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Abstract: New product development may be done by enhancing an existing product or by making fundamental changes in the design parameters of the product which eventually would include significantly new technologies. In most of the companies these processes may cause significant changes in the organizational style and structure, Apple Computer Co. Is a good example of this trend. It has been in the market from the beginning of the personal computer era and has evolved with the market. The three products of Apple represent the result of different periods it has been Apple II (market formation); Lisa (market formation) and Macintosh (second breed of products). Lisa was failure but the others became a legend. This project examines what was wrong or what was right with the products.

MANAGING NEW PRODUCT DEVELOPMENT IN APPLE COMPUTER CO.

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MANAGING NEW PRODUCT DEVELOPMENT IN APPLE COMPUTER Co.

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TABLE OF CONTENT

1. INTRODUCTION

In the newly forming global environment, each day the development of new product is becoming increasingly important. Intense international competition, demanding markets, diverse and rapidly changing technologies are the main factors to be taken care of in order to be successful and improve the efficiency level of new product development.

The technological changes create an extreme pressure on companies to put new products to the market; result: innovate or disappear. Same thing is true for the marketing; consumers' needs change with the technology and new expectations become available. Marketing should be aware of those needs and creates an information base for the future products.

Succesful new product development in the technology-based firm requires the integration of technical and human systems through effective management of complex functional interfaces at every stage of new product development [2.]

Studies of success and failure in new product development have consistently found that good communication and cooperation between functional groups is critical in the new product development process. Also efficiency concern in use of resources has caused to emerge new kind of management: from a pure functional style to a pure matrix organization.

Every company has created its own management style depending on its needs and experiences, but the objective has always been same: to use the resources as efficient as possible, to survive in a competitive environment.

New product development may be done by enhancing an existing product or by making fundamental changes in the design parameters of the product which eventually would include significantly new technologies.

In most of the companies these processes may cause significant changes in the organizational style and structure.

Apple Computer Co. is a good example of this trend. It has been in the market from the beginning of the personal computer era; and has evolved with the market. The three products of Apple represent the result of different periods it has been in:

Apple II	:	market formation (home, schools)
Lisa	:	market formation (business)
Macintosh	:	second breed of products

Out of these three products only Lisa was unsuccessful. Apple II and Macintosh have become a legend among the personal computers. What was wrong or what was rigth with these products?

1.1 Methodology

We will use two different methods to analyze the development of these three products. The first one is the 'mapping process' with which we will evaluate the overall performance of the product in order to define the evolution of critical dimensions` in the market, the technology, and the manufacturing processes. The objective of this model

is to capture the driving force for the business and the functions, and portray their implications for competition.

The second one is the 'informational model', to evaluate the performance of the product by using, lead time, quality, and productivity and its implications on the organization.

The expected result of the project is to give guidelines for the development of a new product.

2. THEORETICAL MODEL

2.1 MAPS AND MAPPING: FUNCTIONAL STRATEGIES IN PRE-PROJECT PLANNING.

The foundation for a successful development project is laid long before the project begins. When the project starts, the project leader and members of the project team need a clear sense of strategic direction in the business and its critical functions. A typical business plan focused on financial and marketing information, prepared by a staff group, is not enough, nor is it sufficient to take a business plan and add sections on functional plans. What is needed is an understanding of where the business is going, what the functions are going to do to get there, and how this project fits into that picture. Thus, behind the foundation of a successful development project must be a process that identifies and integrates the strategies and the functions, and links them to the overall direction of the business.

Experience has taught the thoughtful traveler that an essential part of the preparation for an extended journey is the acquisition of good maps of the area of which the journey will occur. In a similar way, we have found the mapping of the competitive terrain in each of a business's functions to be a powerful link between business and functional strategies and the details of specific development projects. Functional maps (e.g.,[4],[8]) provide both the process and substance for functional integration, establish a context for a stream of development projects over time, and offer guidance and direction for an individual development project.

2.1.1. THE CONCEPT OF FUNCTIONAL MAPS

Mapping has a clear objective: capture the driving forces for the business and the functions, and portray their implications for competition graphically. Defined in these terms, a functional map has the following distinguishing characteristics: it is a visual, graphic display of the driving forces in the market, and the firm's position along critical dimensions of competition over time and relative to its competitors. Each of these elements is critical. The very purpose of a map is to give managers a way to see the evolution of critical dimensions in the market, the technology and the manufacturing processes. Although good maps are based on data and analysis, pulling together that analysis in a visual form greatly enhances communication and the development of insight.

The requirement that a map show driving forces and critical dimensions of competition over time is central to achieving this fundamental purpose: helping managers to see where they are, where they have been and where they may be going. Laying out developments in marketing, engineering, or manufacturing over time helps to uncover underlying trends and provides a useful context in which to evaluate alternative courses of action. In effect, putting driving forces and critical dimensions of competition in their historical context is an important element of providing direction for product and process development.

With a visual, graphic display of critical dimensions of competition over time, functions in a business have a set of maps that facilitate communication, focus attention on salient issues, and provide historical context. What is missing, however, is a benchmark, a standard of comparison that creates perspectives. Thus, the last requirement for an effective map is comparison with competitors. Finding out where we

are and where we are going cannot be done only with internal data. The relevant standards are not past budget or plans, but what the toughest competitors have accomplished. Furthermore, seeing what competitors have done may yield important insight into differences in competitive performance. We may discover, for example, that while our company has followed a broad line strategy, our strongest competitors have focused their marketing and development resources in a few key products area where they dominate the business.

Such insight is invaluable in crafting a business strategy and provides an important context for decisions in new product and process development. Maps help to ensure that all functions share a collective vision of where they are going and how individual projects contribute to their common purpose. Moreover, mapping facilitates effective mobilization of all the organization's resources, capabilities and skills. Maps provide a tool for guiding the development of functional excellence, and they facilitate the strategic integration of that excellence around a common purpose. Additionally, maps help an organization to target its investments. By underlying forces at work in the market place, maps help to clarify choices firms face, regarding which markets to serve with which products, which manufacturing facilities to employ, what process technologies to use, and what directions to take in the development of new product designs.

The specific maps that a business team chooses to develop will vary depending on the circumstances of the business. A map example is given in figure 2-1. The relation to each of the maps, to key strategies, and to operating plans are depicted in the figure 2-2.

