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Author(s): D. Yuwono

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Abstract: This report studies management of new product development. A mail survey was developed to assess current trends in the management of new product development, activities in development process, and major factors that contribute to success in management of the process in high tech industry. The survey results are analyzed and compared to historical theoretical approaches. Suggestions and topics for future projects are presented.

A STUDY OF SUCCESSFUL MANAGEMENT OF
NEW PRODUCT DEVELOPMENT IN HIGH
TECH INDUSTRY

D. Yuwono

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Dharwin Yuwono
Engineering Management Program
Portland State University

TABLE OF CONTENTS

EXECUTIVE SUMMARY

ABSTRACT	1
INTRODUCTION	2
THEORETICAL BACKGROUND	4
Success Definition	4
Background	5
Literature Search Review	6
THE SURVEY	11
Methodology	11
Survey Results	12
DISCUSSION	24
SUGGESTIONS	34
RECOMMENDED FUTURE PROJECTS	36
CONCLUSIONS	37
APPENDIX I: Survey Instrument	
APPENDIX II: Survey Instrument Tabulation	
APPENDIX III: Survey Instrument Summary (A)	
General Information	
Sorted General Information	
Graphical Representation of Sorted General Information	
APPENDIX IV: Survey Instrument Summary (B)	
Types of Positions of Respondents	
APPENDIX V: Survey Instrument Summary (C)	
Organizational Structures of New Product Development	
BIBLIOGRAPHY	

**A STUDY OF SUCCESSFUL MANAGEMENT OF
NEW PRODUCT DEVELOPMENT IN HIGH TECH INDUSTRY**

EXECUTIVE SUMMARY

In high tech industry, the management of new product development is very important for maintaining and developing the short-term and long-term competitiveness of companies in vulnerable situations. The situations include rapidly changing technological environments, shortened product life cycles, changing customer value systems, and increasing domestic and global competition.

This project is a study of management of new product development. A mail survey was developed to assess current trends in the management of new product development, activities in the new product development process, and major factors that contribute to success in management of new product development in high tech industry.

The respondents were from the Portland, Oregon/Vancouver, Washington metropolitan areas. The size of the sample of this survey was 300 individuals from high tech companies. The response rate of this project was 12.7%. Similar surveys typically have shown response rates from 5% to 15%.

The results of the survey were analyzed and compared to theoretical background, and discrepancies between them identify topics for future projects. The results show current trends and suggest some trends in the future. A discussion of results and suggestions for successful management of new product development are presented. Topics for future projects and conclusions complete the project.

ABSTRACT

This project is a study of management of new product development. A mail survey was developed to assess current trends in the management of new product development, activities in new product development process, and major factors that contribute to success in management of new product development in high tech industry. The survey results are analyzed and compared to theoretical background. Suggestions and topics for future projects are presented.

INTRODUCTION

This project is done to fulfill the requirement of the degree of Master of Science in Engineering Management at Portland State University.

In high tech industry, the management of new product development is very important for maintaining and developing the short-term and long-term competitiveness of companies in vulnerable situations. The situations include rapidly changing technological environments, shortened product life cycles, changing customer value systems, and increasing domestic and global competition.

The purpose of this project is to assess current trends in management of new product development, activities of new product development process, and major factors that contribute to success in management of new product development in high tech companies.

The methodology used is a combination of literature search and a mail survey. The literature search was conducted mainly to find recent accounts of successes and failures associated with the management of new product development. The literature search had yielded seven books and 28 articles from periodicals that provided relevant information about this topic. The mail survey was developed to gather information about current practices of management of new product development in high tech companies.

The mail survey was developed to access the respondents from the Portland, Oregon/Vancouver, Washington metropolitan areas. The size of the sample of this survey was 300 individuals.

The backgrounds of the respondents were from machinery, electrical and electronic equipment, transportation equipment, instruments, computer manufacturing industries, software businesses, and consulting firms. According to the functional categories, the respondents were R&D, engineering, manufacturing, marketing, general management, and support personnel. Support personnel provide functions other than those stated above, such as human resources, strategic planning, and financial.

The response rate of this project was 12.7%. Typical similar surveys have shown response rates from 5% to 15%. The returned surveys were categorized into functional areas of respondents and types of new product development organizational structures. The analysis of this project is qualitative and quantitative, and the outputs are suggestions and topics for future projects.

