Product Strategy and Corporate Success

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This article draws heavily upon two articles that we previously co-authored (1985, 1988), and on materials included in E.B. Roberts, *Entrepreneurs in High-Technology* (New York: Oxford University Press, forthcoming 1991).

ABSTRACT

Technology-based firms must choose from multiple strategies for developing the new and improved products that generate corporate growth. This article provides a framework for analyzing a firm's actual product strategy. The framework is applied to produce empirical evidence from 262 individual products developed and marketed by 26 computer-related companies. The authors' analyses demonstrate that young companies that focus their new products on extensions to a single key core technology are far more successful than those that pursue technical diversity. Marketing focus is even more important for achieving success of the high-technology enterprise. The best opportunities for rapid growth come from building an internal critical mass of engineering talent in a focused technological area, yielding a distinctive core technology that might evolve over time, to provide a foundation for the company's product development. Those products should be targeted at a focused set of customer needs, sold to gradually broadening groups of end-users through single channels of sales and distribution.

Formed by three engineers who had done advanced computer systems development in a large electronic systems firm, Computer Technologies, Inc. (CTI) initially developed calibration machines for the production of magnetic tape storage devices, sold directly to large computer manufacturers. Encountering limited opportunity the company then developed its own read/write heads for tape machines, sold as components directly to its manufacturing customer base to satisfy a new user functionality. CTI subsequently developed a third and unrelated product line, attempting to enter the microcomputer software business with a proprietary operating system for a popular microcomputer. In a following product release the firm also developed small business applications software. The two software products entailed major changes from CTI's earlier user functionality, customer groups and channels of distribution, selling these packages through office systems dealers and computer retail stores. None of the products became profitable and, after six years of struggling, Computer Technologies ran out of funds that had been provided by the founders and some private investors. The founder/CEO thinks they would have made it if only they had more capital. We think the fundamental problem was in their product strategy.

Deciding what products to make and how to make them is a constant challenge to the management of technology-based firms. Companies operating in areas such as computers, electronic components, optics, medical devices, telecommunications, lasers and biotechnology are frequently and profoundly affected by rapid advances in their respective product technologies. In these industries where the rate of new product introduction is high, a stagnant research and development effort can be disastrous. Even good ideas are insufficient; firms must turn them into successfully marketed products. Given that technology-based companies must continue to innovate their products (and perhaps their manufacturing processes as well) to survive and grow, they must make fundamental choices about their technology and market strategies.

This article is divided into three portions that treat the formulation and implementation of product strategy for the high technology firm. First we

present some of our strongly held convictions, which both influenced the related field research studies and were enlightened by them. Next we describe a framework that evolved during the research for envisioning a company's product history in a manner that may reveal its de facto product strategy. This method was used in four separate studies to gather data on a number of New England computer-related companies. The framework is presented here along with three case studies from the research. The third section presents some of the statistical results from the field studies, which support the importance of "strategic focus" in new product development for achieving success in the technological firm.

SOME PERSPECTIVES ON CORPORATE STRATEGY

During the 1970s especially, corporations were urged to develop diverse product portfolios in order to grow and prosper. The leading U.S. strategy consulting firms created techniques, such as the "market share/ market growth" matrix of the Boston Consulting Group, to help managements visualize product lines as pieces of a financial investment strategy, often premised on the diversification of risk. Buying and selling product lines and businesses was considered a pathway to achieving optimal portfolio mix. Intensifying or diminishing the internal investment in a business was a function of whether the product line was a "star" or a "cash cow". The technologies associated with those businesses were often considered only peripherally in the making of these decisions, and rarely viewed as a separate strategic issue -- they were most often just lumped in as an amorphous entity that came or went with a business-unit portfolio change. As a result, acquisitions and divestitures often preceded major reorganizations of a company's R&D effort. For managers, this resulted in an unstable engineering resource pool and often ineffective new product development programs.

In the 1980s the business community generally came to appreciate that these earlier perspectives were both naive and wrong. The public as well as the management of many firms began to see that company growth and prosperity depend upon "excellence" at something that the marketplace values, be it a stream of products or the delivery of certain services. (Peters & Waterman, 1982) Today the underpinning of excellence in a product's performance is more clearly understood to lie in no small part with its technology, which had better be planned and managed effectively.

In planning the development of new products, management has three basic

choices in regard to technology and three comparable choices regarding market application. In terms of technology a company may pursue a *focused* strategy of building a critical mass of technological skills for a closely related product portfolio, believing that the distinctive competence achieved in its *core* technology will become the basis of long-lasting competitive advantage. Ketteringham & White (1984) argue for the importance of key core technology in strategic analysis. A second option, that of *evolving* the technology, once again stresses internal technology development, but targets multiple and perhaps unrelated technologies. A firm creates a diverse set of products that does not depend upon the continuing importance of a single core technology. Third, a company may generate a diverse portfolio of products through an *unfocused* or *diversified* strategy of acquisition -- buying into new technological fields by acquiring other technology-based companies, or at least their technologies, and avoiding the long-term effort of building the needed technological expertise internally. The growth of "strategic alliances" among firms frequently reflects one or both of the strategic partners adopting this technology strategy. A firm can obviously combine the third strategy in varying degrees with either of the first two.

Similarly in terms of market applications, a company can adopt a *focused* market applications strategy, pursuing a single product/market area with stable selection of distribution channels. The firm's products offer solutions for the same set of problems, are applied to a single set of customers, and are sold in one basic fashion for the life of the company. Alternatively, the firm can follow a *leveraged* market strategy, releasing products that address different customer groups, typically sharing the same basic functional need, often reached through the same distribution channels. "Leveraged" products that are sold to different yet related customer groups also tend to be based on a single key technology which the firm then customizes to specific niche requirements. The third strategy pattern in the market dimension is a *diversified* one, characterized by products that contain changes in all three market-related parameters of customer needs, end-user customer groups, and channels of product distribution. Again companies may use acquisitions and/or alliances especially to implement this third strategic choice in regard to market applications.

Combining the several product technology strategies with the several market applications strategies leads to a wide range of optional approaches to product development and/or acquisition and sales. Which of these is most beneficial to a company? The answer no doubt depends on many factors

specific to the company and its industry. Product diversity and acquisition may have been attractive growth strategies in corporate America and may be effective for some large companies. Our instincts, however, strengthened by the evidence presented later in this article, strongly indicate that they are ill advised for emerging technology-based startups. **The best opportunities for rapid growth of a young firm come from building an internal critical mass of engineering talent in a focused technological area, yielding a distinctive core technology that might evolve over time, to provide a foundation for the company's product development. Those products should be targeted at a focused set of customer needs, sold to gradually broadening groups of end-users through single channels of sales and distribution.**

Companies observed in the field research studies that attempt to build an overly diverse portfolio of products (through either internal development or acquisition) find themselves over extended periods with technologically mediocre products and diffuse marketing. Companies that concentrate on the internal development of a single technology or a closely related set of technologies, and that focus on related market applications, achieve both technological product excellence and a deep understanding of their customers. These results agree with Cooper's findings (1984, 1985) from survey research on new product strategies by Canadian companies. Without a defensible core technology the technological venture typically has difficulty assuming a leadership role in its target markets and finds itself playing catch-up with competitors. In contrast, companies that develop a strong core technology show the ability to develop new products faster, with greater reliability and quality, than unfocused companies. With a core technology, these technological "winners" are more capable of responding to competitive events and in many cases are able to assume industry leadership by virtue of an exciting new product strategy. The more successful companies stay close to a single set of customers, using their technological advances to capture increasing market share, and gradually broaden their base of customers into related fields. The evolving horizontal integration is achievable with essentially a single type of selling process and stable channels of distribution. From a human resource management perspective, the company can more readily create a close-knit cadre of talented engineers and is adept at hiring and training new engineers for its R&D group. The firm can also recruit and manage sales and field service personnel in a smoother manner.

Beginning with strongly held convictions based on personal experience

and the indirect observation of many technological firms is a potentially dangerous way for researchers to proceed. Yet we exercised great care in the development of a data collection framework and in the actual information gathering and analysis needed to test our hypotheses.