Functional Area/Map Type	Concepts and Specific Measures Used	Sources of Data
Marketing		
Product profile	Product attributes; position relative to competitors	Customer interviews; market research; product testing
Channels of distribution	Sales by channel; market share by channel	Sales organization; trade publications; surveys
Product generation	Timing of new products; life cycle of models; relationship of products to one another	Sales documents
Engineering		
Critical skills	Skill composition of engineering work force	Internal personal research; interviews or comments of engineering managers
Performance tradeoffs	Range of performance combinations possible among dimensions that may conflict (e.g., weight and efficiency)	Test data; product performance specifications
Component technology	Performance of critical components using different technologies	Test data; product ratings
Manufacturing		
Process technology	Degree of automation; fraction of output in different types of processes	Production research; project data
Vertical integration	Role of suppliers; internal operations by component	Purchasing research; internal operating plans
Cost structure	Cost by volume levels; cost by factor of production	Cost accounting research

Figure 2-1 Functional Maps
Source: Wheelwright and Clark

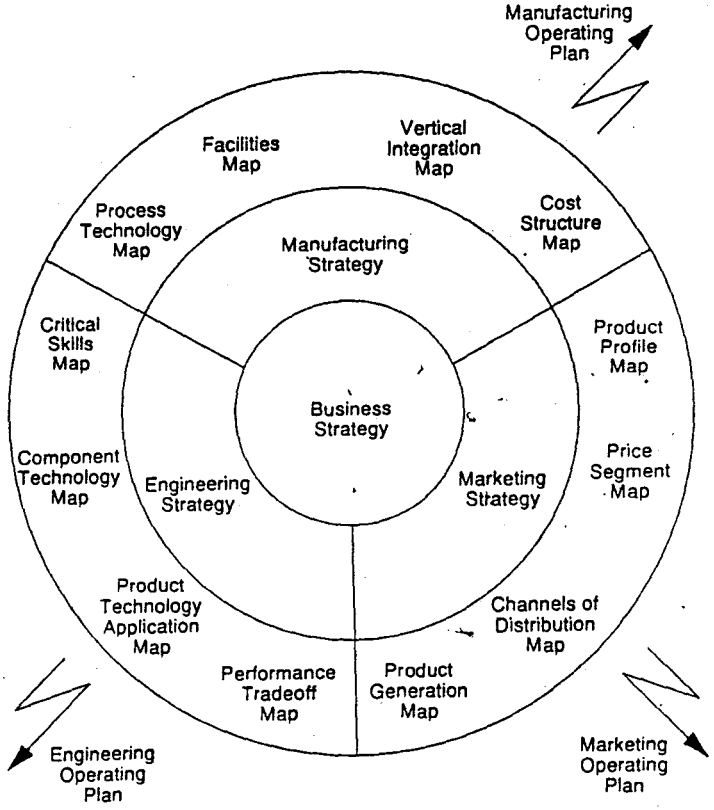

Figure 2-2 Relating Functional Strategies and Maps
Source: Wheelwright and Clark

The MARKETING map describes the mix of product attributes offered to potential customers. It is critical for the marketing organization.

The ENGINEERING map describes an important driver for the engineering function: the shifting mix of critical skills required in the design, development, and engineering of products and processes.

The MANUFACTURING map often finds itself involved at the tail end of product development, reacting to products designs and marketing initiatives. Yet, there are important strategic developments in manufacturing that can have decisive influence on the success of new products. It is important that driving forces in manufacturing de evident and taken in account in the early stages of new product development.

2.1.2. THE MAPPING PROCESS

Maps underscore the critical driving forces in the business and help to clarify the important strategic decisions and directions confronting an organization, but the true power of maps is not so much in the graphs or in the documents themselves, but in the process used to create them. What is important in laying the foundation for effective development projects is the creation of shared understanding, among senior executives, among heads of the major functions of the business, and among engineers, marketers, and manufacturing people who make the product happen. While important insight and pieces of knowledge are incorporated into the maps, shared understanding grows out of the process that underlies them. If the maps are not actively used to structure and uniform decisions and actions, they have little value, but when developed and used in an effective process, maps may play an important role in creating shared understanding.

An effective mapping process has two parts:

- In the first, managers define the critical driving forces in the business and the functions, and then acquire the data necessary to map those forces over time, against principal competitors.

- In the second, managers from different functions in the business develop insight from the maps and share those insights with their colleagues on the business team. In that context, maps provide a new language. By visually presenting the important dimensions of competition and the business's relative position, maps give managers versed in different disciplines and endowed with different experiences the ability to communicate their ideas more effectively.

There are different variation of the mapping process, figure 2-3 lays out the central features of an effective process:

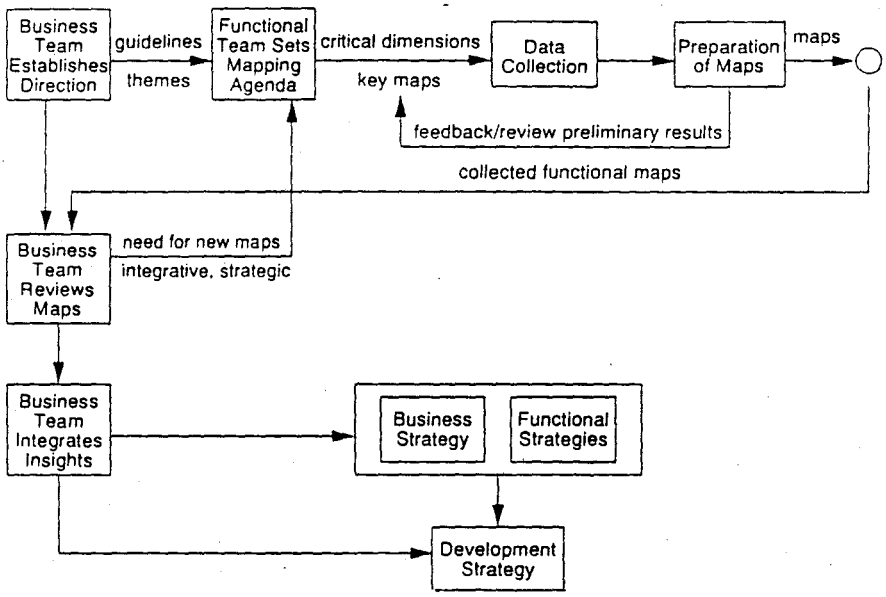

Figure 2-3 Mapping Process
Sporce: Wheelwright and Clark

Mapping is an iterative process carried out by managers in marketing, engineering and manufacturing working separately, as well as jointly as a business team under the direction of the general manager. After meeting together as a business to plan out the mapping agenda, identify important guidelines (timing, number of maps, etc.), and establish overall business themes, the individual functional teams decide which map to develop and how to get the work done. Working together as a team and involving knowledgeable individuals within the function, the functional teams identify the driving forces affecting their functions and sketch out a set of maps to capture those forces. With the mapping agenda laid out, the functional teams proceed to collect data and prepare maps. Once the maps have been developed, the final step within the functional team is to meet, review the maps, discuss their implications, and develop guidelines for functional strategies.

