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Core Competencies, Product Families and Sustained Business Success

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Introduction

This paper examines the issue of sustained success in product development. We have observed that some firms which grow to dominate their markets later falter and are unable to maintain their leading position. Others firms may occasionally hit a "home run" with a new product introduction, but seem unable to extend or repeat that winning experience. A chorus of advice has arisen that says firms must both produce and develop products with ever smaller lead times. We believe that the time-based competition approach cannot be applied in a wholesale manner. For derivative and incremental products, it works. However, rapid concept to market approach can prove dangerous for more novel and exploratory efforts, producing products that customers show little proclivity to buy. Similarly styled advice has emerged in the areas of "core competencies" and "organizational learning" -- but little work has been performed to date to show how firms can systematically measure these phenomena and develop strategies for enhancing them.

The purpose of this paper is to build on prior research in order to understand and clearly structure the concepts and knowledge lying generally within the theme of sustaining success. We then will outline our own research questions, definitions and hypotheses to be studied through more intensive field work, the exploratory phase of which is already underway. In brief, our thesis is that sustained success depends not only on reduced cycle times for development and production, but on the closely related and interlinked topics of developing and renewing the firm's set of core competencies, organizational learning through which competencies are developed and within which they are embodied, and new product strategy as exemplified in the network of relationships among new product developments, established products and product lines, and established and emerging core competencies of the firm.

A Review of Concepts:

I. Core Competencies

Prahalad and Hamel (1990) suggested that a firm's ability to identify, nurture, and exploit its basic strengths into "core products" is both directly related to competitiveness and provides a new perspective on organizational form and process. Rather than examine their firms as "portfolios of businesses", it was suggested that executives should view them as portfolios of core competencies that transcend specific strategic business unit boundaries. These competencies are defined as "the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies." Such competencies serve as the basis for multiple market applications, difficult to imitate, and providing a substantial part of the design in final products that solve customers' perceived problems and needs. From these cross organizational strengths, "core products" can be devised which serve as the basis of target market domination, the "linchpins between design and development skills that ultimately lead to a proliferation of end products." While Prahalad and Hamel provide no methods to measure their concept, nor do they present data, their case illustrations are nonetheless compelling, calling forth firms such as 3M, Black and Decker, Honda, NEC, and Canon that sustain world brand recognition by exploiting their respective core competencies.

Earlier work by the authors and others lends support to the basic idea that core competencies are enhanced or dissipated through the presence or lack of organizational learning, and that strong competencies are associated with competitive success. Meyer (1986), Meyer and Roberts (1988), and Roberts and Meyer (1991), for example, studied new product strategy in technology-based firms. They assessed the creation and importance of "strategic focus" in a firm's earlier new product development activities by examining changes in the product technology and market applications between successive products. More specifically, they examined embodied "core technologies" in the technology dimension, and targeted customer groups, customer uses of products, and distribution channels in the market dimension for a sample of technology-based firms. "Focused firms" were those that concentrated on single sets of related core technologies and applied them to produce what may be referred to as long-term "product cores", the foundations

for a given generation of a product line. The firms were also observed to make major architectural and component-substitution enhancements to their "product cores" in three to five year intervals. Such firms performed better than unfocused ones. Streams of technical and market-knowledge core competencies were observed to have been developed within these high growth firms over time.

It should be noted that these findings were based on averages of product technology and market applications newness, which were then correlated with various measures of performance. The authors knew that in working with averages, the dynamic aspects of core technology enhancement or dissipation and of market applications strengths would be lost. Accordingly, for each of the cases in their sample, the authors connected the product points on the newness classification maps, and compared these "pictures" of new product strategy as presented in Figures 1 and 2. These pictures suggested the dynamic nature of product strategy far more intuitively than did the statistical summations. However, we had no modeling or statistical technique that seemed adequate for capturing the ebbs and flows of core technology and market applications strengths over time. Applying dynamic modelling and assessment techniques to the study of new product strategy and core competence development is one of the overriding goals of our current research.

Insert Figure 1 here

Insert Figure 2 here

In addition to the authors' prior work, Abernathy and Clark (1985) also studied the relationship of changes in both product technologies and markets to product success. They created a "transilience" map for classifying the changes in technologies and markets between successive products, and suggested general types of product innovation that might occur. The map shows another way to visualize the evolution of core competencies as they are represented in products. Their ideas are illustrated in Figure 3. The initial stages of the evolution of a core technical competence will be present in products lying in the upper right quadrant of the transilience map where the firm struggles to find the best underlying, "architectural" design. Once such a "dominant design" is achieved, the strengthening of the core competence then occurs as products shift downwards to the lower left quadrant, or to use the terms of the Utterback and Abernathy (1975)

model, from a "fluid" to a "specific" state, where product versions are created. New products in the upper left quadrant tend to dissipate existing market knowledge strengths, seeking to apply existing technologies to new market applications. New products in the lower right quadrant, on the other hand, seek to replace older generations of technology with new, "revolutionary" substitutes.

Insert Figure 3 here

Perhaps the greatest utility of core technology and market strengths lies in recognizing the down-side, *i.e.* that firms can lose their distinctive competencies just as well as enhancing them. The process is entirely dynamic, and while subject to external competitive and customer events, also subject to management at both strategic and tactical levels.

Can we be much more specific about what a core competence is, and is not? Can core competencies be typed (for example, product technology as a type versus manufacturing technologies or processes as another type), and then tracked between successive new product efforts for the enhancements to them over the course of time? In our research we intend to carefully define the core competencies of a firm based on detailed study of the technological bases of a sample of its most important current and past new product developments. We expect to find that the most critical core competencies of the firm will be seen as central in a wide variety of product development efforts, and that the more important product development efforts encountered will be those which are based on several of the firm's core competencies.

II. Organizational Learning

The second major stream of thought that has recently entered management thinking is that of "organizational learning". Core competencies may be thought of as being strengthened or diminished through organizational learning. Organizational theorists have provided a perspective on organizational learning in which learning is seen to occur as knowledge sharing among and between individuals and teams. Argyris and Schon (1978) considered learning in response to changes in the internal and external environments. Nonaka and Johansson (1985)

studied the level of shared knowledge, information integration, on the job training, and continuing education as key elements of organizational learning. Pareek (1988) focused on team work and suggested that competence building was the primary goal of learning.

Organizational learning is embodied not only in the people and artifacts, products and processes, of a firm, but also in its procedures and linkages. If the same set of people are assigned to different groups, different tasks and different physical spaces, much of what has been "learned" by the organization over a period of years will be attenuated, and months or even years may be required to rebuild communication networks and routines (Taylor and Utterback, 1975). Conversely, if a new entrant is inserted into a strong network of relationships and routines, that individual will quickly become an effectively functioning part of the organization (Gerstberger 1969). Groups which stay together for extended periods have been seen to lose their effectiveness and ability to generate new ideas, or even to keep up with current thinking in their fields of endeavor. This effect can be mitigated by steadily adding new people to the group at a moderate rate, while moving a few of the most experienced members on to new assignments. (Allen and Katz, 1991) This means that an effective organization will be in a constant state of dynamic equilibrium and change, having a steady flow of people through different functions.

The late Jack Morton, while managing Bell Laboratories, described organizational renewal as a constant process of both creating and destroying bonds and barriers among people and groups. An organization with too few bonds or barriers will be ineffective except in the most static environment, as will an organization which seldom changes. However, changing all barriers and bonds at once leads to chaos. Morton (1971), and the authors argue for measured change. In terms of the present study this means that attempting to add many new core competencies to an organization, or to shift people rapidly from one field to another is not likely to be effective. We would argue based on the research on communication and organizational change we have reviewed above, that new and needed core competencies must be carefully selected and added in a measured way to provide for sustained success.

Can we show that organizational learning has occurred for specific core competencies? Further, can we do more than merely observe relationships between

the applications of core competencies to new products, and instead, strive to assess the quality or degree of core competence growth or dissipation between successive new products, or product families?

Organizational learning can be posited to have two basic characteristics: the degree of learning, and the type of learning as reflected in crossing organizational boundaries. With respect to the former, we expect that new product developments based on just one of the firm's core competencies will generally be routine or incremental in nature. This implies a lesser degree of organizational learning. New product developments based on several core competencies, especially including those newly added or developed in the firm's mix, will tend to be more radical or discontinuous than others, to have a greater degree of "transilience" as defined by Abernathy and Clark (1985), or to represent a greater degree of architectural change as defined by Henderson and Clark (1990). Tushman and Anderson (1986) have discussed the impact of technological changes on organizational competencies. This type of change implies a higher degree of organizational learning.

With respect to the nature of organizational learning, product developments which require several core competencies to be combined across groups or divisions within the firm may be spoken of as requiring interfunctional teams or partnerships. We expect that this will be more common in turbulent and rapidly changing competitive environments.