DEVELOPING A FRAMEWORK

New product decision-making in the technology-based enterprise addresses four basic issues:

1. What are the basic needs or user functions that the firm will satisfy with its products and services?

2. What are the groups of customers that share these needs or functional requirements and to whom products and services will be sold?

3. What technology will be used to build the products or deliver the services, and what is the source of that technology?

4. What distribution mechanisms will be employed to bring successfully developed products to the marketplace?

A company that finds a set of consistent answers to these questions, supported by a track record of company actions taken in support, has a firm basis for a product strategy. Product strategy obviously encompasses two key dimensions: the technology embodied in the products, reflecting both the personal skills and techniques that achieve a physical manifestation in any given product; and the market applications of the products, including the intended functionality of the product from a user's perspective and the specific customer groups to which the product is marketed.

In searching for a framework for identifying a company's product strategy Chandler's lead (1962) is helpful. He traces the evolution of seventy large American companies over a period of their growth of approximately twenty years, emphasizing their shifts in strategy and organizational structure. In turn our approach is to trace the evolution of high-technology companies over their life spans, emphasizing the changes in the products they develop and market. To study technological content of the products specific tangible levels of change are identified between successive products created

and sold by a given company, building from concepts first presented by Johnson & Jones (1957). Similarly, to study market change specific shifts are identified in the three marketing-oriented parameters of product functionality, end-user customer groups, and distribution channels.

The Technology Dimension of Product Strategy

Every product made is based on an identifiable engineering skill set, or what might be called a technology. Most products are in fact composed of multiple technologies, some of which are created within the company's R&D group, while others are licensed from outside sources or purchased as components. Assessing technology strategy requires investigation in depth of the internally developed technologies used in products. These technologies evolve within companies over time, finding their way into successive products. As each new product emerges, the cumulative body of the company's technology experience expands. That broadened experience becomes the base for evaluating the "incremental newness" of the technology embodied in the next new product. Our concentration is on the changes made in the key *core* technology which provides the firm with a proprietary, competitive edge and differentiates it from other companies making similar or substitute products. This can usually be distinguished from other "base technologies", also used by the firm in its products, but more commonly available in the marketplace as components. A firm that is in an industry characterized by rapidly advancing technology typically concentrates on one or possibly two specific key core technologies and, by packaging or integrating its core with a variety of component base technologies, generates its final products. The key core technology becomes the basis for the "value added" of the firm.

Tracking the evolution of technology in a company's products involves assessing the degree of improvement in or additions to the technology over time. This level of technological change runs along a conceptually continuous range of expended resources and effort. However, the research studies used four discrete levels of change or newness in product technology to evaluate more than two hundred products developed by twenty-six companies. The first and "smallest" level of technological change identified is a *minor improvement* to the company's existing product technology. This level of change is illustrated by one of the printer manufacturers that, having produced a series of 80-column dot-matrix printers for microcomputers, developed a 132-column printer. The project took less than six months and was introduced easily into the company's manufacturing and sales operations. Minor improvements can

also include efforts as marginal as repackaging existing technology or customizing a product in response to customer requests. For example, a terminal manufacturer developed a series of equipment that contained new communications and terminal "emulation" capabilities so that it could more readily be tailored for use with computers produced by Digital Equipment, Data General, Burroughs (now Unisys) and others. Often, new products that embody minor technological improvements simply correct known problems. Not surprisingly, this is a common type of "new product" among software companies which seem continually to release new versions of a basic product line with more "bug fixes" than genuine new features.

The second level of technological change is a *major enhancement* to an existing product technology, incorporating a substantially larger effort in the improvement or advancement of a technology in which the company has previously developed expertise. A firm often achieves major enhancement through the addition of new base technologies to a product line, frequently requiring substantial development effort. By adding new components or subsystems, the firm can leverage its existing key technologies into new product/market areas without having to develop new core technologies of its own. Companies that can continually succeed with major enhancements often become the "standard setters" in an industry. For example, one of the photocomposition systems developers pioneered the application of color-imaging technology in the 1970s and now sells high-ticket expensive systems to magazines, newspapers and other publishers as a state-of-the-art production facility. A more recent new product allows the user to define extensive graphics "libraries" so that, for example, a digitalized photograph of a sailboat can be augmented with a "prestored" digital female figure, the designer's favorite bathing suit and sunglasses, and other graphic "objects" such as a dog, a beach ball, and a bottle of fine Chardonnay.

Major enhancements tend to be sequenced in intervals of three to five years within specific product lines, although this pace of technological change has been accelerating in recent years under intensified foreign competition. For example, one manufacturer that has focused on high-speed line printers that are privately labeled for resale by a large number of computer manufacturers has over the years upgraded its printing head technology from early rotating "drum" devices in the late 1960s, to "linked chain" printing heads in the mid-1970s, to soldered "band" technology in more recent years. Terminal manufacturers, as another example, have developed high-resolution graphics terminals, more recently with color capability, as an extension of

longstanding alphanumeric display technology. None of these major enhancements to an existing product technology took less than nine months in R&D, and some required two to three years of concentrated effort. At the same time, however, the companies achieve both of these first two levels of technological change with a stable cadre of engineers, augmented periodically with new talent at the junior level, within the company's evolving core-technology skill set.

The third defined level of technological newness occurs when a company develops an entirely new core technology that is integrated with an existing company technology in the final product. Here's an example. One of the terminal manufacturers makes transaction-processing terminals used by bank tellers. The smaller-than-usual terminals are loaded with communications software. In a move to expand upon both its technology and customer base, the company created an automated teller machine. While its previous terminal screens and transaction communications software are employed directly for the screen displays of the automated teller machine, the company's engineers had to develop two additional technologies: the electromechanical technology for the cash withdrawal and deposit safebox inside the machine, and all the applications software for handling the dialogue with the bank user. At first the company employed the services of a software R&D contractor but, finding that approach too unreliable, was forced to hire a number of software engineers. In subtle ways these software applications engineers represent a different culture or style than the company's traditional R&D group and present a new challenge to management in terms of integration and control. When new technology is combined with existing company technology in this way, the third level of technological change is involved, here labeled *new, related technology.* Another example is a software company that had developed as a core-product technology a version of the Unix operating system for personal computers. It then created a new product, a database management system that ran on its Unix operating system. Again, while some of the initial operating system engineers were shifted onto the database project, within a year a half-dozen new engineers were hired who had specific skills in database storage, query languages, and screen interfaces for users. The skill set required for development of the commercial database management system clearly separates it from operating systems work. Yet, since the product is designed for use with the earlier operating systems offering, for this company the database management product is a new, related technology effort.

The fourth level of technological change encompasses new core

technology that is not combined with existing product technology in the company. This *new, unrelated technology* is the "highest" level of change in a company's technology evolution, a major departure from technological focus. Why do companies undertake the risk associated with such diversity? One reason may be corporate survival. Several companies in the sample introduced first products that failed commercially and, rather than cease business operations, management tried a new product technology for a different application. For example, one company initially implemented a cable television network for a local municipality. Today its cable business no longer exists but the company has become a leading supplier of plastic card scanners used by banks for automated teller machines and by corporations and residential complexes for access control. An unfocused technology strategy may also be the result of engineering-oriented management that continually seeks "new hills to climb". One photocomposition company (whose founders are also MIT professors) has developed and sold optical character-recognition devices, a computer-based camera and image composition system, and a multiuser text-composition system, all for use in the newspaper industry. While the first two products are sometimes delivered as a single system to newspaper companies, the third is a stand-alone product, entailing the new core technology of the text-composition applications software. Large-scale additions of different types of engineers were necessary to implement these new products.

These four levels of technological change -- minor improvement and major enhancement to an existing company core technology, and the development of new technology that is either related or unrelated to existing technology -- can be used to assess the technological diversity of any new product. The framework can also be used to develop a portrait of a company's technological evolution over its entire history. Obviously, by using measures of marketing change between successive products, the same assessment can be made of a company's product-marketing history.