Once the functional teams have developed a set of maps, members from each function meet as a business team to share their respective maps, identify important

insights and issues, and develop guidelines for future directions and strategic choices. The business team may then identify further issues that need to be mapped, particularly those that involve cross-functional integration. In addition, the functional teams may meet again to develop strategic maps (maps that look forward and lay out the strategic direction of the business in terms of the critical driving forces captured in functional maps.

Armed with integrative and strategic maps, the business team meets again to integrate the insights, strategic directions, and plans into overall functional strategies and a business strategy. The point is not only to refine and develop the maps themselves, but also to establish guidelines for future development projects. In that sense, functional heads, project managers, and senior executives can use the maps as starting points for developing and implementing operational plans, communicating a sense of direction within their organizations, and providing a context within which plans for specific products and process development projects may be undertaken.

2.2. THE INFORMATION MODEL

2.2.1. DESCRIPTION OF THE INFORMATIONAL MODEL

This section describes another conceptual framework used in our research on new product development. This model identifies the broad competitive and organizational context within the information processing perspective. The information processing model standard approach is developed by Clark et al. [3] and Allen [1].

For most companies, the search for new product items may be the most difficult part of the product process. New product ideas may spring either from a source internal to the company or from some outside source. This idea has been developed by Walter et al.[7]. New product activities start from a number of initial forces such as market needs, technological development, improvements in engineering and production, inventions, patents, and competitors' actions. These forces also act as sources of ideas. Then a product takes shape in the mind of a designer. The designer's proposal and drawings may capture the imagination of managers, and early models and concepts may capture potential customers, but before the factory can produce the real thing, the product idea must get from the designer's mind into drawings, parts, tools, procedures, equipment, and processes. What the firm does and how it does it will determine how the product behaves in the marketplace and its overall competitiveness.

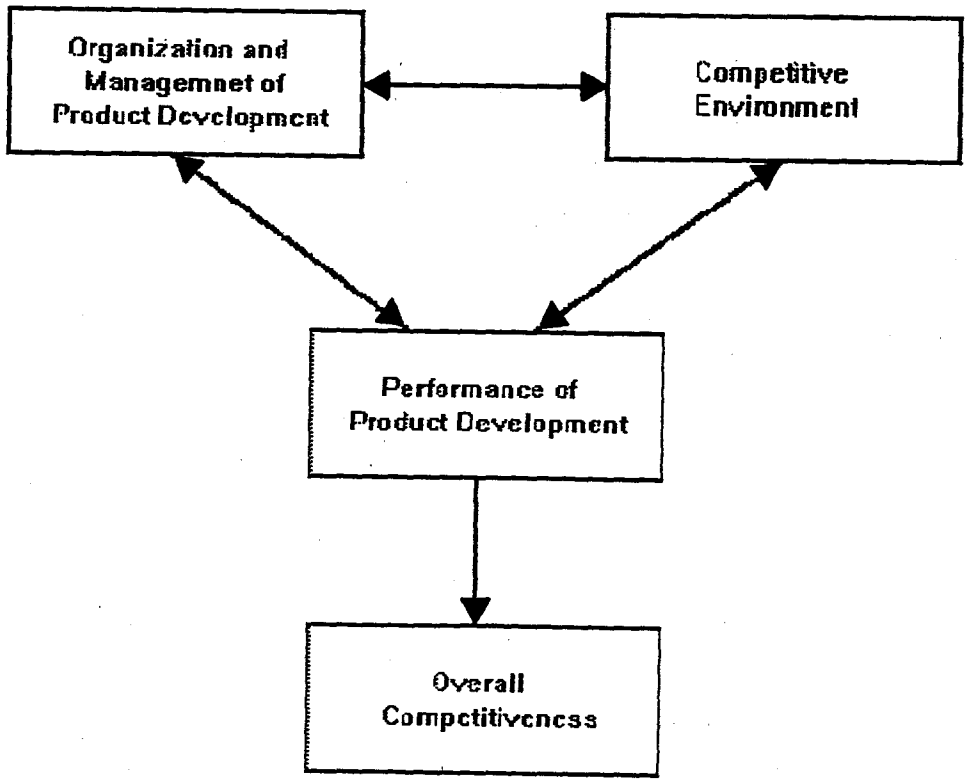

Figure 2-4 Performance, Organization and Environment
Source: Clark and Fujimoto (1991)

This model studies product development in a context that includes "performance, the competitive environment, and the internal organization of the firm" as stated by Clark and Fujimoto [3]. Figure 2-4, shows the importance of performance in product development and its interaction with a firm's strategy and internal organization.

According to Clark et al. [3]: "Performance in a development project is determined by a firm's product strategy and by its capabilities in overall process and organization, but the relationship between a firm's capabilities and its competitive environment is dynamic and rooted in its historical context."

Based on our literature research, companies must adapt their organizations and management to maintain and improve their performance and competitiveness while adjusting to the changing patterns of the environment. In some cases a firm's product might shape the market environment. The market environment is also modified as consumers and competitors learn from new products and services. Organizations and environments adapt continuously through time.

The information processing model approach focuses on how information is created, communicated, and used. This viewpoint emphasizes "critical information linkages within the organization and between the organization and the market" as stated by Clark et al.[3] and helps to clarify the role of product development within the general context of competition.

In the information system model, Clark and Fujimoto [3] present four stages in the process: Product development, production, marketing and customer (users). In this context, product development is a process by which an organization transforms data on

market opportunities and technical possibilities into important information assets for commercial production.

Figure 2-5 contrasts the information model view of the entire scope of business activities with the conventional model view, which focuses on the flow of materials. The conventional perspective, links supplier, producer, distributor, and consumer and gives product development a secondary role.

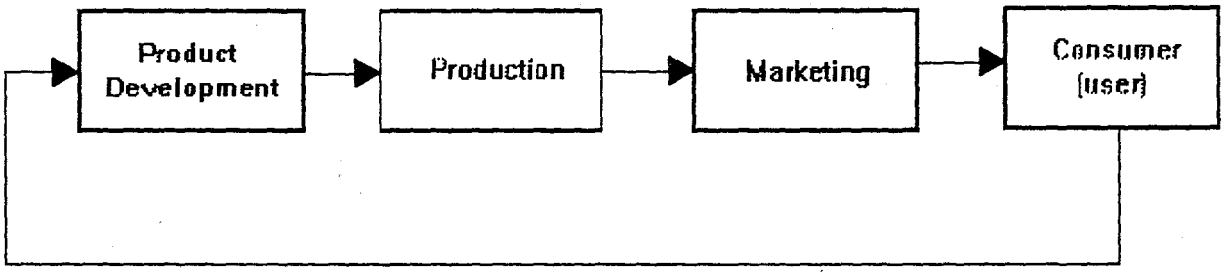

Figure 2-5 Information System
Source: Clark and Fujimoto (1991)

The application of the information model extends beyond design and engineering to other functions such as production and marketing, and to the behavior of consumers.