III. New Product Strategy

The third stream of management thought, one older than those discussed above, is that of new product strategy. The tradition of technology management research has focused on single product successes and failures. Dating back to project Sappho (Freeman 1986), this approach has been carried forward in the more contemporary work of Maidique and Zirger (1985), Cooper (1986), and Souder (1987). We believe that single product focus is incompatible with examining the notion of core competencies and the learning required to enhance them. Core competencies are supra-departmental and supra-product.

The success or failure of various new product development attempts represent in our view one of the most important vectors of organizational learning and the development of core competencies. More recent research has adopted more of a product-line and family orientation.

The work of Meyer and Roberts (1988), for example, studied the core technologies and market knowledge within evolving product lines to assess a firm's strategic focus. Similarly, the stylized "S" shaped curve of increasing technological performance of a product over time (Foster 1986) implies that the slope of the curve is the result of the number of product introductions or "experiments" being conducted at a given time. Maidique and Zirger (1985) enlarge this argument by pointing out that often more useful information is gained from product introduction failures than successes if a firm is open to examining and understanding them. More recently, Sanderson and Uzumeri (1990) have studied the evolution of Sony's portable tape recorders, finding that in "the most successful firms, product families are upgraded and enhanced throughout their life cycle with periodic introductions of new technologies which provide enhanced functionality, higher quality, or lower production costs. (p. 15)"

Utterback and Abernathy's (1975) concept of the "dominant design" suggests the encapsulation of organizational learning in new product development. The turbulent competitive process through which many firms enter and some leave the industry is, at a higher level, a process of experimentation by industry participants. Each product introduction is a new "experiment" from which user feedback is obtained. Performance dimensions will tend to be many and highly varied and often be incommensurate at this early stage. As a product entrants evolve, certain features will be incorporated as a matter of course and thereby subsume the related performance dimensions into the design. With the appearance of a "dominant design," the product may be described by a few related and commensurable dimensions, and from the customer's perspective, may be thought of as "fully-featured". Much learning will have been achieved.

The importance of this idea for the present work is that we expect firms that create a richer environment of product development, one having more varied projects more rapidly brought to market, will also be seen to experience a greater degree of learning from those introductions. In fact, this is the essence of the descriptions of

Gupta and Wilemon (1990), Takeuchi and Nonaka (1986), and others of the rapid new product introduction rates of certain Japanese firms. Of course, one can imagine extreme cases in which the rate of product change is so rapid or unfocussed, or in which personnel turnover is too high, that learning does not occur, competence is dissipated, and resources thus wasted.

IV. Time-based Competition

As with core competence and organizational learning, "time-based competition" is now in vogue. Many arguments have been advanced in favor of moving new products concepts through development and into the market quickly. Stalk (1988) points to the flexible factory as a new source of time-based advantage for Japanese manufacturers. By facilitating greater variety and shorter production runs, flexible manufacturing also may mitigate the "productivity dilemma" originally posed by Abernathy (1978). Flexibility and shorter runs allow more occasions for experimentation, allowing firms to quickly respond to market signals, expanding production of products that are well accepted and dropping others. Stalk extends this idea from production to innovation stating that, "to accomplish their fast-paced innovations, leading Japanese manufacturers have introduced a series of organizational techniques that precisely parallel their approach to flexible manufacturing." (p. 49) Stalk compares the Japanese approach of favoring smaller increments of improvement more often to the claimed Western approach of larger but less frequent changes. He goes on to stress greater use by the Japanese of cross-functional teams and local, decentralized responsibility for development.

Not only are we are highly skeptical of such sweeping generalities, but we do not believe that either approach excludes the other. Our hypothesis is that the so-called "Western" approach may be much more successful when the development of "product cores" (the technical and market bases of product families) is required, while the so-called "Japanese" approach may be more appropriate for proliferating product variety and model changes. Moreover, feedback from each approach should serve to inform and improve the other. Nor are national associations particularly useful. Japanese firms such as Sony spent a patient 20 years in developing the product cores of compact video recorders and cameras (Cusumano et al. 1991). Black and Decker (Lehnerd 1987) dominated the portable power tool market using what

Stalk (1988) called the "Japanese" approach, using rapid rates of product innovation and introduction to increase the range of its product offerings!

As was the case with Prahalad's work, Stalk offers compelling cases and arguments, but no rigorous tests of his ideas. Gupta and Wilemon (1990) in an extensive review of work in this area conclude that though the need for better knowledge of effective ways to accelerate the development of new products is compelling, little work has been done in the area, and none of the work that they encountered was based on a carefully devised large sample. Gupta and Wilemon report virtually unanimous agreement among their respondents on the need to develop more products, while developing products more quickly. However, Clark and Fujimoto (1991) caution that simply trying to accelerate product developments without first achieving simplicity and efficiency can be the road to ruin for a firm. Increasing the number of projects and attempting simultaneously to push them to completion faster by adding to resources, without first streamlining the development process, will rapidly inflate costs.

The authors have also worked in the area of time-based competition. We studied twelve technological ventures undertaken by a large aluminum company that sought to extend the company's core aluminum technological skills to new market applications. Our approach was to first classify these ventures on the well known dimensions of technical newness and market newness, and then look for key differences in terms of the venture creation and management process. Clear differences emerged among the different ventures in a variety of areas (Utterback, Meyer, Tuff and Richardson, 1992). We observed that shortened business and technology development times place substantial pressures on a venture team which may not be desirable from a business perspective in certain classes of ventures. Market research may perhaps be short-changed. The early testing and quality assurance for new products may be performed perfunctorily. The marketing programs and materials required for truly successful market introduction may not be developed fully. All these factors may lead to a failed venture. On the other hand, a well conceived program for technology transfer and achieving market understanding can shorten market introduction time without sacrificing product value.

Thus, we hypothesized that "speed" in developing product concepts is relative to the capability of the company and to the nature of the product development it is attempting. Developments which are small improvements for familiar markets can legitimately be required to move into the market quickly and to meet financial targets. Both dimensions of product technologies and user needs are well known, and hence, speed and effectiveness are compatible objectives, and aligning them yields success. Developments which involve new applications of a firm's core technology in markets which though unfamiliar are simply substitutes for other products or materials require careful and systematic product and market development, with much attention placed on prototype development, testing and evaluation. Parallel prototype development, while increasing expense, has the potential to shorten cycle times and accelerate market penetration. In this type of development, effectiveness may not be equivalent to speed, and thus, speed not necessarily conducive to success. Lastly, development of novel technologies for unfamiliar markets and latent markets requires a great degree of experimentation and learning to reduce uncertainty. Development should proceed slowly, perhaps sequentially, and expenditures should be kept relatively low. Our contention is that in such cases, much care should be taken to develop a "product core" before seeking to speed applications and variations to market.

V. Synthesis

The synthesis of these four basic concepts -- core competencies, organizational learning, new product strategy, and time-based competition -- leads to the following premises that serve as a launching pad for the new research to be outlined in the pages to follow. These premises are:

- Individual new products are the outcomes of a firm's longer-lived, underlying core competencies.

- The fact that a particular new product may not be a commercial success does not necessarily mean that its embodied core competencies are flawed relative to those of competitors. Learning gained from failures may contribute greatly to competence development, and a stream of successful related products over time.

- A firm's competencies, if substantial levels of organizational learning exist, are shared between products and their respective controlling organizational units.

- "Product cores", being the result of one or more core competencies, do not necessarily have to be complete, marketable "products" in the traditional sense, but rather, serve primarily as the architecture and key modules of a series of closely related complete products that ordinarily constitute a "product line".

- The idea that all product developments can be beneficially accelerated is fallacious. Our consideration must be broadened not only to families of serially introduced products, but also to "product cores" as defined above, and to the underlying core competencies of the firm if we are to clearly understand which developments should be hastened and which not.

Applying the Concepts to the Study of Sustained Product Success

The authors' goal is to develop a framework and its derivative hypotheses for studying a technology-based firm's product strategy by studying the evolution of its core competencies. This can be achieved by answering the following basic questions:

- How can one measure and otherwise assess the dynamic evolution of a firm's core competencies?

- How can one assess the type and level organizational learning occurring in a firm over extended periods of time?

- How can the "time factor" for development of new product concepts be incorporated into the study of core competencies and learning? Do stronger competencies lead to shorter development times?

- How can new product "success" also be incorporated into the study? Is there a relationship between the success of individual products related to the longer-term, sustained learning and competence enhancement?