Many thanks to Dr. Dundar F. Kocaoglu for facilitating and directing this project; to Carrie Lee Valkama for editing and facilitating; to Fred Forstner for proofreading; to Lina Jahja for supporting and motivating; to all of the respondents for participating; also to Hogan K. Lim, Agung D. Rachwan and other colleagues for helping the completion of this project.

THEORETICAL BACKGROUND

Success Definition

One of the objectives of this project is to evaluate whether current practices in the companies are successful. The author considers the new product development project to be successful if it provides adequate short-term and long-term corporate growth, achieves corporate financial goals, and attains an adequate relative market share.

A company's growth projection or growth rate is estimated according to whether its growth is faster or slower than that of the economy as a whole. A high growth company has more competitive advantages and better long-term prospects than a slow growth company.

Financial goals refer to the surplus of internally generated funds over expenses. A positive cash flow enables a company to finance new projects or other investments (such as new product development projects and new businesses), and to reinvest to improve existing product lines for the sake of long-term competitiveness and growth of the company.

Relative market share is the ratio of a company's market share to the largest competitor's market share in the same industry. High market share provides cost advantages from economies of scale and experience curve, in addition to favorable product positioning.

Eventually, in term of performance, successful new product development has to include the dimensions of speed, cost, flexibility, quality, product differentiation, profitability, and customer value [19].

Background

Today's management faces the dilemma of product innovation, where there is more pressure to develop and introduce more new products, but the risk of new product failure is very high [9]. Booz-Allen and Hamilton states that firms expect new product growth from 33% to 40% of total corporate sales in the 1980's, and that the number of new products launched to the marketplace will double [3]. But, new product failure rates are estimated to be about 33% of the new products launched [9]. However, the rate of the failure is estimated by other sources to be as high as eight or nine out of ten products introduced to the market, even though over the last five years, R&D spending has increased at an average 14.4 percent per year [5].

The rapidly changing technological environment, shortening product life cycles that makes existing product obsolete earlier, changing customer value systems, increasing domestic competition from foreign competitors, and increasing global competition are becoming the major external environments of companies managing new product development. These environments are very vulnerable and influential in the success of management of new product development in high tech companies.

Takeuchi and Nonaka describe the challenge: "The rules of the game in new product development are changing. Many companies have discovered that it takes more than the accepted basis of high quality, low cost, and differentiation to excel in today's competitive market. It also takes speed and flexibility." [19]

The comments above suggest that the problems and risks associated with new product development are intensifying along with the pressures and desires to develop more new products.

Overall, companies have to be more alert in selecting new product development projects. Also, companies must manage new product development processes effectively and efficiently, from idea acquisition through to product introduction.

Literature Search Review

There are some fundamental reasons that companies should adopt new product development strategies [5]. One reason might be due to increasing global and domestic competition. Another reason is that many of a company's products are in the maturity or decline stages of their product life cycles. Also, if there is excess capacity of a company's production tools and facilities, new products should be considered. New laws or legislations may force a company to consider new product development strategy. Excess cash flow from a mature industry may require a company to diversify into new market for the sake of long-term growth, in which case the company also will need to implement new product

development strategy. In addition, new product development may be required due to technology push. The most valid reason is to increase profit of the company.

Kotler in his book, Marketing Management, notes the most common strategies carried out by major companies, which are: "defend market share position, establish a foothold in new market, preempt a market segment, maintain position as product innovator, exploit technology in new way, capitalize on distribution strength, provide a cash generator, use excess or off season capacity." [25]

Success in management of new product development is not a unidimensional concept, however it needs a multidimensional measurement of success. Cooper and Kleinschmidt have done a study about the parameters whereby new product success is measured. They identify three independent and strong dimensions that characterize new product performance, namely financial performance, opportunity window, and market impact [9].

Gupta and Wilemon have done a study about accelerating the new product development cycle. They offer with six reasons for product development delays: "(1) poor definition of product requirement; (2) technological uncertainties; (3) lack of senior management support; (4) lack of resources; (5) poor project management; (6) poor manufacturing." [19]

In terms of implementation, the activities in new product development process have significant impact on the success of management of new product development [2,4,8,10,11,30,37]. Cohen in his book, *The Practice of Marketing Management*, reveals that the new product development process consists of seven major activities [5]. And, Kotler introduces the new product development process having almost similar activities, consisting of eight major activities [25]. In their recent study, Cooper and Kleinschmidt attempt to bridge the research and practice gap. Here the new product development process, as a process guide for new product managers, is broken down further into 13 chronological activities [8]. Both also suggest that the proficiency of up-front activities or pre-development activities are crucial to new product success.