The Market Applications Dimension of Product Strategy

As mentioned earlier the market applications framework has three parameters, adding distribution considerations to the product usage and customer groups vectors used by Abell (1980) for evaluating business opportunities. The first of these, *product functionality*, is the general set of customer needs that a product satisfies. It is clearly distinct from the technology that is embodied in the product: Functionality is the goal of a

product whereas technology is the tool for delivering that functionality. The same functionality may be delivered by different technologies, perhaps by a process of technological substitution. Conversely, a single technology or group of technologies may be extended to different sets of functionality, if the earlier technology can be stretched to satisfy needs that are different from those addressed by earlier products of the firm.

End-user customer groups is the second criterion used for measuring market applications change between successive products. Industrial classification codes, common organizational environments, and levels of user experience are criteria employed to segment markets into customer groups. Abell & Hammond (1979) suggest additional factors that distinguish customer groups: "Customers may differ in their needs for information, reassurance, technical support, service ... and a host of other "non-product" benefits that are part of their purchase." (p. 48)

The third facet of the market applications dimension is the *distribution channels*. Distribution channels for the technology-based firm include:

1. Direct sales;
2. Original equipment manufacturer (OEM) reselling;
3. Non-manufacturing value-added resellers (VARs);
4. Non-manufacturing, non-value-added resellers;
5. Mail order.

In the first category, direct sales, the firm's own sales force sells the product directly to product end-users. The company typically assumes responsibility for customer support which may include training and equipment maintenance, and sometimes for the integration of the product with other vendors' products that are required by the end-user. Technology-based firms frequently employ the next distribution means listed, the OEM channel. Microprocessors, software packages, terminals, printers, peripheral storage devices, and even entire computer systems are commonly distributed through large manufacturers for integration with the manufacturer's own product line. In the third channel of non-manufacturing value-added resellers (VARs), the firm distributes its manufactured products through systems integrators that specialize in particular vertical market niches. VARs bring together a number of different components, only one of which is the firm's product, and tailor these components to provide complete or "turnkey" systems to end-users. Electronic Data Systems, now a subsidiary of General Motors, is a large VAR that has combined and customized outside vendors' software and peripherals

with its own software packages for application to IBM mainframe environments, successfully penetrating market segments that include insurance, banking and government agencies. The fourth distribution channel, non-manufacturing non-value-added resellers, are more usually called "distributors", and offer lower levels of support to end-users than the previous channels, typically selling a range of products from different suppliers. In the area of low-end computer products the microcomputer store is this type of reseller. Independent sales representatives are a component of this channel of distribution. Finally, the firm may decide to undertake mail order distribution by advertising in publications read by their prospective customers or by direct mail campaigns. "Direct mail" and "direct sales" are appropriately at opposite ends of the spectrum, involving dramatically different commitments of company resources in contact with and support of its customers.

Adopting any one of the five channels identified above does not preclude the use of any other channel. Similarly, as firms grow they may shift channels or add new channels of distribution to those employed for earlier products. For example, starting with the development of a microcomputer version of a popular graphics and statistics package used at MIT, Mitchell Kapor then developed a graphics package that was compatible with the then popular Visicalc "spreadsheet" package. That product, labelled "Visiplot", was sold as an OEM product through Apple Computer. Then Kapor teamed up with Jonathan Sachs and organized Lotus Development Corporation to develop an integrated system, combining his graphics software with their own "spreadsheet" and simple text editing software into the pathbreaking "1-2-3" product. A distribution agreement was signed with a large non-value added reseller that brought the product to hundreds of retail computer outlets. With additional financing, Lotus expanded its market and captured the margins previously sacrificed to distributors by creating its own direct linkages to retail stores. Finally, direct selling to large corporate accounts has also been used more recently by the firm.

Using these three market-oriented parameters, a matrix for the measurement of market applications change can be constructed, as shown in Table 1. The first level of market applications change is no change, i.e. when all three parameters remain unchanged from the previous product release. If only one of the three parameters changes, either a new user functionality or a new customer group or the adoption of a new channel, the product is assessed as being at the second level of market change. Similarly, a change in any two of the three parameters brings about the third level of change. Finally, when

all three parameters change the product is measured at the fourth and "highest" level of market applications newness.

Table 1. Levels of Change in the Market Applications Dimension

	Customer Groups	Usage Functionality	Distribution Channels
Level 1	Same	Same	Same
Level 2	A New Group	Same	Same
	Same	A New Function	Same
	Same	Same	A New Channel
Level 3	A New Group	A New Function	Same
	A New Group	Same	A New Channel
	Same	A New Function	A New Channel
Level 4	A New Group	A New Function	A New Channel

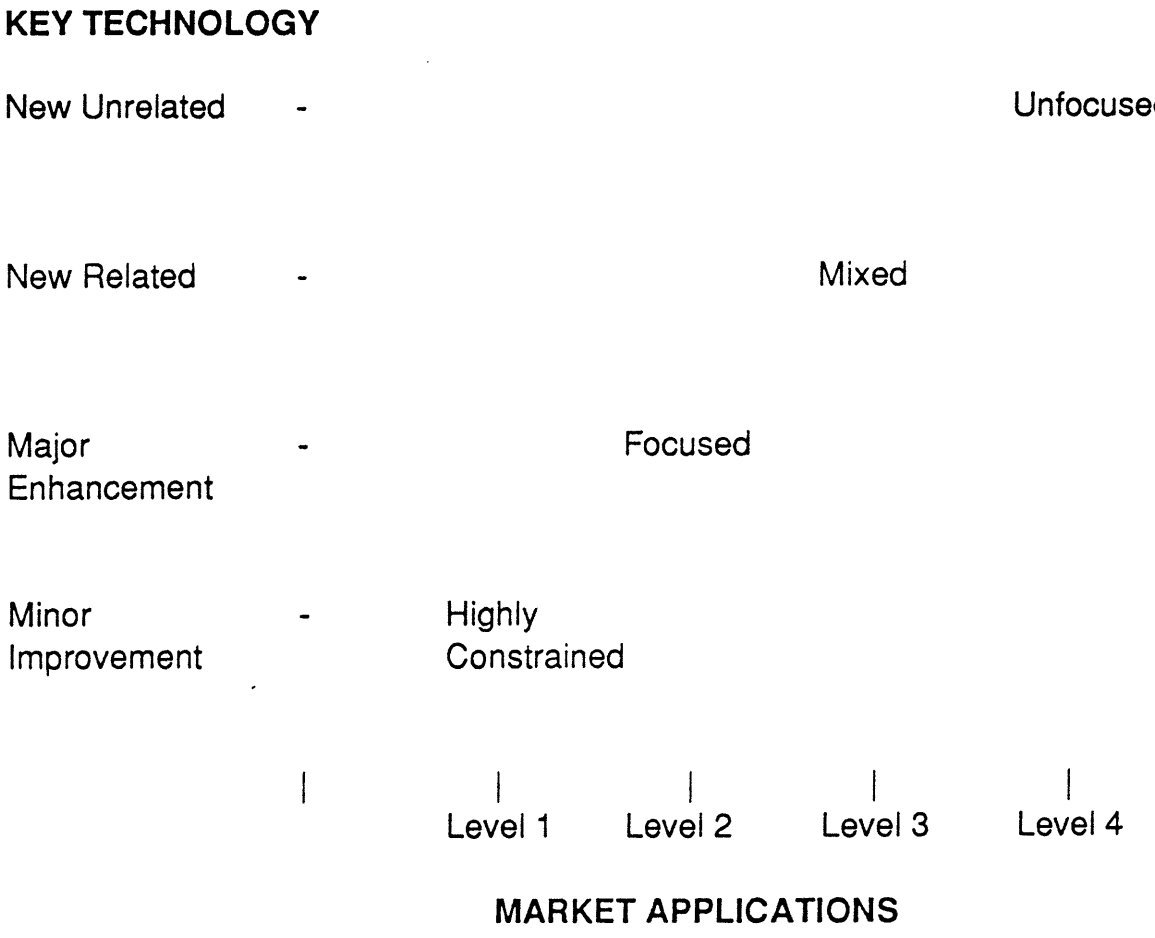
The three different product market applications strategies described in our introductory section on product strategy are associated with these various levels of product market change. The *focused* product market strategy reflected in a series of Level 1 product releases is illustrated by the high-speed line printer company described in the technology section above. The firm has always sold its printers, designed for high-speed data processing use, through OEMs. The *leveraged* market applications strategy is usually based on a series of Level 2 product changes, sometimes mixed with Level 3: The new products address different customer groups, but usually satisfy the same basic need and are distributed through the same channel. This *leveraged* approach is employed by the access control systems vendor mentioned above. Its magnetic card readers are found in bank ATM machines, computer facilities of large corporations, and residential complexes. More recently, the company has developed a set of applications software for "time-in, time-out" management, selling turnkey systems where dozens of its card readers may be attached to a microcomputer. The firm has also recently enhanced its direct sales channel to include sales representatives who cover particular geographic areas and vertical markets. The third and last strategic pattern of *diversified* market applications, distinguished by changes in all three dimensions, is epitomized by one firm in an initial pilot study, identified here as Computer Technologies,

Inc. (CTI) and described at the outset of this article.