The proposed information model focuses on the flow of information - from product development to production, marketing, consumers, and back to product development - brings product development to the fore.

The impact of the information perspective does more than modify the flow diagram; it affects in a fundamental way how we think about producers and consumers. In the information framework, the customer consumes an experience delivered by a product rather than the physical product itself. This experience takes the form of information a customer receives about the product and its behavior in the environment in which it is used. Since market need reflect the highest potential source of ideas, the closer and earlier the new product developers get to the consumer the better. In this framework, marketing is communication at the producer-consumer interface. For a successful launch, marketers create and deliver messages through the product's advertising, catalogues, sales personnel, promotions, distribution strategy, and the product itself, as developed by Urban et al. [6]. These messages are intended to represent the product and its prices and benefits in such a way as to inform and influence the way consumers interpret the product experience.

On the production side, the information perspective focuses attention on the transmission of information from the production process deployed on the shop floor to actual products. The key notion here is that by the time product development is finished, complete information about a product's design is embodied in elements of the production process (e.g., in tools, equipment, worker skills, standard operating procedures, numerical control tapes, and so forth). Production activities transfer the product design to materials that become the physical product. The product development must therefore include an effective interface between the functional areas involved in the implementation process. An integrated team including the marketing, manufacturing, and engineering departments helps to effectively design the new product and process by creating effective information networks. In this context an excellent engineering design is one that not only achieves outstanding performance but also is manufacturable.

In the information framework, communication with customers is the main objective of the firm. The product as a physical object is only the medium or vehicle by which the product experience and the producer's messages are delivered to customers. Product development creates value-carrying messages that production embodies in actual products and marketing delivers to target customers, who interpret and generate experiences of satisfaction or dissatisfaction from the product-embodied information. Looking at the development, production, marketing, and consumer experiences from a consistent, informational point of view enables us to see important interrelationships.

2.2.2. COMPETITIVENESS OF A NEW PRODUCT

When a company sets out to develop a new product, its objective is to attract and satisfy a set of target customers and to do so profitably. In as much as the product has a long life and the company will develop and introduce many products, satisfaction must extend over the long term. Although a company's competitiveness relative to its rivals depends on factors such as advertising, dealer quality, and delivery schedule, the competitiveness of the product -its ability to attract and satisfy customers- is critical.

Three outcomes of the product development process affect the ability of a product to attract and satisfy customers. These outcomes are:

Total Product Quality (TPQ): TPQ is, the extent to which the product satisfies customer requirements. TPQ is affected both by objective attributes and subjective evaluations.

Lead Time (LT): LT is a measure of how quickly a company can move from concept to market. Productivity: Productivity is defined as the level of resources required to take the project from concept to commercial product. Productivity has a direct though relatively small effect on unit production cost and also affects the number of projects a company can complete for a given level of resources.

Figure 2-6 shows the interaction among these three dimensions of new product development performance. Specific patterns of interaction will depend on the way firms organize and manage development, on the market environment, and on company strategies. The framework in Figure 2-6 establishes a link between development performance and the firm's objective in launching new products to profitably attract and satisfy customers.

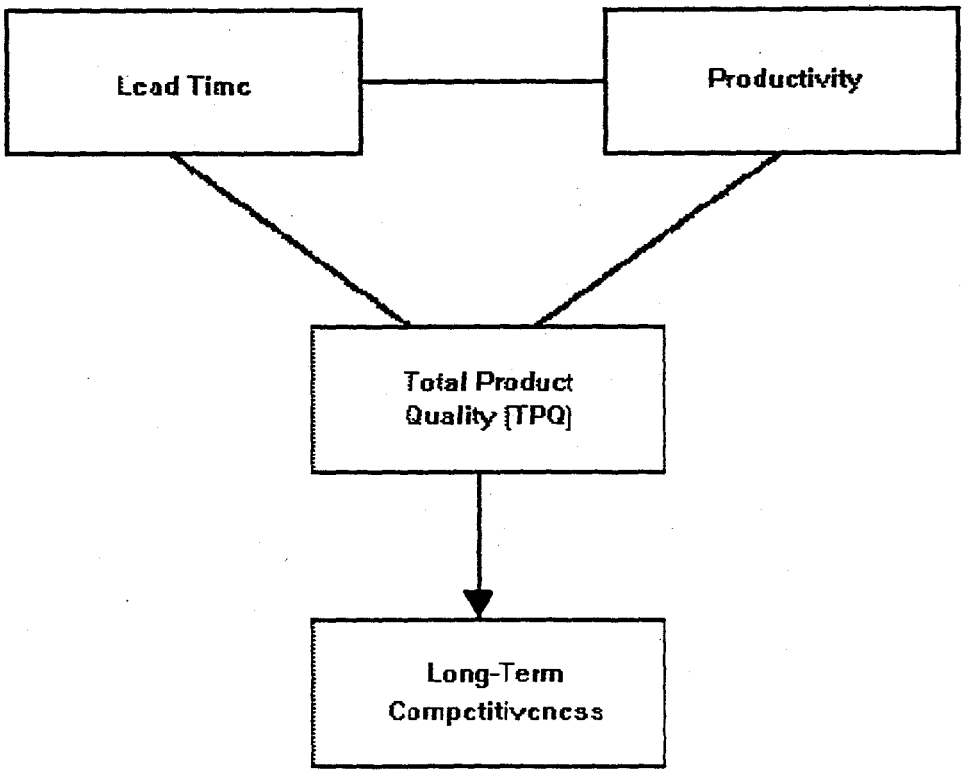

Figure 2-6 Product Development Performance
Source: Clark and Fujimoto (1991)

3. A CASE STUDY: APPLE Computer Co.

3.1. DEVELOPMENT OF THREE MAJOR APPLE'S PRODUCTS

3.1.1. CREATING APPLE II

The Apple II has showed an unparalleled and an unexpected success, in an environment with no known parameters. It was not only a new product but also a new standard for the newly forming personal computer market.

How could the Apple II has been so successful without having even the basic formal organizational concepts? The answer to that question is a genius on electronic and a genius on entrepreneurship; Steve Wozniak and Steve Jobs.

The relative success of The Apple I-compared to other machines in the market, it was made in a bedroom-has encouraged Wozniak and Jobs to go one more step further to the Apple II. They knew they needed to improve the Apple I but not how; they were in touch with their competitors but not with the market.

In the world's first personal computer 'festival' in Atlantic City they met their rivals. Comparing their booth, that consisted of only a table, to others that had every kind of attractions, Jobs immediately decided that they should change their way of business if they wanted to be more serious in this market.