Previous studies have found that many factors can contribute to the success of a new product development. A recent study done by Link is one of them, where 19 variables were considered likely to be important determinant of successful new product development projects [28]. Link concludes that the six most important success variables are: "(1) new product synergy with existing marketing skills; (2) new product synergy with existing technical and manufacturing skills; (3) high product quality; (4) product offered significant user benefits; (5) appropriate targetting and pricing strategies; (6) distribution channel support." [28]

In another study, Cooper and Kleinschmidt conclude ten factors that separate new product winners from losers: "(1) existence and quality of "protocol"; (2) product advantage; (3) effectiveness of pre-hardware activities; (4) effectiveness of technological activities in new product process; (5) synergy with firm's marketing strengths; (6) synergy with firm's technology strengths; (7) effectiveness of marketing activities in new product process; (8) top management support; (9) market potential; (10) market competitiveness." [10] Here, protocol is defined as a statement before product development identifying a well-defined target market; specifies customers' needs, wants and preferences; defines product's specifications and requirements; and carefully states what the product would be and do. [9]

Booz-Allen and Hamilton also identifies seven factors that contribute to the success of new products: "(1) structure of new product organization; (2) favorable competitive environment; (3) use of new product development process; (4) top management support; (5) technological superiority of product; (6) product fit with internal functional strengths; (7) product fits with market needs." [3]

Some other relevant studies also reveal similar outputs. Berkowitz, Kerin and Rudelius describes six fundamental reasons for new product failure [1]. Smilor defines five factors in product success and seven factors in product failure [34]. Crawford's study also points out eight factors that contribute to failure [12].

Gupta and Wilemon, in their study, also state with the current major concerns during the new product development process: "(1) management and organizational style; (2) lack of attention to details; (3) limited support for innovation; (4) lack of strategic thinking; and (5) poor manufacturing." [19]

Those literature knowledges, above, provide background and direction to this project. The next part will discuss more about the survey and its results.

THE SURVEY

Methodology

The methodology of this project to a large extent follows those of Link [28], Cooper [8], Cooper and Kleinschmidt [9-11], and Gupta and Wilemon [19], except there were some updates and modifications of those studies, in this project. Also, the perceptions of the respondents on the importance of each item in the questionnaires were measured.

In other words, this project measures the perceptions or assessments of the respondents in answering the questionnaires, updates past studies mentioned above, making some modifications, by taking advantage of opinion from text books and recent articles about this subject. Then the author analyzes the summary of the surveys, makes suggestions, identifies related topics for future projects, and draws conclusions.

The survey instrument was developed to support a two-quarter project (Winter and Spring Terms 1990), which is utilized to assess current trends of management of new product development, activities of new product development process, and major factors that contribute to success in management of new product development in high tech companies. The survey instrument consisted of 10 questions. A copy of the survey instruments is provided in Appendix I, along with the cover letter.

Survey Results

Thirty-eight questionnaires were returned out of 300 questionnaires, which were sent to key personnel in high tech companies around Portland, Oregon and Vancouver, Washington metropolitan areas. Each individual response is tabulated in Appendix II. All responses are summarized in Appendix III in two ways; one according to the items in the questionnaire and one sorted in descending order, in addition to graphical representations.

All survey responses are categorized by the functional positions of respondents (Appendix IV) and by the organizational structures of the new product development (Appendix V). The sorted data summary in Appendix III then will be referred as the general case. The trends of the survey results are presented and discussed in the following paragraphs.

For the general case, the functional positions of the respondents in their companies, from the most to the least amount, are:

- General management (37.8%)
- Engineering (35.1%)
- Manufacturing (8.1%)
- Marketing (8.1%)
- Support (8.1%)
- R&D (2.7%)

General management positions consist of executive vice president, COO, division manager, director of operation, general manager, president, vice president of operations, and SBU manager. Engineering positions consist of engineering manager, director of engineering, vice president of engineering, manager of

engineering test and research, design engineer, and project engineer. Manufacturing positions consist of product plan manager, director of corporate quality, and vice president of manufacturing. Marketing positions consist of vice president of marketing, and vice president of marketing and sales. Support positions consist of vice president of strategic planning, vice president of human resources, and vice president of strategic planning and product management.