I. Defining a Core Competence

Our perspective on core competencies is very applied. If core competencies are viewed as those skills and assets that exist in a firm that result in actual products and services delivered its chosen markets, then an approach for studying them is suggested by prior research. Let us propose four basic components of core competence:

- **Product Technologies & Design**: Prior research by the authors examined changes in embodied product technologies between successive products. (Meyer (1986), Meyer and Roberts (1988), Roberts and Meyer (1991)). Ketteringham and White (1983) also studied embodied technology in products within the pharmaceutical industry. Roberts and Berry (1985) assessed product technology in their study of new venture strategy, as have Cooper (1986), Maidique and Zirger (1985) in their field studies of product

development. One aspect of the Abernathy and Utterback (1978) model concerns rates of change in product innovation, and Abernathy and Clark (1985) studied changes in product technology within their "transilience map". All these studies were concerned with how a firm builds internal technological strengths to make distinctive products.

- **Market Applications:** This component is typically viewed as specific and distinct groups of external customers for the firm, although if one also wishes to assess the "products" or services of corporate staffs, internal customer groups can be further identified. Changes in customer groups have been studied by several of the authors cited immediately above. These include Abernathy and Clark(1985), Meyer and Roberts(1988), and Roberts and Berry(1985). Utterback et al (1992) also studied the impact of newness in target customer groups on clearly defining customer requirements and on concept to market durations.

- **Distribution Channels & Methods:** Meyer and Roberts (1988) studied the difference between utilizing existing channels for new products and building new ones. From a pragmatic perspective, distribution channel size and effectiveness are clearly central to achieving commercial success with new products and services. (The Economist recently reported that the rapid rate of product introduction for Japanese consumer products was in part due to generally accepted retail practices that led retailers to accept whatever manufacturers wished to supply because guaranteed return policies minimized the risk of unsold inventories.)

- **Manufacturing Technologies & Processes:** Abernathy and Utterback (1978), Abernathy and Clark (1985), Stalk (1988), and De Meyer (1990) are a few of the individuals who have specifically examined the role of manufacturing processes and technologies in commercial innovation, as well as the impact of having to develop new manufacturing capabilities on concept to market issues.

The research performed in each of these fields offers a set of metrics that we can adapt. These metrics evolve around the notion of "newness" (Cooper (1986), Meyer and Roberts (1988), Maidique and Zirger (1985)), *i.e.* the change that the core

competence component represents in a current new product relative to all other prior new product efforts undertaken by the firm. Appendix 1 contains an initial set of measures for each of the four components.

II. Units of Analysis versus Levels of Assessment

Product:

The logical sampling points for measuring change among the four components are each new product released by a firm over time. These can be referred to as individual products. These individual product data can then be aggregated to higher levels, so that the growth or diminution of a firm's core competence can be considered at higher levels. The first of these at the level of the "product line" or "product family". Then, above that level is that of the firm itself. in which "streams" of core competencies evolve over time, spanning multiple product families and their organizational units. Collectively, these three levels constitute the firm's "product network".

The entire historical product portfolio of a firm can be perceived as a "network" of products, representing each new product released by the firm over time. For each product, the product team receives varying degrees of "inputs" in the form of the four components of core competence defined above: existing product technology (internal and external to the firm), prior market knowledge, distribution competencies, and manufacturing capabilities. In the course of developing the product, the team either adds value to these competencies, or creates new competencies in each respective area. In turn, these product assets then become available to other new product efforts, be they in the same product family or in one different than that of the current product. This model of the product is shown in Figure 4.

Insert Figure 4 Here

Product Networks:

Over time, a network of products emerges with a firm. Core competencies flow forward through the network, ostensibly in various forms and mechanisms of learning.

To illustrate the product network, one of Meyer and Roberts' (1988) "focused" firms was reassessed and recast into a network, as shown in Figure 5. That illustration is much like any product line chart that one would expect to find for a product-manufacturing company. This particular firm, Data Printer, had a distinctive core competence for making high-speed line printers. Over the years, there was a high degree of consistency and enhancement in the product technology, market applications and channels, and manufacturing technology from one product to the next. [1] The R&D effort to build "product cores" for each of the three generations of that firm's product lines are also indicated in Figure 5, representing the shift from "drum", to "band", to "chain" line printer architectures.

Insert Figure 5 Here

As another illustration, data from Apple Computer's products were cast into a product network, as shown in Figure 6. These data are for computers, and not Apple's printers or other computer peripherals. These data were abstracted from Swanger and Maidique (1985), whose case covers the first ten years of Apple Computer, and from additional conversations with company representatives. We believe that the company's products are the end result of two specific core competencies: the first (and most obvious) being in the manufacture and distribution of personal computers and peripherals, and the second, in the design and implementation of the user interface software for computers. Each competence has been sustained and enhanced over a substantial period of time, and in combination, have allowed Apple Computer not only to swim against the prevailing tide of IBM-PC compatibility but to establish a dominant design for the

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[11] The authors wish to thank Melvin Litvin, founder and CEO of Data Printer (now a subsidiary of Printronix), for providing these data.

user interface on all PC's.[2] The firm's basic "product cores" are shown to have shifted from the architecture associated first in the Apple I &II series, to those of MacIntosh, the MacII, and more recently, the Powerbook (notebook) and the Quadra (file server) series.

Can the level of continued enhancement or lack thereof in each of four dimensions of core competence across this network be studied with dynamic modelling and statistical techniques that match the ever changing, dynamic nature of learning which occurs in firms? We propose to work toward this end.

III. Measuring Time, Cost, and Success

Understanding the impact on time, cost, and success (as dependent variables) on the levels of core competence development and learning also breaks new research ground. Time can be measured according to certain basic project milestones (initiation, first working prototype, release for sale). Costs can be measured with annual project budgets for each new product. In measurements of success, one is not as fortunate in terms of the availability of consistent information differentiated by individual products. Souder (1987), among others, has used subjective scales as proxies for success, distinguishing between technical versus business success. Appendix II contains Souder's metric.

The measurement of time, cost, and success serve in effect as dependent variables against which to compare core competence development and learning. Our model of the product in Figure 4 reflects these measurements as elements of each product.

As in the case of the components of core competence, these time and cost measurements gathered for individual products can be summarized at the level of product families, and then at that of the firm, showing the life cycle and expenditures for the evolution of specific competencies.

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[2] (Does not Microsoft's Window's, or IBM's Presentation Manager for OS-2, or OpenLook and Motif on Unix workstations look striking similar to the MacIntosh interface?)

Product Line Strategies and Patterns

While product and networks of products suggest an approach for assessing the evolution of core competencies, we also believe that these data may reveal patterns of new product strategy that are compatible with the strengthening of core competencies through organizational learning. In other words, the "product networks" of firms with clear competencies, sustained learning, and commercial success will be visibly different than those of firms without such characteristics.

I. The Home Run Pattern

Figures 7, 8, and 9 show three distinct patterns of new product strategy we wish to consider. The first pattern, shown in Figure 7, is one where little overlap exists between successive new products in terms of the four components of core competencies defined earlier. This may be called the "Home Run" strategy, where for each new product effort, the firm seeks to create major market successes in individual products. In the terms of the Meyer and Roberts (1988), this pattern reflects little "strategic focus"; Prahalad and Hamel (1990) would probably find this pattern suggestive of limited organizational learning and of management which is overambitious with each new product development effort. R&D service firms that release the fruits of their consulting labors in the form of "one-shot" products also fall into this category of strategy.

Perhaps the most successful "Home Run" technology-based firm recently is Lotus Development Corporation, which in the past, has had little shared technology between its major products (spreadsheet, data management, information resource, and distributed document control), and has not viewed them as part of a larger, cohesive "product family". In fact, many of its products have been generated through acquisitions. Philips efforts in the consumer electronics industry also appear as series of unrelated attempts at major technological and product advances, as witnessed by its attempts in VCR's, computers, compact disk players, and digital audio tapes.

II. The Double Header Pattern

The second pattern of product strategy, shown in Figure 8, is characterize by a single product family or by major discontinuities between distinct product families. Within product families, focus exists; between families, it does not. Within this conglomerate approach, highly successful, sustained product lines which exhibit core competence and learning, may be produced. However, the gaps between product lines suggests a lack of sharing and enhancement of core technologies, manufacturing capabilities, and distribution channels between different parts of the business. When such discontinuities within a firm's new product development efforts occurs, it is as if the firm is playing two different games at two different times -- hence our labeling of the pattern as "the Double Header".

Technological advances can force a firm to largely abandon its existing technologies and product architectures in order to remain competitive. For example, in recent years, a number of companies in the computer industry have seen the market demand for "open systems" force them to develop new product lines that are radically different than their older systems. Data General has essentially abandoned its older proprietary minicomputer line for its new, Unix-based Aviion line. Similarly, Digital Equipment Corporation is now finding that its once popular VAX-VMS product combination must be replaced with a substantially different RISC and Unix-based product architecture. Such discontinuities have been successfully managed by firms in the past and led to major, sustained market successes, particularly when the need for change is recognized early by management. Witness Apple Computer's "sea change" from the older Apple product line to the MacIntosh, or IBM's transition from mainframes to personal computers.