The problem was that Wozniak's expectation on the Apple II was limited. He was just seeing the Apple II like Apple I, selling a few thousands of them, but Jobs was serious on going for big business. At this moment Jobs personality has begun to affect

the future of the Apple until his resign after the arrival of John Sculley. They were not a team any more. Jobs was the visionary, leader, and marketer of the Apple Co. and Wozniak was only the product champion.

No one in the market has had an idea of how a personal computer should look like. Usually companies were preferring to make computers by improving the previous ones. Jobs expectations for Apple II were beyond them, to introduce computers in to homes, to make them user friendly-at least looked friendly-but what makes them become real was the Wozniak's unmatched capability in electronic.

Jobs has set the standards for Apple II: color, small package, no fan for power unit, and a plastic cover. He has had some discussions with Wozniak, on whether to put expansion slots or not. In Wozniak's ideal world of computer every computer should have had one, but Jobs refused because it would create more cost and prevent entering the market he wanted to enter: Home and school. Wozniak won the discussion which later proved that he was right. Slots helped Apple II gain more market share.

The creation of the Apple II could be accepted as a 'concurrent engineering', and the chief of this orchestra was Steve Jobs. He has found all the resource necessary for the project. A designer for case, another one for power supply, a company to make the plastic case, and a marketing firm. The only similarity of these people is that they were the best of what they were doing.

Most interesting thing in this project is that while convincing those people Jobs has had no money. The only treasure he has, was his unending insistence. He never accepted 'no' as an answer.

Apple II was like "jihad" for Jobs, he has done everything to make it real. They were successful in getting all the parts in time. The have first presented their product in West Coast Computer Fair. Even though it was ranked as a third machine in speed, Apple II has had ability to produce colors of rainbow with much more less chip then its rivals, which attracted the attention of the crowd. Apple was in the race...

3.1.2. CREATING THE LISA AND MACINTOSH

In the early 1980, Apple was riding the crest of its success with the Apple II personal computer. In 1982, Apple's CEO, Steve Jobs, initiated the development of a new product family, the Lisa-Macintosh personal computer. The Lisa-Macintosh development effort was establish as small, dedicated team reporting directly to Jobs. Its challenges were to make major leaps in both products (hardware and software) and manufacturing process development. An extremely ambitious project, development of the Lisa-Macintosh was assigned to very capable people and had Jobs' personal backing and day-to-day involvement.

The Lisa, priced at $8,000 to $10,000 per unit, was initially regarded at the core of the product family. It would be the family flagship, demonstrating the power of its new technology and serving as the base from which to launch a derivative, but much higher unit-volume product: The Macintosh. Thus, the Lisa was to be developed first and was expected to provide a significant share of the family's combined profit, although not the bulk of its sales volume. The Macintosh was eventually to have its own production facility, but the low volume Lisa was to be produced in the Dallas factory (which would also continue to make the Apple II).

In retrospect, this strategy for the Lisa-Macintosh was more wishful thinking than a well thought- out plan. Although based on highly innovative design concepts, Lisa's sales never reached expectations, and the design of the Macintosh required a number of iterations before it could meet the needs of its evolving market. Such critical issues as customer segment, distribution channels, product support, and follow-on product had not been carefully examined. In addition, little thought was given (even in the later stages of product development) to how new and existing manufacturing facilities would be coordinated.

The absence of strategic planning within the various functional groups created two problems: additional times were spent and the resources were wasted on than one dead end. Introduction of the Macintosh was originally scheduled for March of 1983, but was rescheduled for May, then July, and then late fall (before Christmas, it was hoped). Volume shipment did not actually begin until early 1984. Even with the delay, manufacturing suffered from serious problems.

The original goal was to have a highly automated factory for the Macintosh up and running at the time of its market introduction. Although there was extensive automation of material handling and testing, within eight months of the facility's opening, $7 million worth of automation equipment (one-third of the total spent on the factory) was removed because it had not proven effective.

The delay of the Macintosh's market introduction by several quarters drove Apple's earnings down dramatically and caused the stock markets valuation of the company to fall to less than half its early 1983 value. In the restructuring that followed, Apple closed the Dallas plant laid off several hundred people (over 20% of the entire work force), and took a substantial write-off. By late 1985, Apple had gone through

great agony and emerged a vastly different company. Much of this had its roots in the shortcomings of the Lisa-Macintosh development effort. Although errors were certainly made during the actual execution of the project, the seeds of most Apple's major difficulties were sown beforehand.

3.2. USING MAPS: THE APPLE CASE REEVALUATED

The development of the Apple II, Lisa, and Macintosh illustrates the problems that can occur when product and process development process are launched without clear strategic direction. Mapping can provide such directions, but would the existence of such maps have made any difference to Apple? Did information exist from which it could have gained valuable insight through a mapping process? Each of Apple's three main functions - marketing, design engineering, and manufacturing - confronted issues in the development of the Apple II, Lisa and Macintosh product line that maps could have helped clarify.

3.2.1. APPLE II CASE

3.2.1.1. Marketing

Even if Jobs wanted to focus on the home market and educational market, Wozniak and Jobs didn't know who would buy they computers. What they knew were their major goals: a low price for a user-friendly computer. An obvious clue that they didn't target their market was the conflict between Jobs and Wozniak about the number of expansion slots. Had they known their targeted customers, this conflict would never have happened.

So, if the Apple II was a very successful product, it is not because a market had been well targeted, but because the customers found satisfaction with Apple II features.

3.2.1.2. Design Engineering

Thanks to the experience from Apple I, that 8K bytes of memory were really not enough, Jobs and Wozniak decided to use 16K in addition to the new 4K RAMs for Apple II. A this time, no one else was using RAMs. It would be easy to increase the memory for future products.

Moreover, Apple made available every piece of technical data relating to the machine, a highly unusual move in an industry where secrecy had always been tightly maintained. This open policy allowed sophisticated users to design circuit boards that could plug into the computer and expand its capabilities. In fact, several empty slots were built into the Apple II just for this purpose.

3.2.1.3. Manufacturing

Apple II manufacturing was essentially buy, assemble, and test. Under these manufacturing policies, most components in the Apple II were purchased from outside suppliers who built ship, boards, cases and other part of Apple specification.

With regard to facilities, Apple operated out of one plant in California until June 1980. At this time Apple instituted the "module" concept. This included the "parent plant" for the Apple II, located near corporate headquarters in California and in closed contact with the engineering staff. Satellite production facilities (called "modules") that replicated the assembly and test portion of the parent plant were then developed as

additional capacity was required. The satellite facilities were in Dallas, Texas and in Ireland. This choice of Ireland is supported by tax considerations, but also because of transportation facilities to open a market in Europe. This plan was very successful and the European market grew rapidly.

3.2.1.4. Conclusion

Apple II, if built without a targeted market, was a successful product thanks to its characteristics. Apple, aware that it could be easily improved, made a good strategic plan with the manufacturing facilities choice.