For the general case, the measures of effectiveness for achieving successful management of new product development in the last five years, ranked from most to least successful, are:

- Market share
- Growth rate
- Financial goals

For the organizational structures of new product development, most structures have the same trends. The matrix structure is an exception; it attains high financial goals, then company growth projection/rate, and market share objectives.

For the general case, the following organizational structures are utilized for new product development projects. They are listed from most to least prevalent:

- Project structure
- Hybrid structure
- Functional structure
- Matrix structure
- Other structure

"Other" structure includes the imbalanced matrix structure, which emphasizes more on functional rather than balance of project and functional, and also includes teamwork.

For the general case, the one who is responsible for the new product development process, from most to least prevalent:

- Other
- New product team
- Product or program manager
- New products manager
- New product committee
- New product department
- Intrapreneurs

The functional structure shows an interesting trend in that new product team is dominantly responsible. The trend for the rest of the structures parallel general case. "Other" consists of engineering department, process and equipment engineering and R&D, vice president of engineering, corporate quality department for the new product development process and project managers for individual projects, general management team, president, and vice president of operations.

For the general case, the main causes of delays in the new product development process, from most to least important, are:

- Inadequate product definition
- Lack of resources
- Communication barriers between R&D and marketing
- Other
- Communication barriers between engineering/manufacturing
- Organization structure
- Communication barriers between R&D and engineering
- Communication barriers between manufacturing/marketing
- Use of old technology

All organizational structures and most types of positions suggest that inadequate product definition and lack of resources are the main causes of delays. Among functional positions, the support position perceives a slight variation for inadequate product definition, where it is ranked as moderately important. The general management positions show inadequate product definition

and "other" as the main causes. "Other" includes difficulty in assigning priority between new products and current product production, development of key components, lack of good estimating tools and database of prior projects, actual customer application needs, pushing state-of-the-art, underestimating the size of the task (especially integration and test), inadequate project planning and management, conflict with other high priority work in process, lack of structure/process, and technological problems related to new technology.

For the general case, the emphasis placed on each stage/activity of the new product development process, from most to least significant, are as the following activities:

- Product development
- In house product testing
- Preliminary technical assessment
- Idea acquisition
- Concept development and testing
- Production start-up
- Customers tests of product
- Product introduction/commercialization
- Business/financial analysis
- Preliminary market assessment
- Initial screening
- Development of marketing strategy
- Detailed market study/market research
- Trial production
- Test market or trial sell
- Pre-commercialization business analysis
- Other

The findings tend to agree with the literature. The literature indicates that areas needing more emphasis were initial screening, detailed market study, pre-commercialization business analysis, and business/financial analysis. From the findings, it seems that in the future the emphasis should be on the following

activities: preliminary technical assessment, initial screening, development of marketing strategy, detailed market study/market research, trial production, test market or trial sell, pre-commercialization business analysis, and "other".

All organizational structures and all types of positions respectively perceive that their organizations follow trends as of the general case. "Other" includes transition of the customer from one version to the next, and program/project planning. One interesting comment from a respondent: "Any choice other than high at each stage would suggest that a company is bringing new products to the market in a vacuum! Each item listed is critical to the success of a new product and must be emphasized accordingly!"

For the general case, the activities of new product development process, from the most to the least time consuming, are:

- Product development
- Production start-up
- Concept development and testing
- Customers tests of product
- Detailed market study/market research
- Product introduction/commercialization
- In house product testing
- Idea acquisition
- Development of marketing strategy
- Preliminary market assessment
- Test market or trial sell
- Trial production
- Preliminary technical assessment
- Business/financial analysis
- Other
- Initial screening
- Pre-commercialization business analysis

All organizational structures and most of the type of positions follow the same trend as the general case. The general management position is an exception; it perceives product development and detailed market study or market research as the most time consuming activities. "Other" includes transition of the customer from one version to the next; and program/project planning.

For the general case, the activities of new product development process, from most to least costly, are:

- Product development
- Production start-up
- Product introduction/commercialization
- Concept development and testing
- In house product testing
- Customers tests of product
- Detailed market study/market research
- Trial production
- Test market or trial sell
- Preliminary technical assessment
- Preliminary market assessment
- Development of marketing strategy
- Business/financial analysis
- Idea acquisition
- Pre-commercialization business analysis
- Initial screening
- Other

All organizational structures and most types of the positions tend to correspond with the trend of the general case; with an exception is general management, which perceives product development and customers tests of product as the most costly activities. General management also makes an exception for the most time consuming activities. Noted here, the most time consuming activities, which are product development and production start-up, are also the most costly activities.