The Product Innovation Grid

The two dimensions of new product strategy can be integrated into the Product Innovation Grid shown in Figure 1. The term "innovation" reflects the

Figure 1. The Product Innovation Grid



perspective that innovative activities in the realm of new product strategy are not confined to technology development alone, but rather also encompass the market applications dimension of the products. A firm's historical product portfolio can be plotted on the grid, where each product is measured along both the technological and the market applications dimensions for its level of change compared to the product developed before it. Abetti & Stuart (1987) have conceptually modified this two dimensional grid into three dimensions, separating out as the third axis the product functionality aspect of the market

applications considerations.

Four generic labels of product strategy characterizations are shown on the Figure 1 grid, representing "average" levels of combined technological and market newness for a firm's entire product sequence. The Highly Constrained pattern is one where the company chooses to perform only minor enhancements to a single core technology and sells its products to a particular market niche for one usage and with an unchanging sales mechanism. The Focused pattern is marked by major enhancements in technology that are leveraged into products for several customer groups. The firm aggressively employs new component technologies to provide new levels of functionality to its users. The third pattern, called "Mixed", involves a strategy where the firm has ventured into new product areas by developing new core technology and integrating it with existing core technology. New functionality, different customer groups, and different distribution channels are encountered in such efforts. Other firms in this product strategy group may be companies that have tried various product development approaches before settling down into a more focused strategy. Finally, the Unfocused strategy represents wide diversity along both dimensions in the firm's product sequence.

It is important to realize that a high level of interproduct change is not synonymous with overall aggressiveness, even in regard to technological advance. Focused companies that exhibit low or moderate levels of change in product technology are hardly stagnant. Remaining competitive in dynamic technological fields required equal if not greater amounts of research and development on the part of the companies studied as venturing into new and different technologies. The successful technologically focused company demonstrates a combination of aggressiveness and "working smart" to build a distinctive competence and generate a strong core technology.

Three Case Studies

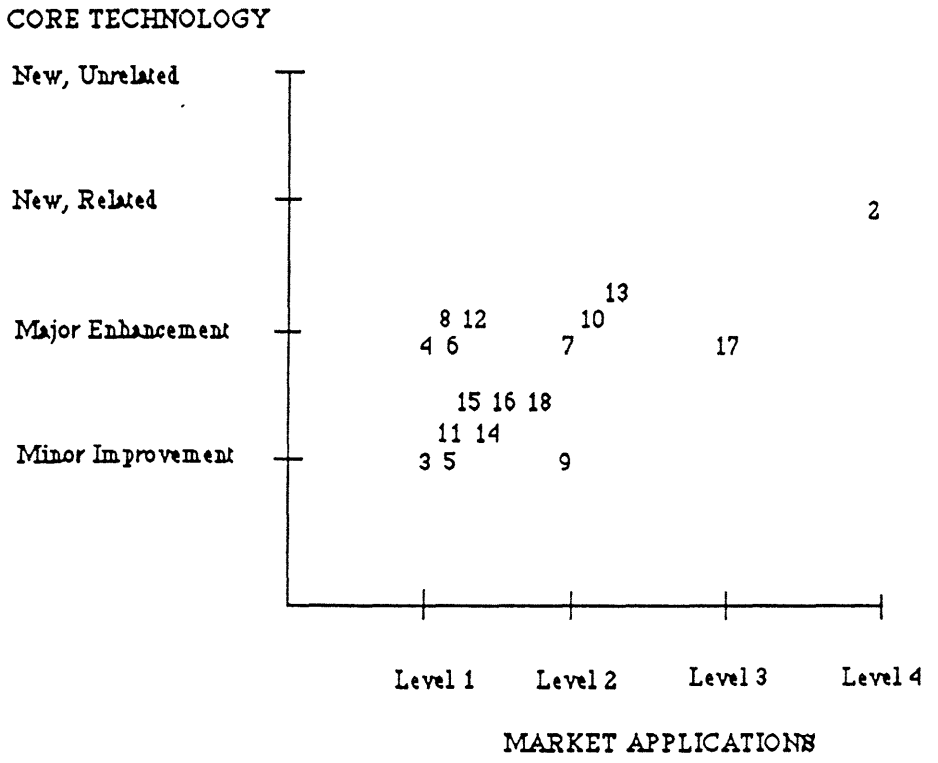
In the course of carrying out the research reported here the process of developing and displaying a plotted presentation of a company's product history provided useful managerial perspectives. The resulting Product Innovation Grid can be used to provide a "snapshot" or portrait of a firm's product activities at any point in time. Three companies from the database are discussed here in detail, both to expand on the methods used in product assessment and further to illuminate the arguments for a focused product strategy.

FastPrint

Figure 2 displays the product sequence of a printer manufacturer that has followed a clear technological and market focus: It has developed a strong core-technology capability, has developed and reinforced its primary marketing approach, and competes effectively against Japanese as well as American companies.

Let's call the company "FastPrint". Notice that in Figure 2 the lowest number on the grid is "2", which represents the company's second product. In this methodology the first products of companies are not scored on the grid, but are instead used as the baseline to evaluate the newness of the second and subsequent products. FastPrint has released a total of eighteen products since its founding in the late 1960s. It was started by several MIT professors whose first product was, of all things, one of the first electronic-gambling systems for a Las Vegas casino. Requiring inexpensive printing stations for the gambling systems and unable to find them on the market, these entrepreneurial academics then made one of the first small dot-matrix printers; it was the company's second product. Thus product #2 is positioned on the grid as (relative to product #1) having new, related

Figure 2. The Products of FastPrint: A Focused Strategy



Product Number	Technology Score	Market Score	Product Description
1			Computer gambling machine for resorts; Direct sales to Las Vegas casinos
2	3	4	First dot-matrix printer; first used with gambling machines; New users: minicomputer users; general purpose printing; OEM channel
3	1	1	First printer refined; Same market applications
4	2	1	Printer redesigned for cost reduction; Same market
5	1	1	Previous model refined; Same market
6	2	1	Higher speed matrix line printer; Same market
7	2	2	High speed line printer acquired and enhanced; Same applications; added sales reps.
8	2	1	New generation of dot-matrix printers; Same market applications
9	1	2	Refined dot-matrix, low cost version; New users: personal computer owners
10	2	1	Desktop printer underwent major redesign; Same market applications
11	1	1	Quick upgrade to smaller, less expensive dot-matrix printer; Same market
12	2	1	New desktop version of #10 with faster paper handling; Same market
13	2	2	Color capability added to dot-matrix; New functionality: color presentation graphics
14	1	1	Desktop line refined and repackaged; Same market
15	1	1	Low cost printer acquired and refined; Same market
16	1	1	Another low cost printer acquired and refined; Same market
17	2	2	Band-line printer: new core technology, but acquired and refined; New users: data processing facilities
18	1	1	Paper handler and sheet feeder: simple peripheral technology development; Same market, sold with printers

technology and Level 4 market applications change, meaning concurrently new customers, new user functionality and new channels of distribution. In the products listing under Figure 2 product 2 is given a Technology Newness Score of 3 ("new, related") and a Market Applications Newness Score of 4. As indicated above each product is measured along both the technological and the market applications dimensions for its level of change compared to all the

products that had been developed before it. All the later products are positioned on the grid and scored in this manner.