The Double Header pattern of new product strategy can also be produced by a firm that seeks to diversify into new product/markets through acquisition. Kodak, for example, has in recent years acquired a number of companies in an effort to diversify beyond its traditional film business. Atex, one of these acquisitions, has created a product family of newspaper publishing systems which, from a core competence perspective, represents a significant discontinuity for Kodak from film. Similarly, Prime Computer, traditionally known for its minicomputer products in the office automation line, created a new product family branch through its acquisition of Computervision (CAD systems).

III. The RBI Pattern

The last of the three generic patterns of new product strategy, shown in Figure 9, is called the "RBI pattern". It encapsulates the applied meaning of core competence development and extension. Unlike the Home Run management, RBI-style managers do not seek home-run type successes with any particular new product, but rather, sustained market dominance through the collective force of all the elements of any given product family. To achieve this end, even as products are released to the market for a given product line, management plans for their obsolescence through a program of major enhancement to underlying product architectures on a regular basis. This keeps the firm on the leading edge of advances in its industry, and over time offers existing customers an "upward migration path" that not only reassures existing and prospective customers about doing business with the firm, but also provides the firm with repeat customers.

Sun Microsystems is a good example of RBI-style management, and in many ways has been similar to Apple Computer in the character of its "generational" approach to hardware improvements. A leader in the workstation market, Sun's hardware product line has provided cost-performance alternatives for customers. These "solutions" have targeted three levels: "desktop" workstations, "deskside" office-level servers, and high performance "data center" servers. In the early 1980's, the firm introduced the "Sun 2", based on the Motorola 68010 and one of the first commercial workstations. Over the course of the next several years, Sun introduced a series of monochrome workstations and "servers" based on the Motorola's next generation of chip technology, the 68020. Then, in the latter 1980's, Sun upgraded its architecture to the Motorola 68030 chip, higher resolution and color displays, and the VMEbus for the high-end servers. The firm also introduced a lower-end Intel-based product (the Sun 386i family), which met with limited market success. Finally, in the last several years, Sun developed "SPARC" as its own chip architecture, and has introduced several generations of "SPARCstation" and server products using the new RISC chip since that time. On the software side, Sun has led developments in making the Unix operating system suitable for distributed processing -- and in developing software tools for developing distributed applications. This software R&D resulted in regular upgrades to the firm's operating system, networking, and window development tools across its entire product line.

The RBI pattern also differs markedly from the Double Header pattern in that new product families are produced with major technological and market knowledge inputs from existing families, and hence, core competencies. While discontinuity may exist, it is less extreme, and the organization is more likely to tolerate substantial transfers of persons and their expertise from existing business lines. It does not always guarantee success, however. For example, in our study of the internal venturing activities of a large materials company, we observed that the company's engineers were able to successfully create new aluminum applications for products as diverse as railroad cars, automobiles, industrial pumps, super-fine filter membranes, and batteries. Learning new market requirements and establishing distribution channels could not be as quickly nor as easily achieved. Today, many of these new product spin-offs are no longer pursued by the firm, whose senior management wished to see more immediate commercial results.

Summary

Over the course of time, a large technology-based firm might indeed pursue two or perhaps even three of the new product strategy patterns described above. Further, at any single point in time, one business unit of a firm might be a "Home Run" hitter, while others adopt the "Double Header" and "RBI" approaches. However, we believe that at any given point in time, a firm exhibits a particular pattern more strongly than others. Further, we hypothesize that some patterns of new product development will be much more functional than others in supporting the sustained success of the firm. In particular, we expect that:

> A corporate product technology strategy in which there are several product cores, each of which involves renewal and extension of a well developed existing and successful product core (the RBI pattern) will be more highly successful than will one which includes a series of new product concepts extending a well developed existing and successful product core (the Double Header Pattern).

And that:

> A corporate product technology strategy in which each new product concept is an extension of a well developed existing and successful product core (the Double Header Pattern) will be more highly successful than will one in which each new product concept is based on a new or emerging product core (The Home Run Hitter Pattern).

Once again, we doubt that any of these patterns will be absolutely clear or unique in any actual situation, but that they will serve as a useful basis for classification of firms' product development strategies.

Additionally, we believe that in studying the time required to move product concepts to market, that:

> In the development and regeneration of "product cores", *i.e.* the underlying technology architectures of product families, the quality of outcome is more important to sustained success than rapid development time, and that a competitively distinctive "product core" facilitates a rapid introduction of specific new products based on it.

Appendix 3 contains a more extensive presentation of research hypotheses. In order to succeed in the investigation of these questions, not only must operational measures of the components of core competencies as described above and shown in Figure 4 be developed, but we must consider analysis methods that capture the changing and dynamic fashion in which a firm's data are likely to evolve over time. These are not simple tasks, but we believe that achieving them will provide a significant contribution to the advancement of technology management.

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Appendix 1*

Product Technologies and Design

What are the "core technologies" embodied in the product?

Identify source of Technology (Description and External/Internal).

Core Technology	Source	Newness

Evaluate for each Core Technology the level of newness as follows:

1. The Core Technology is embedded in the company's own current products or services?
2. The Core Technology was licensed from external vendors.
3. The Core Technology is the basis of prototypes developed in the company's R&D laboratories, but not yet embodied in actual products or services nor licensed from external vendors.
4. None of the above, but there exist technological skills within the company that direct relate to the Core Technology required by the new product.
5. None of the above. The Core Technologies represented a new technical effort for the company.

* Taken from Field Research Questionairre

Market Applications Targets

Describe the Market Applications for the Product(s) in terms of the characteristics of each major customer group. Then, score the Familiarity of the Group and the Functional Use

Customer Group	Familiarity of Customer Group to the Company (See below)	What did the Customer use the Product for?

Evaluate each Customer Group in terms of the team's familiarity with the Group as:

1. An existing customer group
2. New, but existing for other parts of the company
3. New, but closely related to existing customers
4. New, and loosely related to existing customer groups
5. New, but unrelated to existing customer groups

Distribution Channels and Methods

Brief Description of Primary Channel:

Evaluate the primary channel for the Product:

1. Used existing channels with no changes or improvement
2. Used existing channels with some changes and improvement
3. Significantly expanded and improveed existing channels
4. Developed new channels, using distributors/OEM's already serving the target market
5. Developed new channels, using your own sales personnel

Rate Adequacy of Primary Channel in reaching target market:

Many Problems	Some Problems	Adequate	Very Good	Outstanding
1	2	3	4	5

Is this an actual result, or a likely expected result?

Actual Expected

Manufacturing Technologies and Processes

Identify and describe each of the distinct manufacturing processes employed in manufacturing the Product(s). Then score each process in terms of newness to the company. Lastly identify whether the manufacturing is being done internally or is being subcontracted.

Manufacturing Process	Newness to the Company	Internal/External

Newness of each Process at the time that the project began:

1. The process utilized existing production facilities that have adequate capacity, existing measures of quality, and existing degrees of precision.
2. The process of the product required the addition of extra capacity.
3. The process required a retooling of existing facilities.
4. The process required new production processes, new measures of quality and degrees of precision.
5. The manufacturing of the product required new facilities and production processes, new measures of quality and degrees of precision, all of which were created by the company itself.

Appendix 2*

Project Outcomes

Circle the Category Descriptions that Best Apply to the New Product:: Answer for the Product Family if Appropriate:

	Success OutComes**		Failure Outcomes	
Degree of Success or Failure	*Technical Outcomes*	*Commercial Outcomes*	*Technical Outcomes*	*Commercial Outcomes*
High	Breakthrough	Blockbuster	Complete Dud	Took a Bath We Won't Forget
Medium	Enhancement to Existing Core Technologies	Above Expectations	Gained Some Technology	Protected Market Position But Lost Money
Low	Met the Specs	Met Expectations	Learned About Technologies	Below Expectations

Is this an actual result, or a likely expected result?

Actual Expected

* Taken from Field Research Questionairre

** Souder, William E., ***Managing New Product Innovations***, Lexington, MA: Lexington Books, 1987.

Appendix 3
Research Hypotheses

Intra Project (Concept to Market)

Greater values of:

Technology Newness
Product Scope
Customer Newness
Distribution Newness
Manufacturing Newness

Product Newness to Market
Customer Receptivity (-)
Competitive Intensity (-)

Market Ambitiousness
Resource Requirements

Are expected to be related to longer development periods.

Greater values of:

Quality of Senior Management Support

Parallelism in Functional Activities
Use of Cross Functional Teams

Appropriateness of Organizational Control
Quality of Business Planning

Effective R&D Alliances
Effective External Marketing Alliances
Effective External Manufacturing Alliances

Are expected to accelerate development periods, other factors being equal.

A product concept which extends an existing and successful product core will be more likely to be incremental and more likely to be developed within the expected schedule than will a concept which must draw on a new or emerging product core.