For the general case, the following sources of new ideas are used to acquire new product ideas. They are listed from most to least often:

- Customers
- Marketing department
- Competitors
- Sales people
- R&D department
- Engineering department
- Top management
- Middle management
- Inventors
- Consultants
- Channels of distribution
- Manufacturing department
- Suppliers
- Publications
- Market research firms
- Universities
- Other
- Advertising agencies
- Commercial labs
- Patent attorneys

All organizational structures and all types of positions within these structures perceive a trend parallel to the general case, that the most frequent sources of new product ideas come from customers, marketing department, competitors, sales people, and R&D department. "Other" consists of everyone in plant by a suggestion form, acquisition of other companies, and shop personnel.

The findings show that there is a growing trend to take advantage of customers, market research firms, acquisition of other companies, also commercial labs.

For the general case, the major factors that contribute to success of new product development, from most to least important,

are ranked as following:

- Satisfactory product quality to customers
- Product fits with market needs
- Good timing
- Top management commitment
- Product offers significant benefits
- The NPD project is well managed
- Product compatible with technical & production capability
- Appropriate pricing
- NPD fits to company's missions and culture
- Product creates new markets or expands existing markets
- Adequate sales force effort
- Adequate promotion and advertising
- Product is compatible with current marketing skills
- Being first in the market by faster NPD
- Adequate market research
- Product is novel/technologically superior
- Product requires little change in users attitude/behavior
- Appropriate distribution channels
- Anticipated market conditions
- Favorable competitive environment
- The target market is large and rapidly growing
- Good structure of new product organization
- It is not innovation; it is incremental improvement
- Adequate stock availability
- NPD process is internal and external development
- It is adaptable, can be used for many industries
- Other

The findings strongly support the information found in the literature. Hybrid structure suggests that being first in the market is also a major factor for success. "Other" structure shows that major factors for success include: product requires little change in users attitude/behavior; adequate promotion and strategy; the target market is large and rapidly growing; favorable competitive environment; and the new product is adaptable, can be used in a wide range of different industries. Matrix structure points out that the major factors include: product creates new markets or expands existing markets; NPD fits to company's missions and culture; and appropriate pricing. Functional and project structures suggest the same trend as that of the general case.

Most types of positions perceive the same trend as that of the general case. Manufacturing positions perceive the major factors also include: product is compatible with current marketing skills, and products create new markets or expands existing markets. One interesting comment is that it is better to use "second to the market" strategy than to be first in the market.

For the general case, the key factors for successful new product development, from most to least significant, are:

- Market potential
- Existence and quality of "protocol" (*)
- Product advantage
- Synergy with company's marketing strengths
- Top management support
- Synergy with company's technology strengths
- NPD fits to company's mission and culture
- Effectiveness of technological activities in NPD process
- Effectiveness of marketing activities in NPD process
- Market competitiveness
- Effectiveness of activities before product development of the NPD process
- External sources; have relationship with other companies
- Other

(*) Protocol is defined as " a statement before product development that identifies a well-defined target market; specifies customers' needs, wants, and preferences; defines product's specifications and requirements; and carefully states what the product would be and do."

These results support the information from the literature. All organizational structures and most types of positions perceive the same trends as that of the general case. Interestingly, engineering positions assess the list, from most to least important, as the following: product advantage, top management support, market potential, existence and quality of "protocol"; synergy with company's technology strengths.

"Other" includes criteria such as: has the market been developed?; should the market be developed?; is the technology available?; will the customer buy it?; key customers contact (pareto rule 80/20, where 20% customers = 80% of sales; who are the 20%?); and the project teamwork composition.

For the general case, the current significant issues in new product development process, from most to least important, are:

- Top management support
- Composition of the product development team
- Attention to details
- Communication channels
- Support for innovation
- Product fit with internal functional strengths
- Strategic thinking
- Organizational structure
- Level of technology
- Management styles
- Other

These findings support the information from literature. All structures and all types of positions have a trend parallel to the general case. "Other" includes what customers' needs. In this case, "other" only had one response, although the value of the mean is the highest of all it is not reliable, so the author consider "other" to be the least significant item.