From this point on FastPrint's product strategy was focused on printing technology and its applications in the minicomputer and later the microcomputer marketplace. FastPrint scored its biggest success in its mid-life by making the first popular desktop dot-matrix printer, which was widely sold through retail stores along with the first popular Apple microcomputer system. The company's technology development has been continually aggressive, with repeated major enhancement efforts designed at providing faster speed and better dot-matrix printing at lower cost. The technology descriptions associated with the product numbers in Figure 2 demonstrate this pattern. To develop the ratings shown here minor improvements were differentiated from major enhancements by working with the vice president of engineering to assess the time and resources allocated to each product. Major enhancements that went into one product were often consolidated later with minor improvements in new product releases, either to reduce production cost or for repackaging. On other occasions, when FastPrint wanted to go into a new technological area, such as building a higher-speed line printer, it licensed products from other companies and refined them for its own purposes. This occurred in products 6, 15, 16, and 17.

From a marketing perspective FastPrint's initial printer, product #2, had the highest level of change, shifting from direct sales of its earlier gambling machine to sale through OEM computer manufacturers for use in minicomputer printing and by small data processing facilities. Subsequent products show a consistent focus on OEM channels, with minor occasional market applications changes. For product 7, for example, FastPrint added independent sales representatives to its distribution channels. With product 10 came the new user group of microcomputer users. A new user functionality of color printing was served by product 13, and a new customer group, the high volume data processing facility, was reached by product 17.

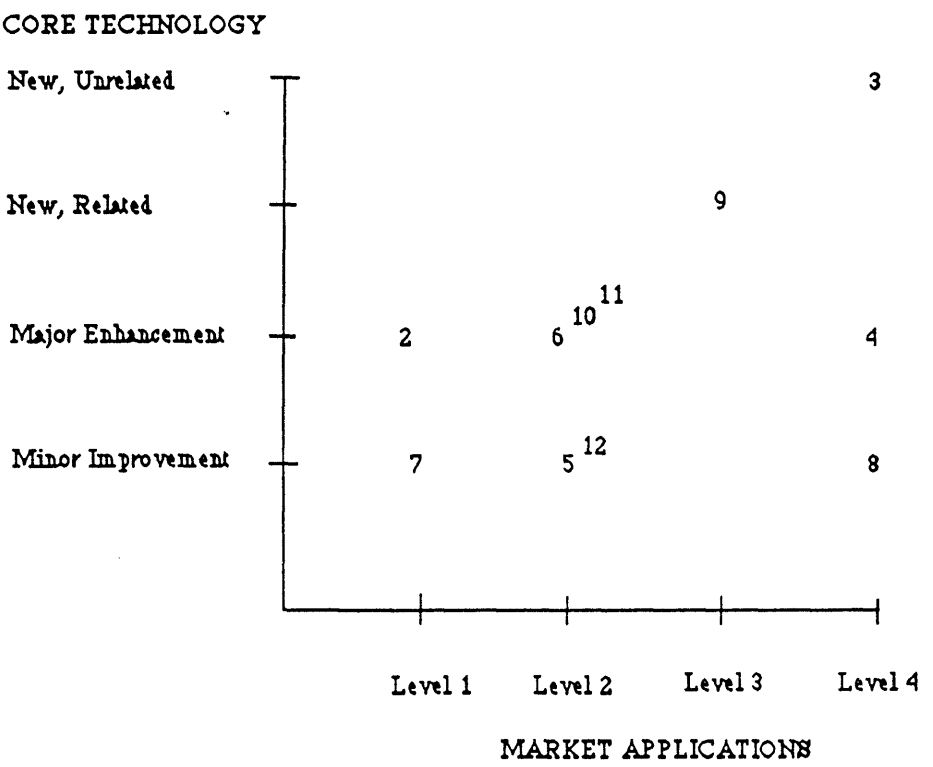
FastPrint is a clear example of a company that is both technologically and market focused. Its distinctive core technology, developed over years by a fairly stable corps of dedicated engineers, has been a key factor in the company's leading market position. Its long-term focus on relating to and selling through OEM computer manufacturers has generated customer relationships based on mutual understanding and shared dependence, as well as ready access to high volume sales opportunities.

Techlabs

A contrast to this focused strategy is the case of a newspaper-composition systems company that pursued many technologies and, though sticking to the same newspaper organizations as customers, attempted to satisfy varied needs of different individuals, often through different sales channels. The product history of this company is shown in Figure 3.

Founded also by an MIT professor, the company, here called "Techlabs", created one of the first "raster display" graphics terminals in the late 1960s, thus permitting time-shared minicomputers to have graphic displays. The initial product was sold directly to universities and other scientific institutions. Soon, however, Tektronix released its own (and now industry standard) raster display graphics terminal and has since come to dominate the marketplace. Techlabs responded not with another terminal, but rather with a graphics tablet that could be attached to engineering workstations. This new technology was marketed exclusively through a large computer-aided design systems manufacturer. Techlabs then used the cash generated from this product to venture into yet another technological field, developing a

Figure 3. The Products of Techlabs: An Unfocused Strategy



Product Number	Technology Score	Market Score	Product Description
1			High-resolution graphics "raster" terminal, among the first; Direct sales to academic users
2	2	1	Major upgrade; Same market
3	4	4	Graphics tablet for CAD workstations; New functionality sold through OEM CAD company to engineering users
4	2	4	Text editor hardware and software, licensed and enhanced; New usage: editing; new customers: office; new channel: new sales force
5	1	2	Text editing system made multiuser; New usage
6	2	2	Purchased and implemented new 16-bit chip set for the editor;
7	1	1	New version of 16-bit editing station; Same market applications
8	1	4	Minor revision of software, newspaper text composition; New usage, customers, channels
9	2	3	New release of hardware workstation; New users: publishing niche; new channel: graphics supply houses
10	2	2	Wire service package developed; New usage
11	2	2	Telecommunications package developed; New usage: intercomputer telecommunications
12	1	2	Classified ads package developed; New usage

text-editing workstation in the mid-1970s, complete with hardware and applications software. In addition to direct sales, the company sought to contract with distributors to sell this product. In subsequent products Techlabs undertook costly hardware projects, in a sense pioneering microcomputer architectures for its own text-editing product line. With limited success the company then focused on its text-editing software, releasing a series of packages aimed specifically at small newspaper companies. Its more recent products, for example, include packages for managing classified advertisements, newswire communications, and text composition. Outgunned by its various competitors in the domestic marketplace, Techlabs has recently sought to exploit the European marketplace through distributors that include graphics supply houses in various European countries.

With such diversity in technology (requiring major enhancement efforts in both hardware and software) the company cannot be clearly identified by a single core technology. Its engineering pool has undergone numerous transformations in terms of skill content and emphasis. Further, the company's diverse products, each targeted to different types of customers for widely varying uses, has yielded multiple distribution channels and marketing programs. When Techlabs managers were interviewed recently, they were clearly struggling with this complexity. The company is experiencing little growth and its cash flow cannot sustain current operations.

BestScreens

A company's product strategy can also change dramatically. Companies that were once highly focused and successful can dissipate their core technology and, with a commensurate lack of market focus, find themselves very quickly in financial straits. A third case description illustrates this. "BestScreens" had risen to approximately $50 million in sales by supplying a highly reliable yet inexpensive family of alphanumeric terminals that could be used efficiently with a range of computer manufacturers' protocols, including those of Digital Equipment and Unisys. These terminals were sold through OEMs and dealers. BestScreens had also produced a very popular graphics terminal that could at the same time be used as an alphanumeric terminal. Thus, its product strategy had been classically focused, major enhancements to a single technology with market adaptation for a series of related customer groups.

Then, as a result of ambition (or greed) and not desperation, BestScreens' management changed its orientation and sought to become a full-fledged computer company through both internal R&D and technology acquisition. BestScreens first acquired a small company that had made a portable microcomputer. Management established limited retail distribution for the new product. The product was a costly failure, especially after IBM and Compaq among others released comparable products. Still maintaining its success with its long-standing terminal product line, management decided to have another go at diversification. BestScreens proceeded to develop inhouse a multiuser desktop minicomputer based on the then new Intel 80286 chip. While designing and manufacturing the new computer internally with the best of its existing hardware engineers, the company also had to hire a number of operating systems software specialists needed to integrate the Unix operating system that the company had licensed from AT&T. The new computer was aimed at the Value-Added Resellers distribution channel and, compared with

its previous products, targeted new applications. BestScreens' second venture into diversification had a more telling impact than the previous one. This publicly traded company went into a tailspin, and within two years BestScreens sought legal protection from its creditors.