A product concept which draws on several existing and successful product cores will be less likely to be developed within the expected schedule than will a concept which draws on a single existing and successful product core.

A product concept which draws on several existing and successful product cores and a new or emerging product core will be less likely to be developed within the expected schedule than will a concept which draws on several existing and successful product cores.

A product concept which draws on several new or emerging product cores will be more likely to be radically different and will be less likely to be developed within the expected schedule than will a concept which draws on several existing and successful product cores and a new or emerging product core.

Inter Project (Core Competencies and Networks)

A corporate product technology strategy in which each new product concept is an extension of a well developed existing and successful product core (Pattern B) will be more highly successful (proportion of projects judged to be technically successful and commercially significant) than will one in which each new product concept is based on a new or emerging product core (Pattern A). However, such a strategy may enjoy diminishing levels of success over time due to the obsolescence or replacement of the base product core by competitors.

A corporate product technology strategy in which there are several product cores, each of which involves renewal and extension of a well developed existing and successful product core (Pattern C) will be more highly successful (proportion of projects judged to be technically successful and commercially significant) than will one which includes a series of new product concepts extending a well developed existing and successful product core (Pattern B).

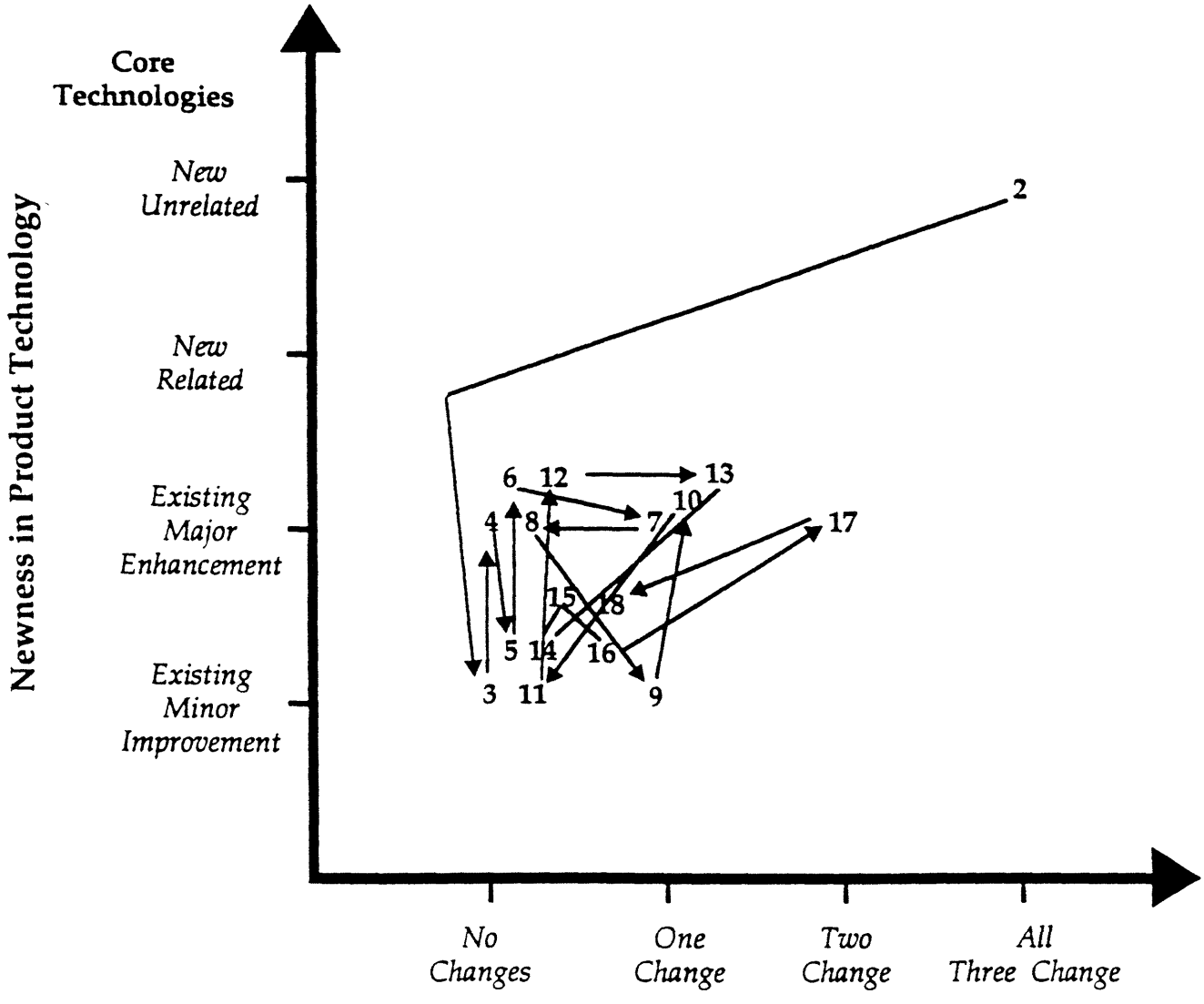
In general Pattern A < Pattern B < Pattern C in terms of longer term success in effectively developing and implementing new product concepts.

Reducing the time required to move from concept to market is not necessarily functional for core concepts as illustrated, especially in Pattern B.

Reducing the time required to move from concept to market is expected to be functional for derivative concepts as illustrated in Pattern B.

Sustained product lines will be seen to go through waves of major core concept enhancements over time as illustrated in Pattern C.

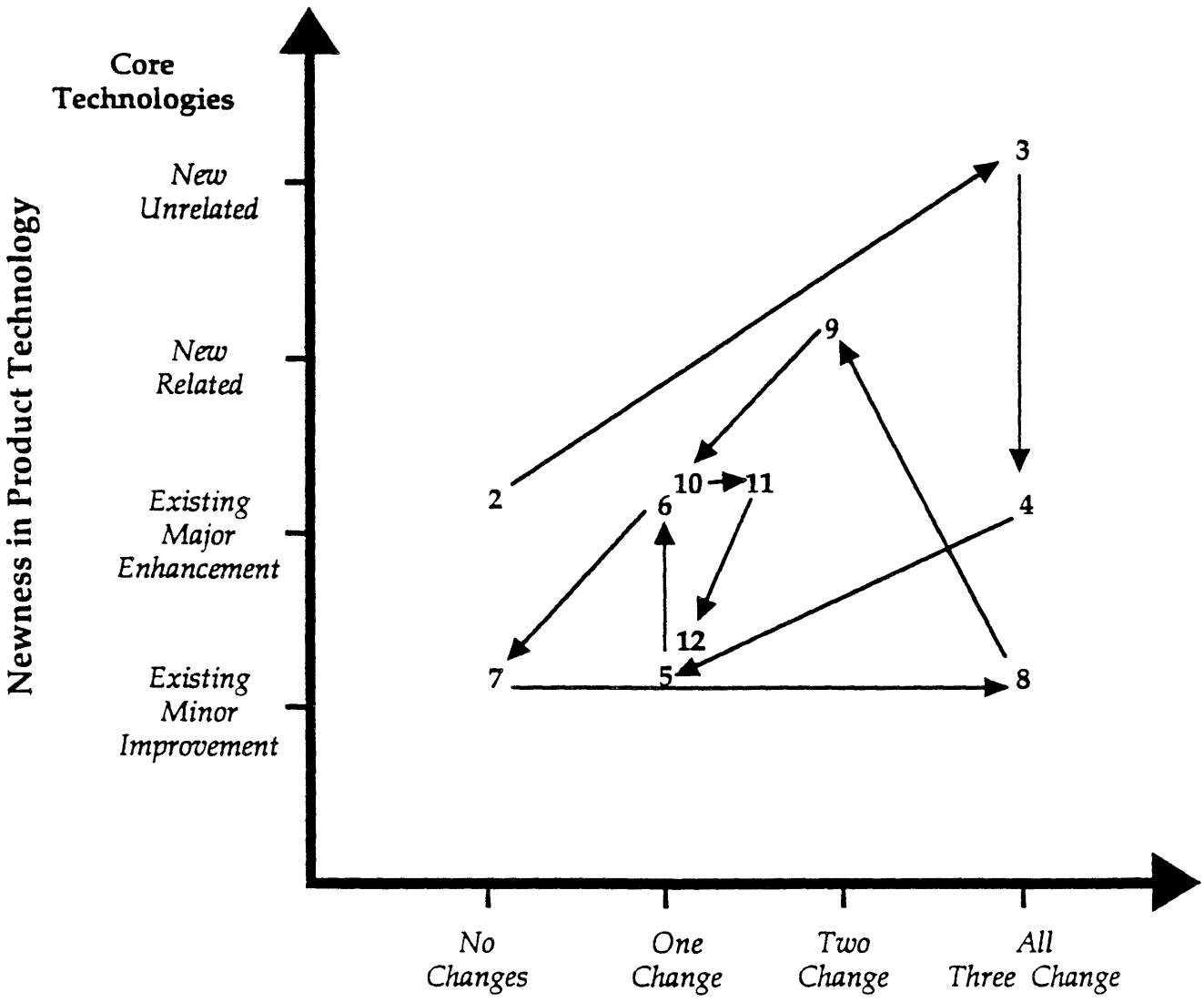
Figure 1
A Focused Firm
A Mapping of Its Historical Product Portfolio