One respondent gives an interesting comment about the significant issues for new product development process, he points out the five major issues as the following: "The issue here is that ideas are very sensitive and personal things. The key to success is to nurture the team for ideas and manage it well. Five most significant issues are: (1) strategic thinking includes good

product planning, know what you want to do; (2) composition of the product development team, the right people make the team work; (3) support for innovation, support those key ideas required to make the product work technically, marketing and manufacturing; (4) pay attention to details; (5) top management must be committed to the entire ideas."

Additional comments about this project are:

"The most successful companies with successful products are those who listen and react to their customers' needs. Product definition is absolutely critical to the new product development process, and that phase must be a partnership with a number of common customers. Once there is a strong feeling that concensus has been achieved, the product ERS (External Reference Specification) is locked up and the new product development process begins!"

"There has to be a need or the need must be created."

"The forklift business is a mature market. New opportunities arise through product differentiation and innovation. Buyers are very price conscious, and there is heavy discounting. It is important to be able to respond quickly to subtle market changes. Product development teams must be formed early in the concept phase in order to develop precisely the product needed in the marketplace."

"NPD at ██████████ Corp. is currently being revamped with more emphasis on market research and project manager training."

"The success of a new product development is wholly dependent upon the focus it gets from all levels of the company. Top management must understand and support the product to focus resources. Marketing must focus research and customer input on the problem to be solved. Engineering must focus its skills and time on the problem in order to achieve timely results. Manufacturing must be involved at the outset of the project in order to focus process and test development for the product. Sales must be given data and tools that allow them to focus on the right customer and the right customer problem to be solved."

Overall, the results of the survey are making sense. They are within the range of the expected feedback/response outcomes, some are supporting the literature knowledge and some are providing slight variations that may suggest the trends of management of new product development in the future.

DISCUSSION

The following is a further discussion of the findings of the project.

The level of innovativeness in a company is likely to affect the perceptions of the respondents in responding to the questionnaires. The more innovative the companies are, the more dependent is success on the existence of the rapidly changing technological environment and demand, the product uniqueness, and the rapidly growing market.

Highly technology-based companies, which utilize their technological advantages to create the market opportunities in related areas, tend to expand by internal venturing; i.e., new product development rather than acquisition. There are some successful companies that expand based on internally generated innovation, for example 3M, Du Pont, IBM in PC market, Compaq Computers, etc.

New product development usually begins with R&D. A company should communicate the missions, objectives, goals, and strategies of the company to its engineers and scientists in order to ensure the common visions between the company and the personnel. This provides the pathway to undertake research in the areas which are relevant to a company's missions, objectives, goals, and strategies. Following these, the link of communication between

R&D and marketing personnel should be provided and enforced, so the researchers can be directed to the needs of the market. Also, the communication link between R&D and manufacturing should be emphasized, so the company can ensure that it is able to manufacture any proposed new product idea. It shows the importance of horizontal integration among different functional areas.

In terms of implementation, many companies achieve integration among different functions by utilizing teamwork or project team and matrix structure. As the organization progresses, in the organizational life cycle, there is a movement toward teamwork for better horizontal coordination.

From the findings, in term of financial goals, the matrix structure seems to be more successful than the others. Ironically, matrix structure, whether balanced matrix or functional matrix or project matrix, is the least utilized of all the structures.

Matrix structure has been carried out by many technology-based companies so far. As many of them find that it is hard to maintain a balanced matrix structure, where functional manager and project/program managers have equal authorities and responsibilities. In reality, many of them tend to emphasize either functions or projects rather than striking a balance with equal emphasis on both the functions and projects. As a result

they implement a functional matrix or a project matrix structure instead of a balanced matrix structure. The conflict between the functional and project/program managers in a matrix structure certainly exists, but the level of the conflict should be controllable.

Teamwork or project teams consist of personnel who represent various functional areas. The main task of the team is to oversee the new product development project. By adopting parallel processing, the team is able to significantly reduce the time for new product development. For example, as the R&D personnel are developing the product design, marketing personnel are developing the marketing plan, and manufacturing personnel can be developing the process design, facility planning and capacity planning. Compaq Computers successfully utilizes project teams to oversee the new product development process. By achieving high integration among different functional areas, Compaq only needed six months to introduce its first portable PC, from idea acquisition to product introduction/commercialization.

Findings indicate that in the functional structure, the new product team is primarily responsible for the new product development process. For the functional structure, the coordination among different functional areas is a major issue. In this perspective, the advantages of teamwork seem to be strongly recognized by the functional structure.