EMPIRICAL EVIDENCE SUPPORTING FOCUS IN PRODUCT STRATEGY

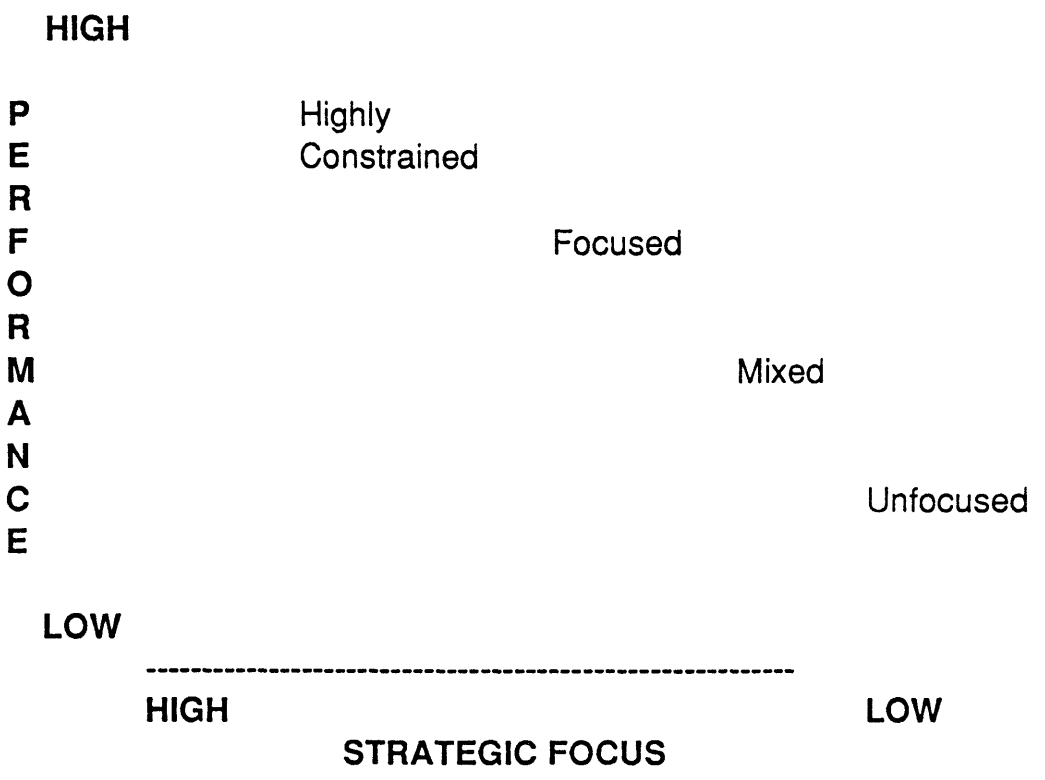
These three examples illustrate how product focus in terms of both technological and market applications dimensions figures into the success of high-technology companies. Are these observations merely flukes, or are they representative of an underlying truth that is generally applicable to technology-based companies? To find an answer the Product Innovation Grid framework was applied systematically to evaluate product change in a sample of 262 products from twenty-six New England companies.

The Strategic Focus Hypothesis

The main hypothesis is that firms with a high degree of strategic focus in their product innovation will over time outperform less focused companies. This hypothesis is pictured in Figure 4. Examining the limits of the hypothesis suggests one refinement. At the one extreme, the bottom right of the diagram suggests failure for an organization that pursues an ultimately unfocused strategy, implementing for each new product a new unrelated core technology, and targeting new functional uses, different customers and distribution channels. Cooper's (1979) findings support this reasoning. His "High Budget, Diverse" firms, whose products have unrelated technologies and are scattered in market orientation, contain the weakest performers, in line with our expectations.

But the other extreme, the top left of Figure 4, suggests greatest success for the firm that undertakes for all its products only minor improvements to its single initial core technology, to be sold exclusively to one set of customers for one specific function through one stable channel of distribution. At first glance this may seem the least risky of strategies because the firm takes no chances in exploring new technological areas or market applications for its products. However, a dogged faith in the continued viability of a single technology/customer set could, over time, prove to be a very risky course of action. By labeling this strategy "Highly Constrained" we have already set it up by implication to mean "Too Highly Constrained"!!

Figure 4. The Strategic Focus Hypothesis: Strategic Focus versus Performance

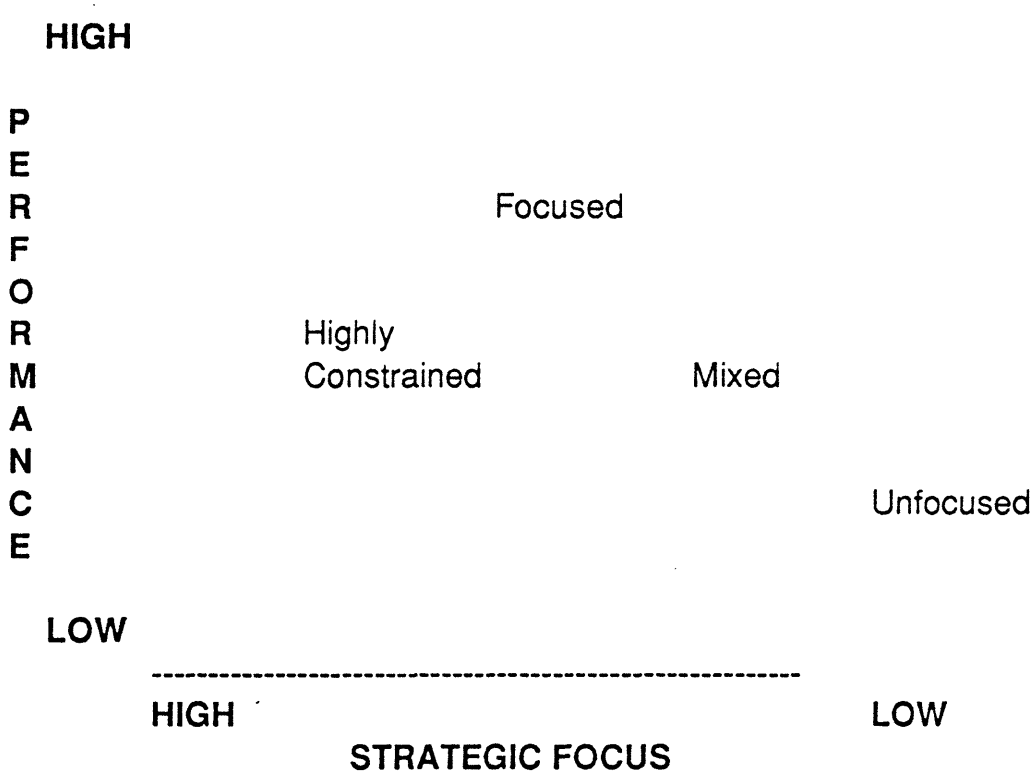


Indeed several reasons suggest that the "Focused" strategy should assume the top position with respect to expected performance. The environment of rapidly changing technologies mandates that firms keep abreast of technological change through well-timed major enhancements to internal core technology. Similarly, a company often cannot be satisfied with a single customer group for the life of its entire product line. A specific customer group may be limited in size or the object of greater competition as time progresses. New markets for technology products tend to evolve into more well defined subgroups, and products targeted for the initial market undergo needed "differentiation" better to satisfy the requirements of the emerging market niches. In addition, new markets for technologies are continually born, and may present attractive opportunities for the firm to leverage its core technology into new functional applications and customer groups.

The company that performs periodic major enhancements to its product line and aggressively pursues new customers is very different from the firm that relies on a single familiar customer set with successively repackaged and

customized technology. A "Focused" versus a "Highly Constrained" strategy is also potentially more successful because the firm seeks new related growth opportunities. Thus the revised hypothesis is that the most effective product strategy is one that focuses upon some level of highly directed change in either the technology or market applications dimension, pictured in Figure 5 as a bell-shaped curve skewed to the left.