A Computerized Gambling Machine

A Product Familiy of Dot Matrix Printers

Figure 2
An Unfocused Firm
A Mapping of Its Historical Product Portfolio



High Resolution Raster Terminals

→ **Graphics Inputs Tablets**

→ **Word Processing Turnkey System**

→ **Word Processing Software**

→ **Advertizing Software for Newspapers**

Figure 3
An Adapted Transilience Map

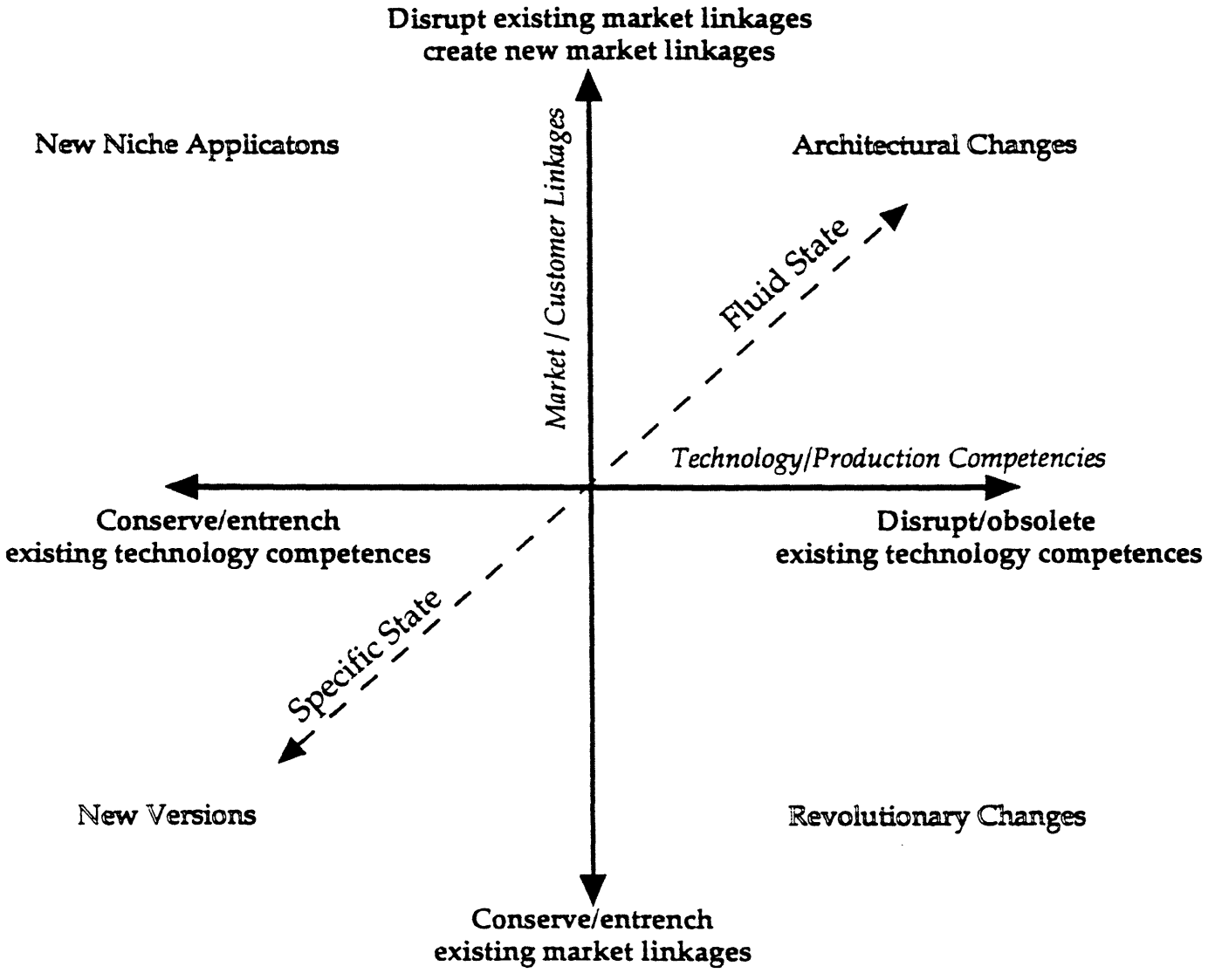
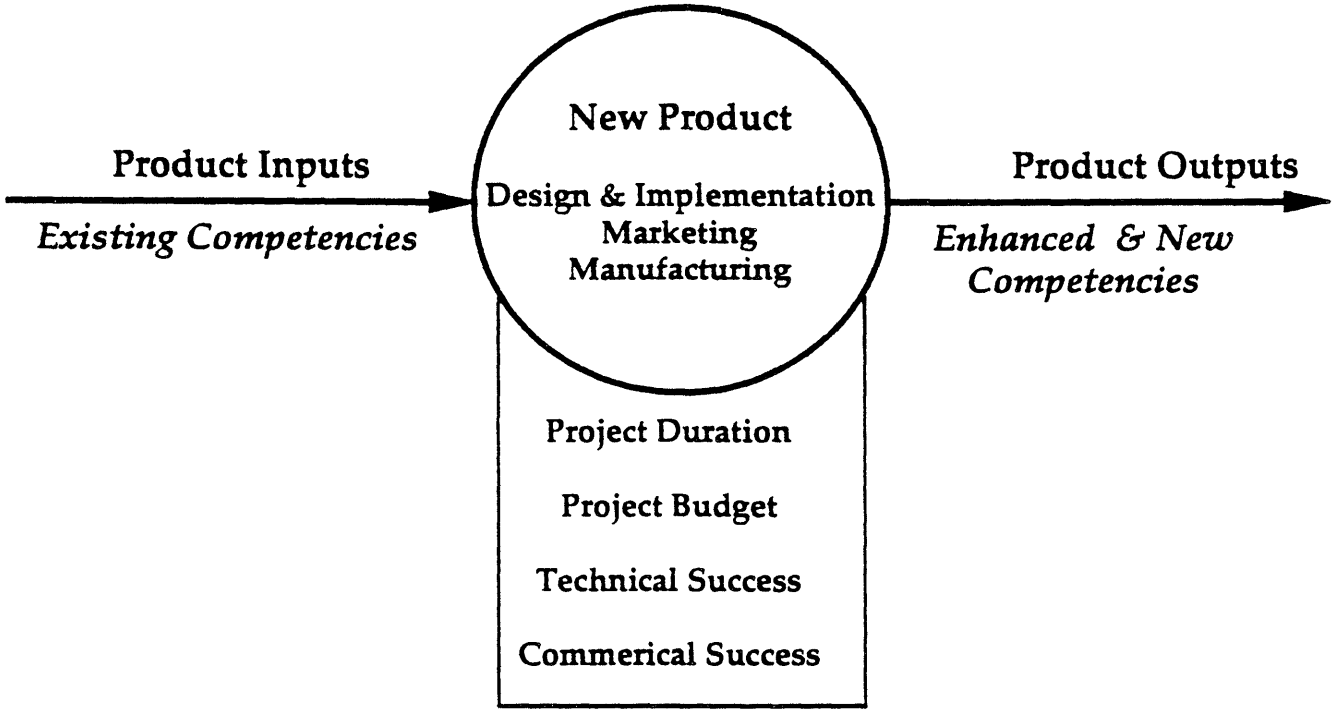


Figure 4
The Product Object



Components of Competencies

Product Technology
Market Knowledge
Distribution Capabilities
Manufacturing Technology