3.2.2. LISA-MACINTOSH CASE

3.2.2.1. Marketing

The Lisa and Macintosh were viewed primarily as engineering projects, and thus marketing issues- though they had a profound influence on both product design and ultimate sales- received secondary attention. Marketing thought of the Lisa as a high-end of its product; the Macintosh was slated to serve the lower end of that market, with some application to education and home use, but information available in 1982 indicated that this concept ignored several important issues.

A comparison of the importance placed on different criteria in Apple's development program (performance, price, features, reliability, user friendly, connectivity, field support, application software) and the needs of different market segments suggest that the Lisa was a machine without a market: Lisa was targeted at the corporate office (high emphasis on connectivity, field support and application

software), but it was developed with a focus on performance and user friendliness. Additionally, though Apple intended the Macintosh for large cooperations, it appeared better suited to the needs of small businesses and universities. The map thus highlights a mismatch between development objectives and market requirements that should have been apparent in 1982.

3.2.2.2. Design Engineering

The Lisa was to be both a high-end machine for offices and a technology platform for subsequent products like the Macintosh, but apparently little thought was given to the way that the Lisa itself would evolve, nor does it appear that the Lisa-Macintosh development team understood the implications of evolving component technology.

The Lisa was based on the Motorola 68000 microprocessor and employed new concepts in software (windows, icons) and user-machine interaction (the mouse). Higher performance models were unveiled after initial introduction, but they simply incorporated additional memory. The original design of the Lisa, despite its innovation, didn't lend itself to future evolution and development. Not only was it very expensive to manufacture, but its use of many unusual parts and design concepts made it difficult to modify. The Macintosh also was based on the 68000 microprocessor, however, and the price of memory was dropping rapidly. As a result, the Macintosh soon was able to provide most of the capabilities of the original Lisa at a fraction of the price. A product generation plan, together with a forecast of the likely evolution of component technology would have suggested in 1982 that the Lisa was likely to be a dead- end product.

3.2.2.3. Manufacturing

Apple's production experience as of 1981 had been limited largely to labor-intensive assembly in a batch processing environment. Automation was a relatively recent addition to the manufacturing organization. The Lisa required only manual assembly and fits well with Apple's capabilities, but the Macintosh was a different story. It was decided that it should be the vehicle for developing Apple's capabilities in both line-flow (as opposed to batch) processes and automated manufacturing.

Apple's manufacturing has evolved from simple manual to fully integrated, automated processing. The plan was to make the transition from unskilled workers with solder guns to automated lines in a single step. However, the various parts of the organization apparently did not have a shared understanding of what this implied, the kind of organizational capabilities that would have to be developed , or the alternatives. Thus, even where subparts of a plan existed, they were often incomplete and contradictory.

3.2.2.4. Conclusion

It is obvious that Apple didn't develop a set of functional map before the project began. Some issues would have surfaced before Apple made commitment to specific target markets, product design, and manufacturing equipment.

3.3. USING THE INFORMATIONAL MODEL TO EVALUATE THE DEVELOPMENT OF APPLE II, LISA, AND MACINTOSH

3.3.1. Introduction

In this section of this study we will analyze three of Apple's most important computer models developed by the company during its first ten years of existence (1976-1986). Products like Apple II, Lisa and Macintosh were technological breakthroughs developed by the company but with different customer acceptance levels. While Apple II and Macintosh were very successful and are responsible for Apple's actual strength in the personal computer market, Lisa was an economic failure. We will analyze this model's using the lead time, productivity and total product quality (TPQ) performance parameters.

We measure lead time as the time elapsed between the initial idea or concept development and the final market introduction of the product.

We will measure productivity based primarily on the number of new product developments introduced by the company up to the development being analyzed so far and we will discuss what the company did to increase it for each product developed such as the organizational structure used. We will also include information regarding the investments involved for each new product developed.

In this analysis TPQ includes customer evaluation of the product including characteristics such as design, handling and comfort. TPQ is affected by factors such as product market price, ease of use, compatibility among different products of the same and other companies and technological level of the new product.

3.3.2. Apple II: Performance factors

Lead Time: The Apple II was developed in one and a half year. The Apple II was fully developed by the fall of 1976 and introduced during the summer of 1977.

Productivity: The Apple II was the first truly successful "personal computer" and it was developed by Wozniak who designed the majority of the internal workings and Jobs who defined the overall concept and appearance.

TPQ: The Apple II was a product which basically created the personal computer market had very low expectations, in part because it had little competition. The early personal computers were purchased by hobbyists that had the knowledge to program their own routines. At the beginning there was little standard software available, but with the introduction of Visicalc, a financial modeling program developed by two Harvard Business School students, the demand for the Apple II increase. As the Apple II became popular its features were enhanced by adding peripheral devices to expand its applications. The hardware and software programs stimulated sales. This technology was enhanced in the Apple III to solve the shortcomings sensed by market research. Another further application was the Apple IIe which was introduced as an "enhanced" Apple II.

3.3.3. Lisa: Performance factors

Lead Time: Work on Lisa began in January 1979 and was launched in March 1983. The lead time of this project was four years.

Productivity: The Lisa initial project was to be accomplished in May 1981 but took two more years to develop. The Wall Street Journal reported in January 1983 that:

One reason the Lisa has taken so long getting to market is that Apple was undertaking an enormous development job for such a young company.

Up to this development Apple II was the only successful product created by the company and after six years it was becoming an obsolete machine. By this time IBM's PC. was establishing itself as a strong competitor and beating this product in sales. To develop the Lisa, Apple invested 50 million dollars.

TPQ: The Lisa was designed to appeal to a new breed of business people and was targeted at large corporate customers, a market traditionally dominated by IBM and new to Apple.

The market research prior to Lisa's development showed that people were using the Apple II basically due to the spreadsheet and work processing activities and they also needed graphic and communication capabilities. The most important conclusion of this research was that the consumers expected a machine that was more user friendly.

Lisa was a market failure. It's initial introduction price of $9,995 was too expensive compared with the IBM oriented Pc. The Lisa was not faster than the IBM-PC because its superior graphics capability consumed much of the machine's higher processing power.

Apple sold the Lisa from stock in distribution rather than through classic booking, so it didn't know the demand at any particular point in time.

Other reasons for Lisa's failure were that it couldn't communicate with other computers and incompatibility with the Apple's already developed software. To overcome these problems the company finally merged the Lisa's division with the Macintosh development.

3.3.4. Macintosh: Performance factors

Lead time: The lead time of the Macintosh's development was three years. The project started in March 1981 and was introduced in January 1984. This product was initially scheduled to be launched in 1983 but was delayed six months.

Productivity: In order to develop the Macintosh , Apple assembled a separate team of people from the Apple II and Lisa group project. Many other were hired from Xerox Parc. This new product also included a total new manufacturing process development.