Figure 5. The Revised Strategic Focus Hypothesis



Methods and Measurements

The sample evolved over the course of four studies of New England firms into small but consistent clusters in four computer-oriented industrial groups: terminal manufacturers, printer manufacturers, systems houses making newspaper-composition systems, and software companies making programming tools. All of these groups have experienced high levels and widely different patterns of complex product innovation, but of course may not be representative of issues encountered in other technological fields. Rather than conduct a telephone or mail-based canvassing of several hundred companies, which could yield only a superficial level of product strategy information, we worked within company locations to examine closely 262 individual products,

including 26 initial products, constantly probing for evidence to measure degrees of technological and marketing change.

All the companies studied are small or medium sized. We gathered extensive product and financial data for each company since its founding year up to the time of the interviews. Usually the founder-CEO or senior technical and marketing managers provided the information, requiring on average about four hours in each company. In many companies we interviewed two persons to provide increased reliability for the product scoring. As might be expected in these volatile industrial sectors, a broad range of success in overall performance is encountered. The largest company in the sample has sales approaching $200 million, while several of the smallest companies have become bankrupt since the time of data collection. The range conforms to our attempts to develop a sample composition that includes both successful and failed companies, allowing more clear differentiation of policies that worked from those that did not.

Relying upon careful joint determination with interviewees, all products are assigned technological and market applications newness scores of one, two, three, or four, based on the four-level typologies explained earlier. The level of newness is measured relative to all product development activities undertaken by the firm prior to the specific release of a given new product. Therefore, the base against which both technological and market newness are measured grows with each successive product of a firm. Then three different quantitative indices of product focus are calculated for each company: technological focus and market applications focus, looking separately at each dimension of interproduct change; and overall product focus, generated by combining the two separate measures.[1] (Superscripts refer to numbered Notes at the end of the article.) These indices are based primarily on the average level of change for each company's products, and secondarily upon a measure of the consistency of change (a simple mathematical variance). Overall performance for each firm is assessed by using company sales data, the most readily available and consistent performance indicator that relates to the entire product history of this sample of companies, normalized (to produce a time series of current sales per year of company existence) and then averaged over the life of the firm.

Company Data

The processed data for the 26 firms are shown in Table 2, including rank

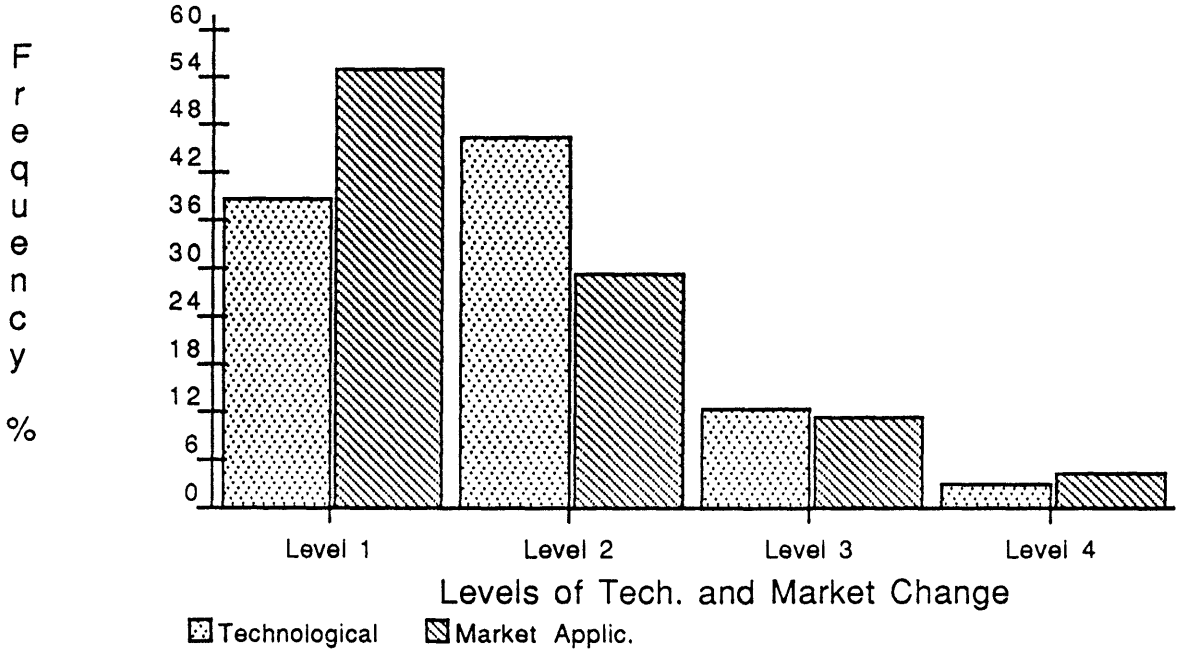
orders for each company in regard to Technology Focus, Market Focus, and Overall Product Focus for all the firm's products, and Sales Performance. The companies range in age from 4 to 17 years, with an average age of 10, and in sales from $150,000 to $167 million in the last complete year prior to data collection, with mean sales of $29 million.

Table 2. Companies Ranked by Focus Indices and Performance

Company	Description	Technology Focus	Market Focus	Overall Product Focus	Sales Performance
A	Airline reservations terminals	6	12	12	17
B	Electronic funds transfer terminals	12	19	16	19
C	CAD/CAM and medical imaging term.	11	11	10	10
D	Infrared factory control terminals	24	26	26	26
E	Handheld process control terminals	10	17	13	23
F	General purpose terminals	1	14	3	4
G	Lottery systems terminals	18	4	4	6
H	General purpose terminals	9	13	15	11
I	Newspaper composition systems	4	10	2	3
J	Newspaper composition systems	15	22	21	18
K	Newspaper composition systems	25	9	19	9
L	Graphics composition systems	21	24	22	16
M	Image scanners	13	25	23	21
N	Color photocomposition systems	16	15	17	5
O	Dot-matrix printers	5	7	5	1
P	Color ink-jet printers	20	18	18	13
Q	Letter-quality impact printers	23	21	24	14
R	High-speed line printers	22	5	14	8
S	Dot-matrix printers	2	6	1	2
T	Mainframe spreadsheet programs	8	8	6	12
U	Graphics programs for microcomputers	17	1	7	20
V	Mainframe database management system	7	3	8	7
W	Unix database management system	26	23	25	25
X	Mainframe database management system	19	2	11	15
Y	Language compilers	14	20	20	24
Z	Microcomputer Unix operating system	3	16	9	22

Figure 6 shows the distribution of levels of technological and market innovation among the 236 subsequent products from the 26 firms. The frequency of 55 percent first level marketing changes, almost twice that of second level changes (29.8%), is somewhat as expected. However, the relatively greater number of major enhancements to minor improvements on the technological scale underscores the degree of rapid and substantial technological change embodied in these companies' products. While the issue

Figure 6. Distributions of Levels of Technological and Market Change in All Products in Entire Sample (n=236 products)



of strategic focus in R&D and marketing activities still remains to be explored, the data show the firms as strong technological achievers. Self-assessment by the firms as to the levels of technological accomplishments in the first products of these firms, with respect to the state of the art of the industry at the time of product introduction, also reflects a high level of asserted technical aggressiveness. Table 3 presents the majority claim for the first products as being "highly distinctive", with only 3 of the 26 assessed as a "major breakthrough", no doubt due to modesty on the part of many of the entrepreneurs! In fact, Tushman & Anderson (1986) show that technological

Table 3. Distribution of First Product Technology (n=26 companies)

Technology Relative to Competition	Frequency(#)	Percent(%)
Undistinctive	2	8
Somewhat Distinctive	8	31
Highly Distinctive	13	50
Major Breakthrough	3	12

"discontinuities" which destroy the competences of an existing industry are typically introduced by new firms, opening up a product class to a wave of new entrants. (p. 460)