Figure 5
Data Printer's
Product Line Evolution
1968-1980

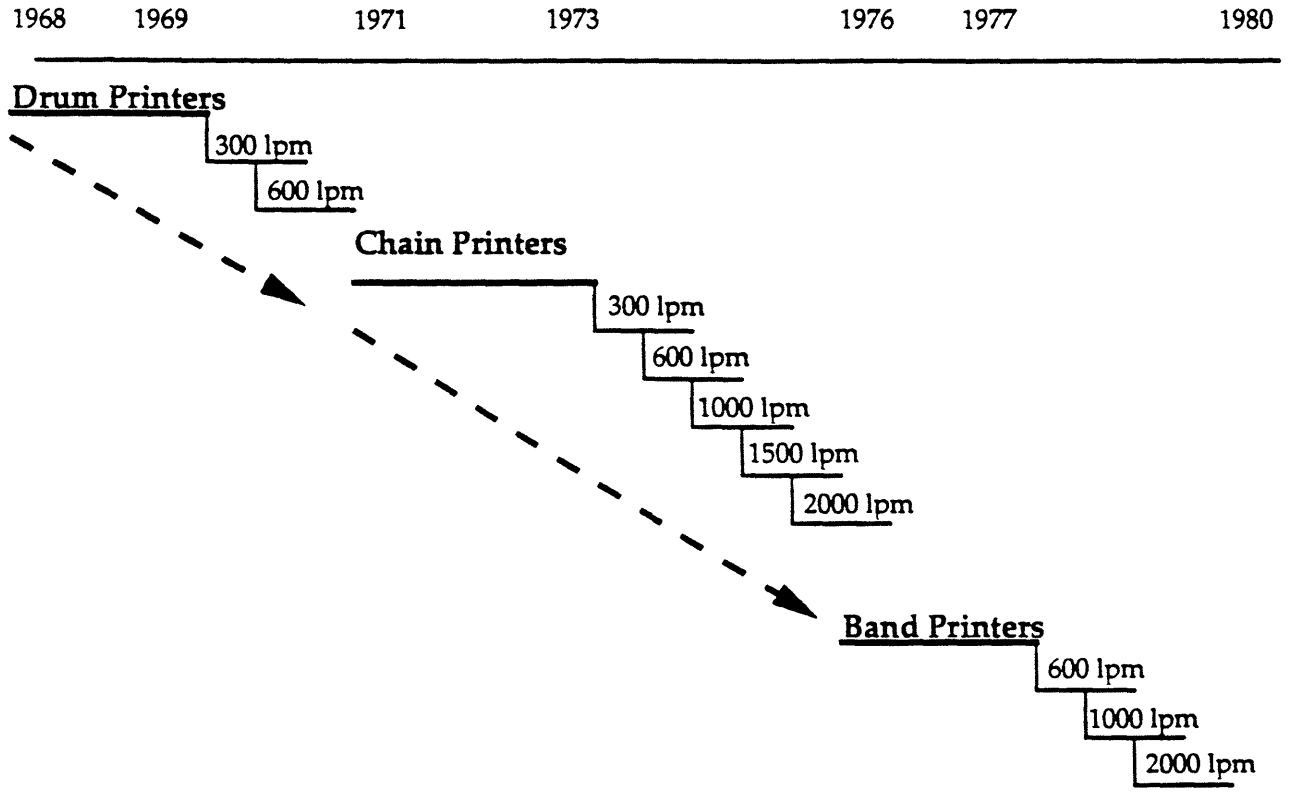


Figure 6
Apple Computer's
Product Line Evolution

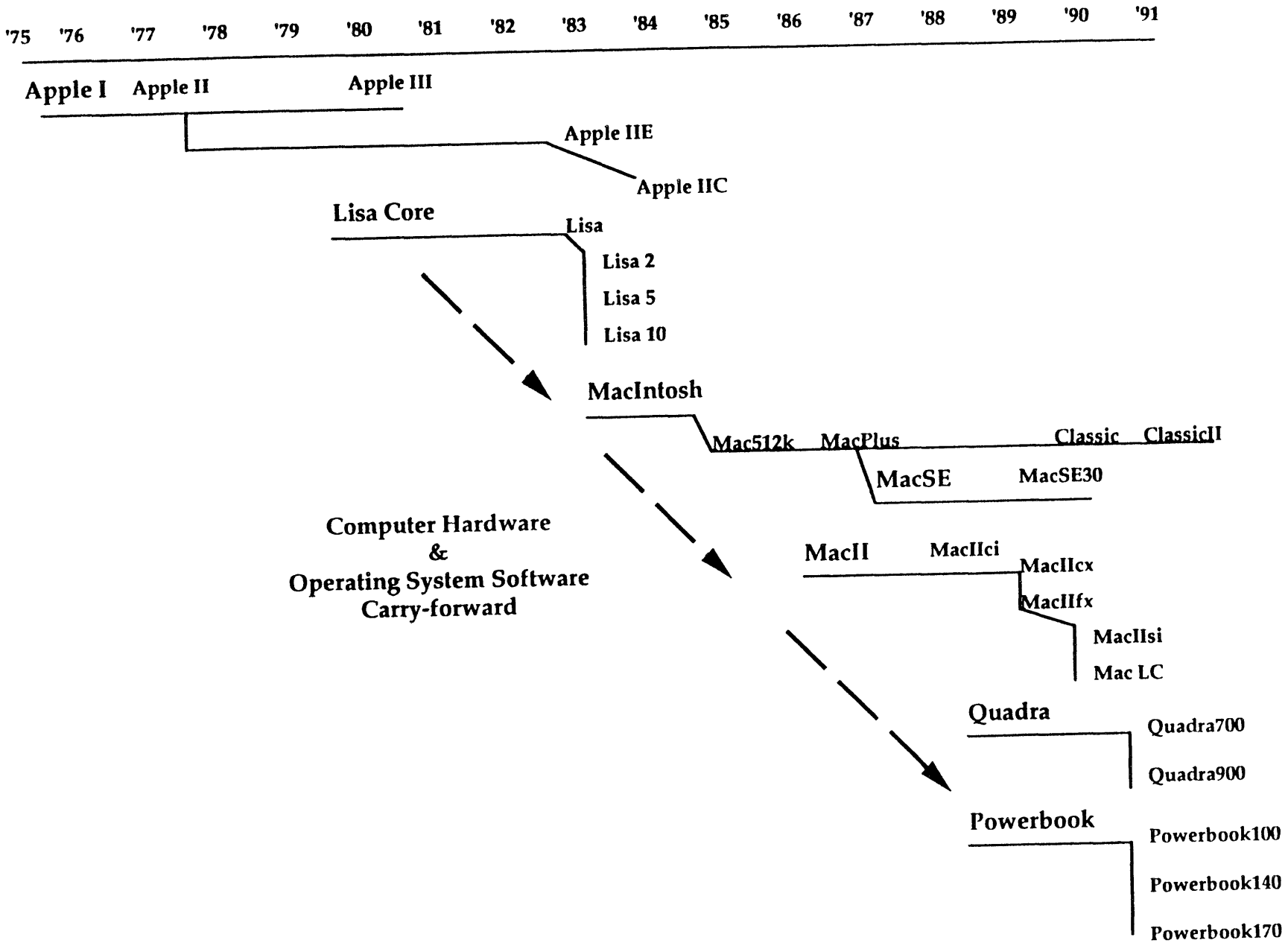
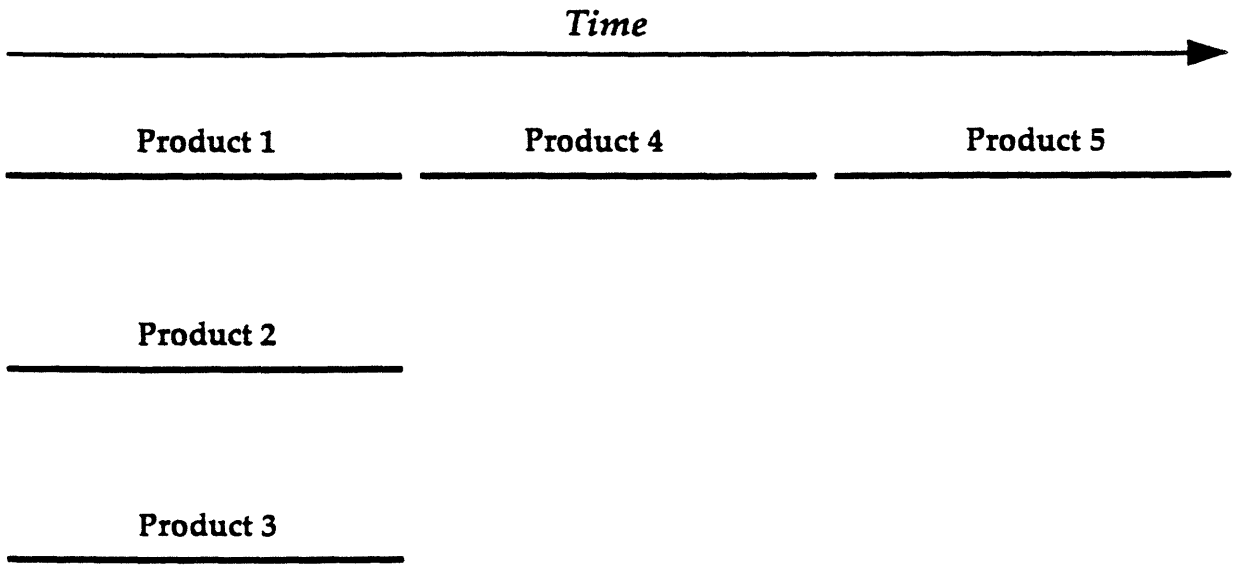