In terms of implementation of new product development, functional structure pursues internal efficiency and technical quality. Project structure pursues external effectiveness, adaptation to changing organization environment and customer satisfaction. Matrix structure pursues external effectiveness, adaptation to changing organization environment, customer satisfaction, product innovation, and technical specialization. A matrix structure provides efficiency within some functions despite conflict between functional and project managers and shared of authorities between both managers. Hybrid structure refers to the combination of those three structures [14].

High tech companies tend to pursue the strategy of product differentiation through high quality and good service. This leads to fewer hierarchical levels and more decentralized decision making in order to meet customers' demands faster and more flexibly. Here, top or senior managers should delegate operational decision making to their subordinates and spend more time on strategic issues.

The heart of the matter is that the allocation of responsibility and authority in the organizational structure of new product development must fit to the needs of the company in order to achieve successful new product strategies.

The findings indicate many companies utilize "being the first in the market" and "being second to the market" strategies according to the companies resources and competitive advantages.

The strategy of being first in the market is attracting many companies. The first company in the market has a greater chance to capture a substantial market share, is able to take advantages of the experience curve as the product grows in its life cycle, is able to take advantages of economies of scale if it can get adequate market share, can build brand loyalty, and has more favorable product position in the market when other companies enter the market.

However, the strategy of being the second to the market is also favored by many companies. This strategy is less expensive, because there is no need to build the market; the first company has already done this. Also, there are less risks since the second company can enter to the market when there is a growing need. The second company may choose to invest in the business by incorporating the latest technology that might make the product cheaper and have higher quality.

One comment: "Structure assigns people to tasks and roles (differentiation) and specifies how these are to be coordinated (integration). However, it does not of itself provide the mechanism through which people can be motivated to make the structure work. Hence the need for control." [21] In other words, a company needs to select the right combination of organizational structure, and integrating and control systems to achieve its new product strategy.

New product strategies can only be implemented successfully through appropriate organizational design. Bad organizational structure of new product development may result low communication, less integration, more centralization, and bureaucracy, etc. However, the integrating and control systems are also important. Integrating mechanisms coordinate the different functions and divisions of a company; a more complex organizational structure requires the use of a more complex integrating system. Through control systems, a company is able to monitor, evaluate, and change its performance. These systems give information about how well a company's strategy and the organizational structure are working. In this way the appropriate organizational structure would work. Thus a corporate culture that supports innovation should be able to foster the organizational structure, through integration and control systems, in order to achieve successful management of new product development.

With regard to the main causes of delays in new product development process, the findings generally support the literature. These causes are: inadequate product definition, lack of resources, communication barriers between R&D and marketing, "other", and communication barriers between engineering and manufacturing.

There appears to be a new trend that causes delays in new product development, namely communication barriers between engineering and manufacturing. The issue here is how to optimally introduce

new product concept/design or new process from engineering to manufacturing. To some extent, the problem is to introduce new technology to manufacturing. The rapidly evolving technological environment requires a better communication among different functional areas. Here, communication between engineering and manufacturing is becoming one of the bottlenecks within a company. It may be overcome by coordinating and integrating the different functional areas earlier in the new product development process.

Some possible causes of failures in the "protocol" that lead to inadequate product definition are, more technology push, new emergent technology, lack of truthful answers in concept testing, and lack of information about the environments. In addition, scarcity of resources also may be caused by lack of top management commitments in the forms of funds, priority, etc., and by lack of support from other departments.

Paul Houston, a manager from ManagersEdge, introduces a rule of thumb in managing new product development: "Be guided by your entrepreneurial instincts, but learn from your customers the narrow focus needed for success." [23] In other words, he suggests to have a relation with external sources, specifically the customer.

The findings suggest that there is a growing tendency to utilize customers and other external sources, such as market research

firms, acquisition of other companies, and commercial labs. The utilization of external sources can be done in different ways. A company may involve the customers in developing new idea, screening new idea, concept development and testing. A company also may contract the product development to independent researchers or new product development agencies.

For the stages of new product development process, one respondent states that each stage is critical to the success, and must be emphasized accordingly. In short, there is a tendency to say that the more stages that are utilized, the more successful the new product development project is. Also, the quality of each stage determines the success. Better execution of each stage will result more successful new products.

Obviously, a company will benefit if it can go through all the process, , since there are some filters in the stages, such as: initial screening, preliminary market assessment, preliminary technical assessment, market research, concept development and testing, business/financial analysis, in house product testing, customers tests of product, trial sell, trial production, and pre-commercialization business analysis.