Statistical Results

The principal statistical results relating to the strategic focus hypothesis have already been suggested by the various rank order tabulations in Table 2, where company rank according to sales growth performance can be compared visually with the ranks according to degrees of technological, market applications, or overall product focus. For example, the top-ranked company according to Overall Focus of its products, Case S (a dot-matrix printer manufacturer), ranks second in the sample for performance (now exceeding $200 million in annual sales). The second-ranked company in product focus, Case I (a producer of complex composition systems for large newspapers), ranks third in performance. Conversely, the last-ranked company in overall product focus, Case D (a producer of infrared factory control terminals), is also last in performance. Perhaps panic reaction to imminent company failure causes a flailing lack of product focus, rather than the other way around. No doubt strong positive feedback relationships exist between focus and performance. Many less clear matches are also shown by the table. While exact matching in rank order would be beyond belief, a clear pattern does emerge. Based on Spearman rank-order correlation coefficients shown in Table 4 (where 1.0 represents a perfect match), the products' overall focus is

Table 4. Correlations of Overall Product Focus and Performance: Technology and Market Applications Combined (n=26 companies)

Product Cluster	Number of Companies	Rank Order Coefficient	Statistical Significance
Composers	7	.943	.05
Printers	5	.900	.05
Software	7	.750	.05
Terminals	8	.881	.01
Entire Sample*	26	.646	.01

* The entire sample was sufficiently large to permit calculation also of a Kendall Rank Coefficient = 4.151, with significance = .0005.

demonstrated to couple closely with the overall growth performance of the companies.[2] An independent analysis of 42 computer firms (Feeser & Willard, 1990) confirms the significance of product focus in achieving high growth.

Separating the overall product focus measure into its two-dimensional components permits examining the importance of each direction of product change. Technology development is assumed to be a less difficult resource to manage for relatively small technology-based firms than their market applications resources. Many high-tech firms achieve outstanding technical feats, but often fail to demonstrate comparable ability to implement effective sales programs for their products. One reason for this is likely to be the engineering backgrounds of most entrepreneurs of technology-based companies, as well as the relative lack of marketing people within the founder groups. Similarly, new technology development may often be achieved with a relatively small number of talented engineers. Whereas the implementation of sales programs for the market applications of new products requires participation of many groups of individuals, some of whom are usually external to the company. The range of activities needed includes end-user documentation, development of marketing materials and advertising, implementation and maintenance of sales programs, and the creation of effective product support mechanisms. By implication, then, market applications diversity should be most difficult for a small technology-based firm to manage effectively, even more so than the development of multiple core technologies. The data analyses indicated in Table 5 support this hypothesis. In three of the four clusters, and confirmed by

Table 5. Comparison of Product Focus in Technology and Market Applications (Spearman Rank Correlation Coefficients) (n=26 companies)

Product Cluster	Technology Rank Coefficient	Market Applications Rank Coefficient
Composers	.028	.886
Printers	.800	.600
Software	.428	.679
Terminals	.429	.786
Entire Sample*	1.986	3.828

* Kendall Rank correlation used for entire sample

the product sample as a whole, product focus for the market applications dimension correlates more strongly with performance than technological focus. The stronger correlation of performance with high levels of relatedness in product market applications than with technological focus is also supported by an analysis of variance.[3]

The importance of strategic focus in products is reinforced by the absence of statistically significant relationships between overall company performance and the technological aggressiveness of first product launches (see Table 3 for the underlying data), nor with the rate of new product releases per year. Each of these areas is postulated by others as a possibly critical determinant of success for the technology-based company. (Feeser & Willard, 1990, confirm no relationship between technological pioneering and high growth for their sample of computer firms.) In fact the additional analyses provide specific support to the arguments on behalf of focused product innovation. For example, no significant relationship exists between the technological aggressiveness of the first and subsequent products, indicating that firms that begin with technical leaps are able to exploit their advantages through a continued set of minor improvements and timely major enhancements, rather than a series of continuous ambitious technological jumps. The innovation intensity of the product strategies (as measured by the mean rate of technological change embodied per year in the company's new products) correlates negatively and significantly with sales performance for the entire sample, bolstering the concept that somewhat lower levels of average technological change per year are preferable.

STRATEGIC CONCLUSIONS

Companies that historically show product strategic focus perform substantially better over extended periods of time than companies that implement multiple technologies and/or seek market diversity. A quick telephone follow-up with the sampled firms shows that this hypothesis is still on target. The ten top companies in terms of product focus have an average product-related sales level of approximately $56 million. This contrasts sharply with the bottom ten companies, again ranked in terms of product focus, whose average sales are approximately $3 million. The research demonstrates that managing widescale product diversity is, at the least, a most difficult endeavor for the small or medium-sized technology-based company. Conceivably, larger firms or less technology-dependent ones might be better able to handle greater product-line diversity, although the strategic advice of

"stick to your knitting" (Peters & Waterman, 1982) and earlier studies of diversification (Rumelt, 1974) and acquisition strategy (Ravenscraft & Scherer, 1987) generally support the importance of focus for large companies too.

The data do evidence, however, an "inside limit" to the strategic focus concept. Not surprisingly, companies that show a total lack of technological aggressiveness, undertaking only minor improvements to their core technology, do not perform as well as companies that over time make major enhancements to their core capabilities. This is true also in regard to better performance being achieved by firms that seek market expansion through steady introductions of new functionality, moving toward related customer groups, and adding distribution channels fully to exploit the available marketplace.

At the same time a company that is "focused" would be mistakenly viewed as less aggressive than another firm that shows high levels of technological diversity. On the contrary a firm can be highly aggressive as it sustains leadership in the applications of a single core technology, and as a consequence have a higher R&D budget, more engineers and a higher intensity of new product development activity than an unfocused firm. Thus the focused new product strategy is a matter of the hard working company "working smarter" than competitors.

NOTES

1. The mathematical formulae used for calculating the three focus measures are shown here, as calculated for each company. First, the Focal Point for each dimension and their combination are calculated. Next, the Variance for each dimension and their combination are computed. Finally, the overall Strategic Focus index are determined for each dimension and for their combination.

Focal Point:

$$FP(T) = \frac{\Sigma\, |\Delta T_p|}{N-1}$$

$$FP(M) = \frac{\Sigma\, |\Delta M_p|}{N-1}$$

$$FP(TM) = \frac{\Sigma\, |\Delta T_p \times \Delta M_p|}{N-1}$$

Variance:

$$V(T) = \frac{\Sigma\, |\Delta T_p - \Delta T_p|}{N-1}$$

$$V(M) = \frac{\Sigma\, |\Delta M_p - \Delta M_p|}{N-1}$$

$$V(TM) = \frac{\Sigma\, |\Delta T_p \times \Delta M_p - \Delta T_p - \Delta M_p|}{N-1}$$

Strategic Focus:

$$SF(T) = FP(T) \times \sqrt{V(T)}$$

$$SF(M) = FP(M) \times \sqrt{V(M)}$$

$$SF(TM) = FP(TM) \times \sqrt{V(TM)}$$

where: FP = Focal Point
T = Technology Dimension
M = Market Applications Dimension
TM = Combined Technology and Market Applications Dimensions
ΔT = Level of Technological Newness
ΔM = Level of Market Applications Newness

N = Total Number of Products
p = A Product
V = Variance
SF = Strategic Focus

2. These results are reaffirmed with statistical confidence through a variety of additional analyses, including: (1) tests of the sensitivity of the findings to possible shifts between rank orders of pairs of firms within each cluster; (2) recalculation of the combined focus measure using alternative formulas; and (3) computation of the performance index based on non-normalized sales data.

3. To carry this out the 26 companies are divided into four groups in terms of their measured degrees of focus upon each of the two dimensions. The four quadrant data are shown in Table 6. The F-statistic for the overall

Table 6. Sample Divided into Product Strategy Quadrants

TECHNOLOGY FOCUS		MARKET APPLICATIONS FOCUS: LOW	MARKET APPLICATIONS FOCUS: HIGH
	HIGH	Quad 2 5	Quad 4 8
	LOW	Quad 1 9	Quad 3 4

model is most significant, at 21.699, with effective probability of error of 0.001. The F-statistic for the technological dimension is 3.640 (p=.07) and 8.254 for the market dimension (p=.009), with no significant interaction effect observed between the two variables.

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