The development of Macintosh cost Apple approximately $35 million. The launching campaign cost $15 million and after four months the company reported it had shipped more than $70,000 Macintosh computers.

TPQ: The Macintosh developed from the same basic concept that initiated the Lisa but had a better introduction price, was introduced with more software packages available for the customers.

Steve Jobs wanted this computer to have a lower price than the original Lisa and not to overpass $2000 dollars. Apple wanted to design this computer as comfortable and natural as possible. An important aspect of creating this atmosphere was achieved by developing a software that would make the human interaction with the Macintosh easier than that offered by other computers.

The Macintosh was focused primarily on the office segment and had only small penetration on the field of education, home , and small business. By 1985, the Macintosh was the most important product of the company.

3.3.5. Conclusion

The information model shows that even though Apple has been a technological innovator its success has focused on two products which are the Apple II and the Macintosh. The Apple II basically created the personal computer industry and had no other serious competitor until IBM introduced its PC. The Macintosh was a technological breakthrough creating a computer which was easier to use. This computer developed from the same concept that initiated the Lisa project but was priced correctly. The Macintosh linked the product and process development effectively. The market research that showed the need for a friendly computer environment

Linked the product with the customers' requirements. The Lisa failed because there was a mismatch between its features and performance and the office market it was oriented to capture.

The analysis of the lead time shows that Apple did not accomplish its goals within the expected time. Further analysis of this shows a company with many internal communication problems which are reflected by constant changes in its organizational structure.

An analysis of its productivity factor shows that Apple has invested huge amounts on research and development. Once again the constant changes of internal structure show a constant effort to be more productive and to create effective interface networks.

Appendix includes diferent stage of the organisational charts throught out first eight years of Apple.

An analysis of its TPQ shows an interest on superb quality, an interest on market research but lack of feedback for proper implementation of the newly developed products regarding the targeted market.

CONCLUSION

Having two different models helped us to cover all the major aspects of the new product development process. It has been concluded that companies are in a constant change whether they change their organizational style or not. Their capability of changing organizational structure dynamicly is important for their survival in a rapidly changing technological environment.

Mapping process concludes that creating coherent functional strategies is essential to the success of new products and processes. Getting straight the driving forces in the business and function, the position of competitors, and the choices confronting the business, is essential to picking the right projects, establishing support capabilities, and achieving effective projects. Maps can play a critical role in clarifying choices and facilitating communications.

The informational model provides a good approach to study Apple's developments in the past and shapes its future technological strategies. In the Apple case, the model shows that:

-to increase the technological productivity

-to increase the sucess of targeting the right market

-to keep the TPQ standards (by maintaining its position as an innovator)

-to reduce the lead time

Apple has changed its organizational structure dynamicly throughout its evolution.

It is obvious that Apple is the perfect example for other companies in an emerging market, or in a high-tech environment. Therefore they should consider the following guidelines:

- Draw the marketing map: identify the target market and involve the customers to define the features of the product.

- Draw the design engineering map: consider the feasibility of the new product improvement and set the lead time according to the forecasted evolution of technology.

- Draw the manufacturing map: adapt the manufacturing process to the product (manual operation, automation).

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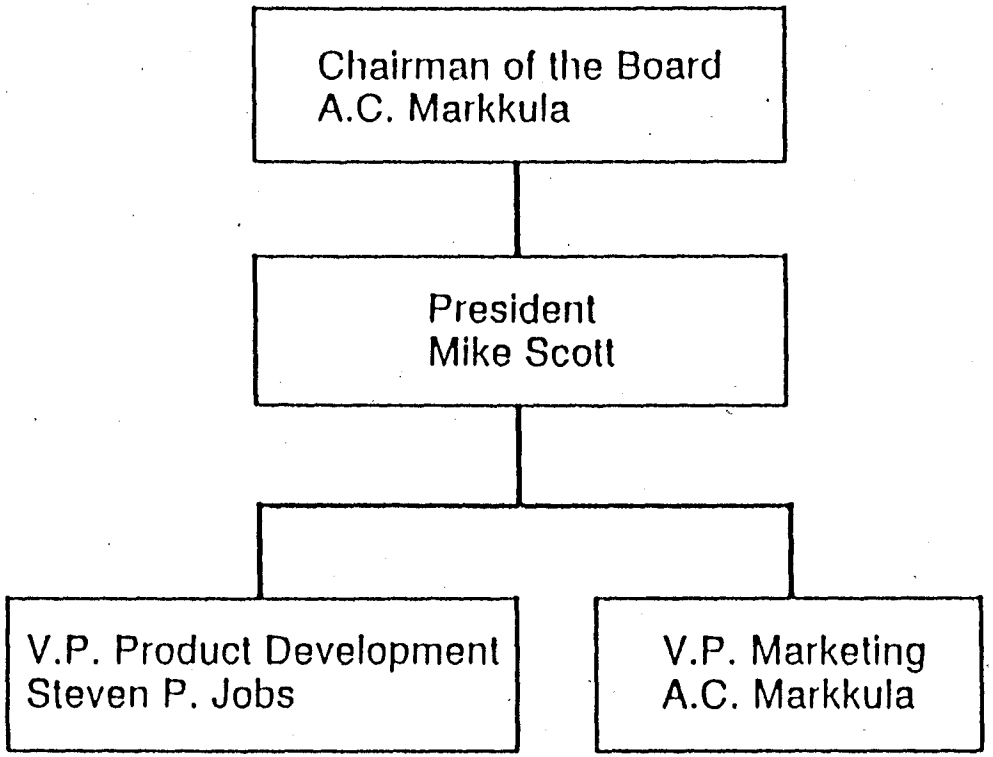
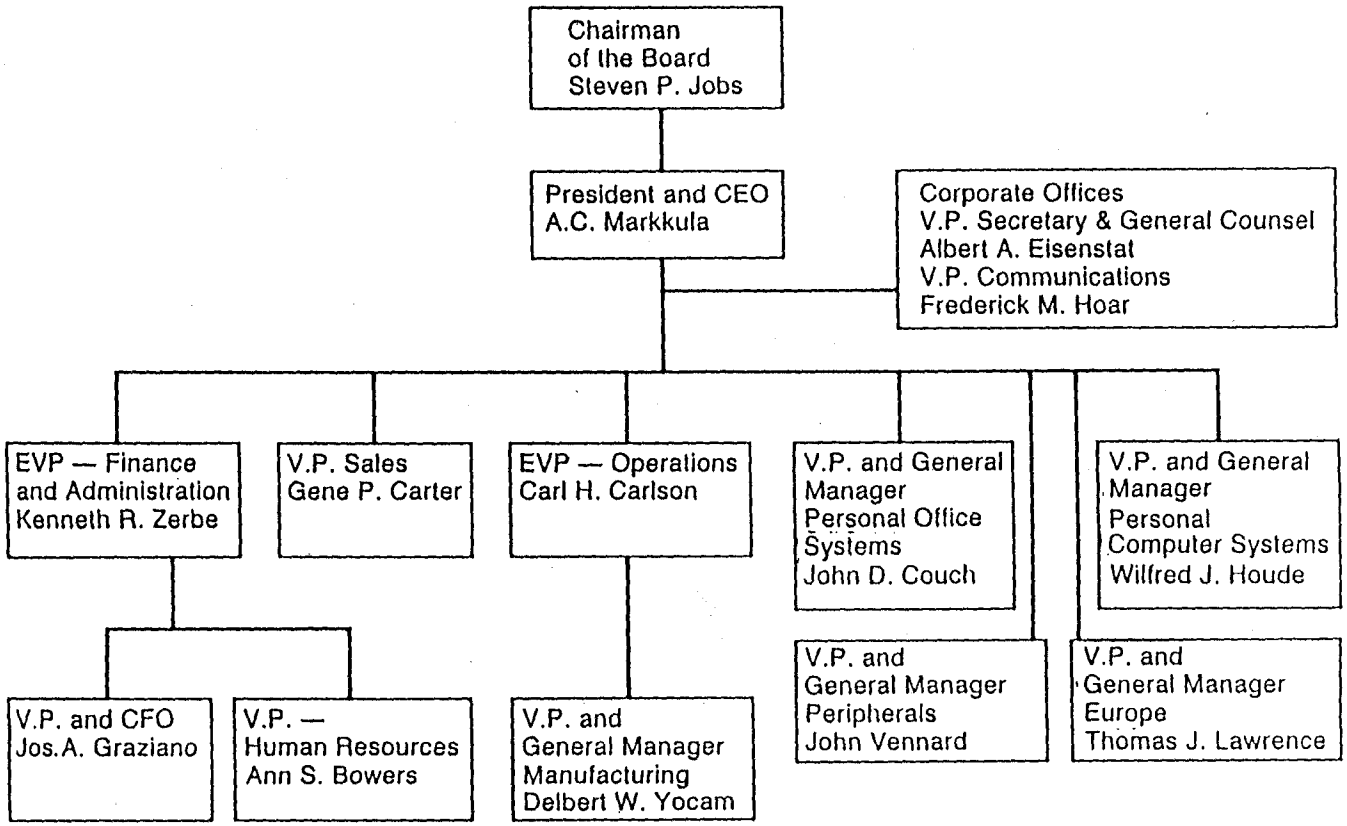
Appendix