However, there are some other issues to be considered, like the size of a company, resources available in a company, and timing. There certainly are tradeoffs among time, costs and performance. The cost-benefit analysis before the new product development

process should incorporate those three dimensions (time, costs and performance), while considering a company's prospective financial goals, market share, and growth. It is noted from the findings that the focus of new product process is product development, yet product development is also a very time consuming and costly stage/activity.

The factors that contribute most to success of new product development are: satisfactory product quality to users, product fits with market needs, good timing, top management commitment, product offers significant benefits, good project management for new product process, also product compatibility with technical and production capability. Here, using external sources contributes a lesser degree to the success, but it appears to be a growing trend.

The findings indicate that the one essential key for success is a strong market orientation of everyone within a company. Product quality is still the first factor that contribute to success in management of new product development, although today's external environments of a company are more challenging and vulnerable than in the past.

Manufacturing personnel imply that the bottlenecks in the management of new product development are the market potential and the marketing constraints, such as whether the market is big enough to serve, whether the marketing people can sell adequate volumes of products to maximize profit. The production people

seem to see themselves having no problem.

The findings indicate a strong consensus regarding the key factors in new product development process: market potential, existence and quality of "protocol", product advantage, synergy with company's marketing strengths, top management support, and synergy with company's technology strengths. The findings strongly support the information found from the literature.

The current major issues in new product development process support the literature information. The trend is to pay comprehensive attentions to the following items: top management support, composition of the product development team, attention to details, and communication channels.

The following are suggestions, recommended topics for future projects, and conclusions.

SUGGESTIONS

The author suggests some guidelines for better management of new product development:

1. New product development should be measured with multi-dimensional measures.
2. In selecting a new product development project, it is wise to consider the nature of the product, synergy, project definition, and market environment [26].
3. Companies must put more effort into providing product advantage with significant customers benefits, such as favorable customer perception on the product advantage, high product quality, adaptive products, and user-friendly products.
4. New product development project should have a clear and well-defined "protocol."
5. New product development project must be consistent with the corporate missions and objectives and to company's internal functional strengths.
6. The market should appear to be favorable to the new product.

In terms of implementation, some suggestions for successful new product development are as follows:

1. Top or senior management should support the new product development process.
2. Provide a positive working environment or culture which supports innovation at all levels in the organization.

3. Involve individuals from various departments on the new product development process as early as possible.
4. Take advantage of external sources.
5. Adopt parallel processing during the new product development processes.
6. Utilize product development teams consisting of individuals from marketing, engineering, R&D, manufacturing, general management, and support functional departments.
7. Utilize matrix organization as the structure in the new product development process.
8. Implement effective project management techniques.
9. Implement computer-network information systems and other modern communication technology throughout the organization for higher degree of integration and communication among functional departments and different vertical levels.
10. Create separate organization (intrapreneurship).

RECOMMENDED FUTURE PROJECTS

In this project there are several questions that need to be asked and need further investigation:

1. Overcoming R&D and marketing communication barriers.
2. Overcoming engineering and manufacturing communication barriers.
3. Detailed study on success and failure factors at each stage of new product development process.
4. Developing a strong market oriented new product development teams.
5. Utilizing external sources more effectively, for successful new product development.
6. Utilizing knowledge-based or expert systems effectively in the new product development process.

CONCLUSIONS

Respondents' perceptions/assessments in answering the questionnaires applying to the new products in the companies they worked were not necessarily "how it should be", but rather as "how it is."

Product innovation is very important to maintain long-term corporate growth, but it is faced with problems such as high risk of failure, difficulties, barriers and resistances, rapidly changing technological environment, shortening product life cycle, changing customer value systems, increasing domestic and global competition.

For successful management of new product development, it is better to use stakeholders approach, by involving individuals from different functional areas within the organization and those outside the organization, who have relations to and interests in the new product development process in a company.

There are patterns and logical steps in the management of new product development that can be learned from successful companies. These include management styles, organizational structures, strategies, corporate cultures, and the activities or stages in new product development process.

The author realizes that there are still many subjects to be explored in this area. However, considering this project as an individual study course work, the author believes that he has succeeded in creating a good basic reference from which to conduct this exploration. The author finds that the effort to finish this project had been difficult but interesting experiences. The author truly believes that the concepts learned and the process gone through in doing this project will benefit his personal life in the future as a professional.