of how prospective managers can learn by doing. *One of the most practical training is on-the-job training in the project management office.* A pool of young engineers or project manager candidates may work for a particular project manager as an on-the-job training.

CHAPTER 9

CONCLUSION

The high-tech market is characterized by market uncertainty and accompanied by rapid changes in technology. Hence, high-tech companies must create their own unique set of product - development practices to survive in this risky market environments. It is true that product - development practices vary depending on company strategy, culture and technology; however, cross functional integration in the product - development process is a necessary and effective management responsibility in every case. Integration can actively stimulate the product - development environment to compete in risky high-tech markets. Effective integration improves the company's product development process and results in shortened development cycles, successful transformation of research results to production, successful marketing, productivity improvement, innovation project success, and high-quality problem solutions.

There are two key integration approaches depending on market uncertainty and technology uncertainty. One by integrating marketing and R&D, while the other includes integrating R&D and manufacturing (or engineering). If the technology is new and the target market is highly uncertain, then strong integration between R&D and marketing is required. On the other hand, if the technology is more certain and the market is stable then strong integration between R&D and manufacturing is required. In a certain product development environment, reducing time to market is a critical competitive advantage.

An important way for integrating key functions is the organizational approach. In this sense, Korean high-tech companies' current product - development practices have disadvantages in international market. Their current product development practices were formed during past stable and certain business environments that included a protected home market, various government supports, and an OEM export policy. It is characterized by strict hierarchical organization, time-consuming sequential product-development process, and indirect marketing following OEM. These are not long-term advantages in highly competitive international markets.

One of the principal challenges to Korean high-tech companies is to improve their current product-development practices for inducing innovations in technology and product. Korean high-tech companies can change their product development environments if they can achieve changes in the four dimensions of product development: product-development process overlap, organization structure, product-development tools, and company culture. Changes should occur concurrently across the four dimensions in the process of implementing the new model. If changes occur inappropriately, the company's product-development practices may not be effective in the uncertain and rapid changing high-tech markets.

Since the suggested product-development model includes organizational change, a step-by-step approach is desirable in the Korean context. The step-by-step approach consists of four phases to develop cross-functional integration in a company. Phase 1 starts with top management's initiative to cross-functional integration. A project leader and project office staffs are then selected by senior management. Developing detail plan for company-wide cross-functional integration and learning for new practices are the major concern in Phase 1. Cross-functional integration is thus limited to R&D for these reasons. In Phase 2, the cross-functional integration is expanded across all functions by introducing a SCFT (Single Cross-Functional Team) structure that has one project goal and full time functional representatives. In Phase 3, the cross-functional integration is expanded to all projects and therefore at least two or more projects are concurrently managed in the MCFT (Multiple Cross-Functional Teams) structure. In Phase 4, project management is conducted in a vertically and horizontally well balanced matrix organization. In this final phase, functional representatives may handle two or more projects in their functional departments, hence project managers and functional managers should share communication channels and information with each other.

The changing of organizational or product-development practices is a burdensome challenge to senior managers; however, without their initiative and leadership, significant changes cannot occur in an organization. Top management should be patient and take risks during transitional management. And they should recognize that organizational change in the process of redesigning product development practices requires time and continuous learning.

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