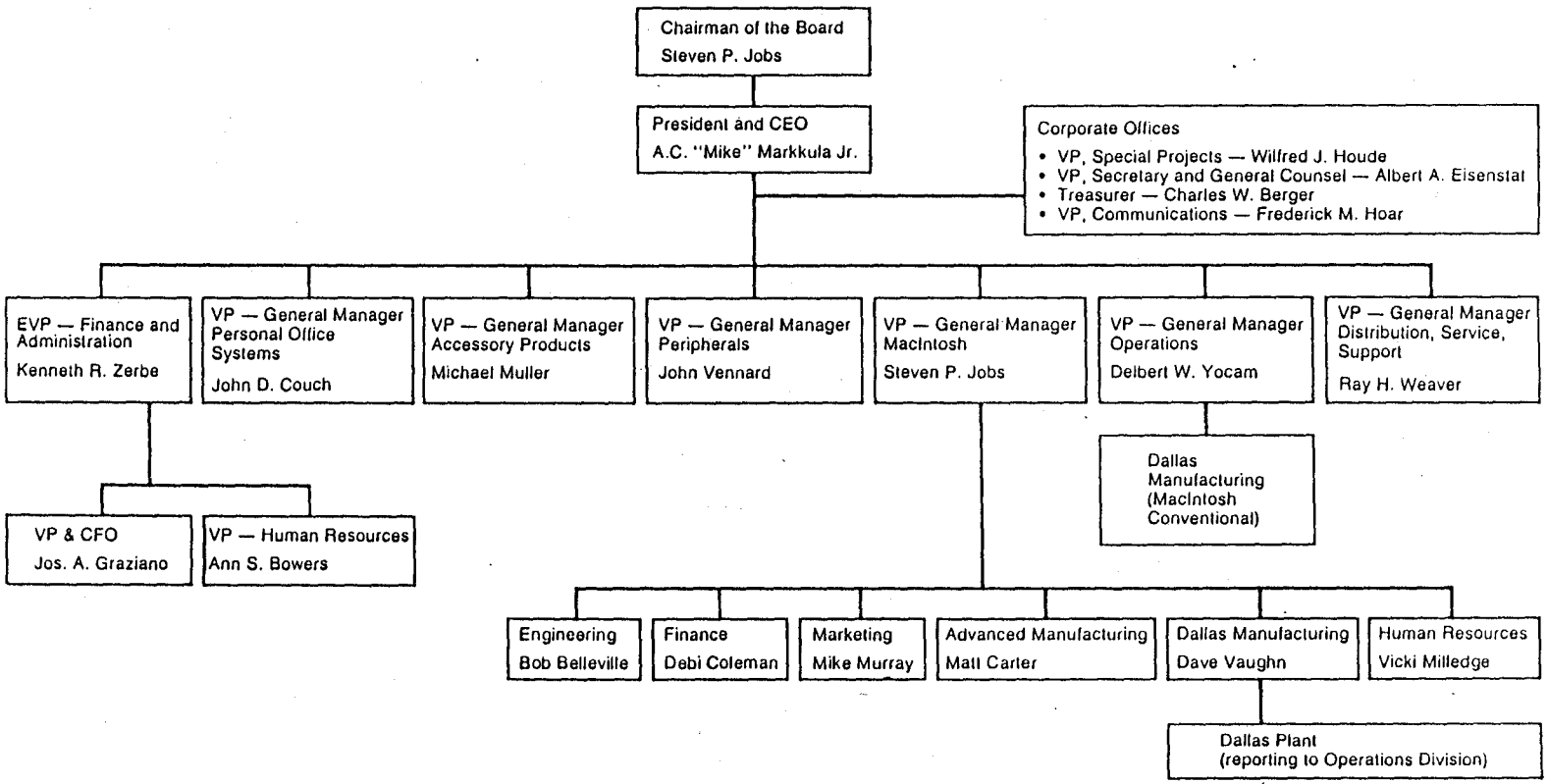
Company Organization, 1978



Company Organization, 1981



Company and Macintosh Organization (February 1983)



SOURCE: "Apple Computer, Inc.—Macintosh (A)," Stanford University, Graduate School of Business Case #S-BP-234, p. 25, revised 3/12/84.

Company Organization, September 1984