Figure 7
Patterns in New Product Strategy
"The Home Run Hitter"



For Each New Product:

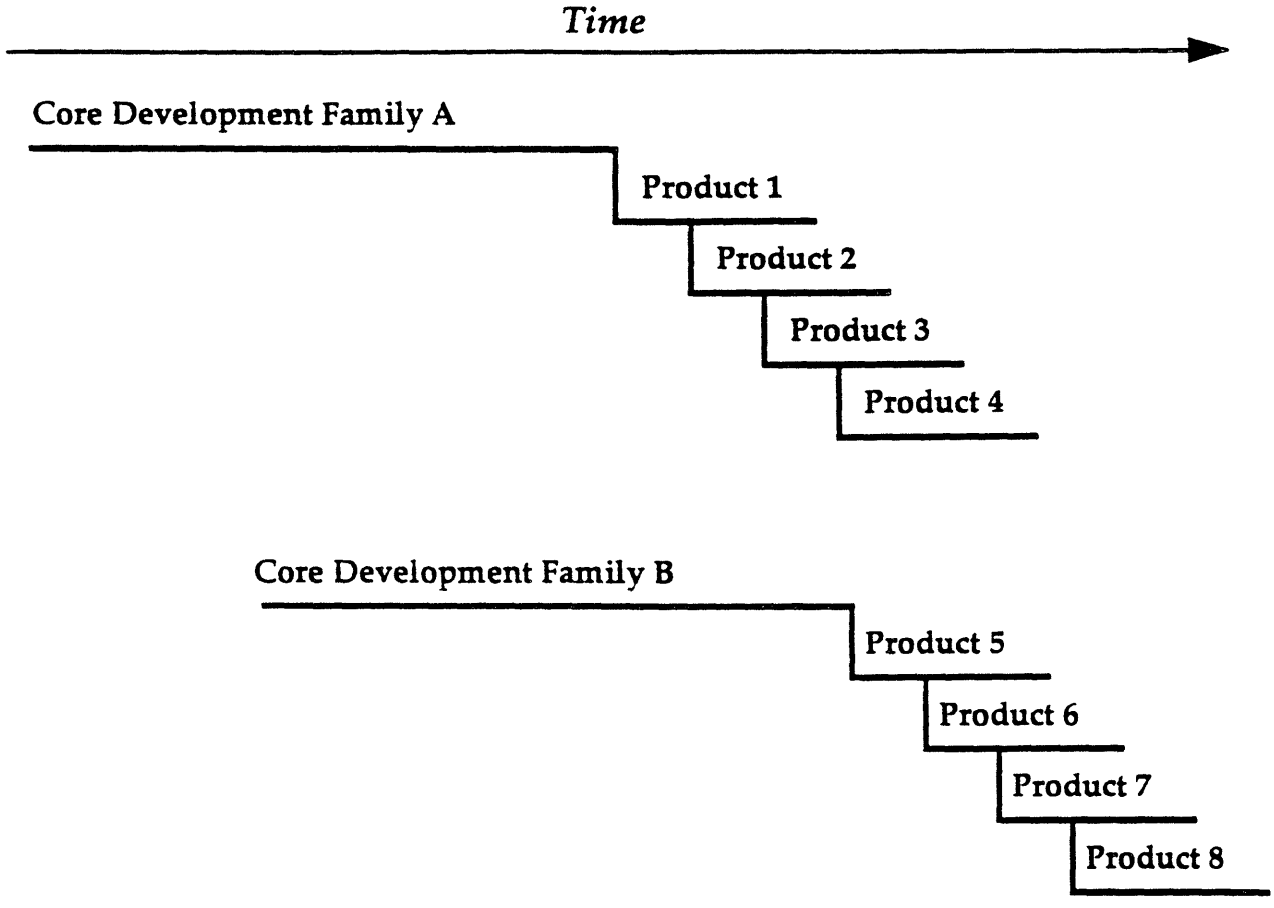
- o Largely New Product Technology Development
- o New Market Planning & Distribution
- o Often New Manufacturing Process and QA

R&D Firms that occasionally produce Products from R&D

New Venture Diversification Activities from Mainstream Business for Single Dominant Product Companies

Lotus, Phillips in VCR's

Figure 8
Patterns in New Product Strategy
"Diversified Product Family Development"



For Each Product Family:

Initial Development of Core Technical, Marketing, and Mft Resources

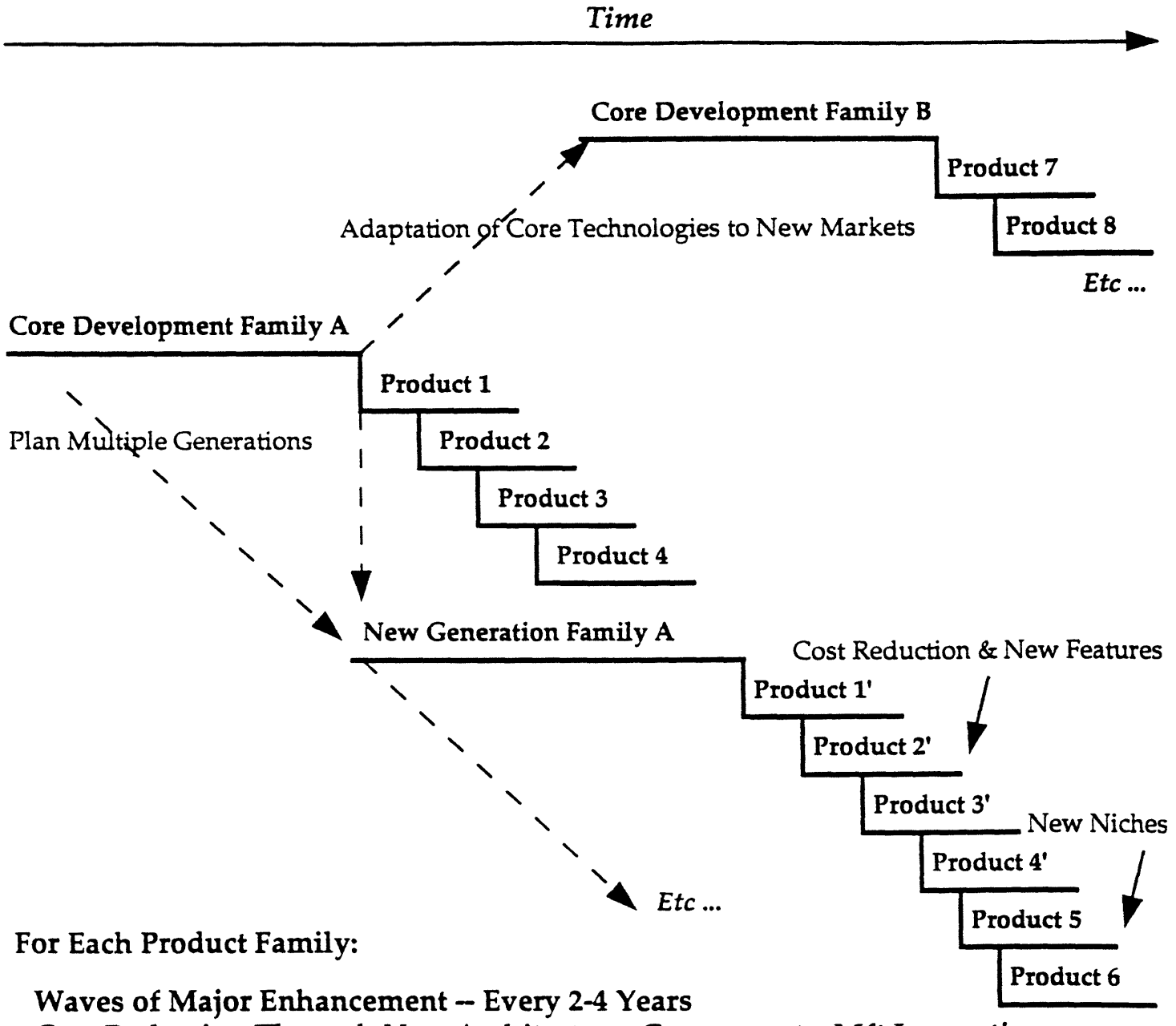
Product Families Separated by Organizational Boundaries

Diversity in Product Technologies, Customers, & Distribution Between Families

Vulnerable to Competitive Substitutes and/or Technological Obsolescence

Wang or Data General

Figure 9
Patterns in Product Strategy
"Multi-Generation Approach"



For Each Product Family:

Waves of Major Enhancement -- Every 2-4 Years
Cost Reduction Through New Architecture, Components, Mft Innovation
Expansion of Consistent Distribution Channels
Extension of Market Applications

Technology serves as the "Seed" for New Product Families

SUN MICROSYSTEMS or COMPAQ, MICROSOFT
JAPANESE Consumer Electronics, CANON in Copiers