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The Product Family and the Dynamics of Core Capability

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Introduction

Why is it that some firms introduce distinctive new products time and time again, when so many other firms are far less able to generate new products? More specifically, some firms while strong in product design, fail to gain commercial reward, while their more successful counterparts exhibit the "right mix" of capabilities in implementation, manufacturing, and distribution as well as product design? Much current management addresses successfully developing single products as rapidly as possible. Developing products in this mode has two essential problems: redundancy of both technical and marketing effort and lack of long term consistency and focus. We will argue for an approach to managing new products that is broader.

Concentrating at the level of the product family, and more specifically at the development and sharing of key components and assets within a product family, is the vital issue. The benefit of examining elements shared by products within a family is that firms will then develop the foundation for a range of individual product variations. At an even broader level one can examine relationships between product families themselves to achieve even greater commonality in both technologies and marketing. For an existing product family renewal is achieved by integrating the best components in new structures or proprietary designs. This improves of all products within the family. Diversification can be achieved by building upon and extending capabilities to build new, but related foundations. For example, Hewlett Packard built on a foundation in scientific instruments to create a family of computers, and then built on both to become a leader in medical patient monitoring systems.

Figure 1 portrays a set of products and their relationships over time. Earlier generations are followed by successive generations that refresh existing products with improved designs and technologies. New product families branch from existing ones, using expanding technical skills, market knowledge, and manufacturing capabilities. The development of new technologies is focused. Market extensions are related. High levels of customer recognition are the cumulative effect of a robust product family. Strong financial performance follows.

Deliberately building product families rather than single products requires management of a firm's core capabilities[1]. Quinn, Doorley, and Paquette view the firm as an intellectual holding company where products and services are the application of its knowledge assets. By targeting and focusing upon the best ones a firm can dominate its rivals.[2] Core capabilities cannot be divorced from or viewed separately from the actual products that a company makes and sells on a daily basis. Core capabilities are the basis of products. Non distinctive capabilities lead to non distinctive products. Strong capabilities lead to strong product families.

Our purpose in this article is to define the product family as a basis for planning and managing new business and product development and to assess the firm's core capabilities, relating both to management and performance. We have developed and applied a method to three product families in a large corporation to illustrate our ideas. The combination of a product family approach and core capability assessment serves as a genuine and effective basis for tackling the problem of corporate renewal.

Defining the Product Family

What is a product family? What are those characteristics and properties shared by and therefore common to a series of related products grouped into a family?

The term product platform was used earlier in its common meaning of encompassing the design and components shared by a set of products. For example, Chrysler has just released a new line of cars based on a common platform where three different lines of cars share the same basic frame, suspension, and drive train. To achieve a powerful definition of the product family, market understanding, distribution, manufacturing, and service dimensions must be included. Instead of using the term product platform, we have coined the term *product core* to reflect the multifunctional meaning of our definition.

A product core is the heart of a successful product family, serving as the foundation for a series of closely related products. Figure 2 illustrates the idea. Individual products are refinements or extensions of the product core. For example, Chrylser's forthcoming upscale New Yorker model will be based on a longer version of its new platform. Products that share a common platform but have specific features and functionality required by different sets of customers will be called a product family. The product family typically addresses a market *segment*, while specific products or groups of products within the family target *niches* within that segment. The commonality of technologies and markets leads to efficiency and effectiveness in manufacturing, distribution, and service, where the firm tailors each general resource or capability to the needs of specific products and niches.

The technology embodied in a product family has two key parts: design and the implementation of the design. Design groups dedicated to new product platform research create basic designs, standard components, and norms for subsystem integration. Implementation teams create different models integrating component technologies to achieve specific goals. [3] [4]

An effective product core for a family of products requires clear and deep understanding of what target customers need the product for, how they will use it, and how the customer will integrate the product within the technical and business infrastructure. [5] Manufacturing cost and reliability are also required, as are strong and suitable channels for distribution and methods for promotion. [6] Once in the field, products must be well supported in terms of helping customers to understand and solve problems. For example, IBM has designed remote diagnostic capabilities into its mainframe computers.

To illustrate these ideas consider Sony's Walkman product family. Sanderson and Uzumeri catalogued all products introduced in the portable tape cassette segment. [7] Sony introduced more than 160 variations of the Walkman from 1980 to 1990. The foundation for these products was a platform that Sony refreshed with four major technical innovations. [8] The company combined these major innovations with incremental improvements to achieve better functionality and quality while lowering

production costs. Sony's trademark is virtually synonymous with the product class.

Black and Decker's power tool business is another example of building product cores.[9] In 1970, the company had hundreds of products. The products used more than thirty different motors, sixty different motor housings, and dozens of different operating controls. Further, each of the hundreds of power tool products had its own unique armature. Management determined that in order to remain competitive, it would have to decrease its cost of goods sold by about a third in the coming decade. Black and Decker created a plan to design and manufacture product families based on shared components and modules. Nearly $20 million was allocated to the effort. First, the company developed a hexagonal, copper wire wrapped motor field with standard electrical plug-in connections that would serve all its power tools. [10] Engineers designed standard motor housings and controls as well as a more standardized adhesive bonded armature. The company tacked each product family in succession (drills, jigsaws, sanders, etc.). The results were dramatic: product costs were reduced by 50%, market share rose from 20% to a dominant share, and competitors declined from more than twenty to three. The case also shows the extent to which product families can share design, market, and production knowledge.

Mapping Product Families

Individual products are therefore the offspring of product cores that are enhanced over time. Product families and their cores are themselves generated from the firm's underlying core capabilities that, in well-managed firms, tend to be of much longer duration and broader scope than single product families or individual products.

We believe that the product family can be used as a basis for assessing the dynamics of a firm's core capabilities, i.e.. how these capabilities grow, decline, and integrate with one another over extended periods of time. The first step is to *map* the chronology of a product family. The follow pages will describe

our method as we applied it to three product families in a large corporation engaged in the electronic imaging business.

Figure 3 shows a product family map. The general application of the products shown in that Figure has been to reproduce computer screen images onto various presentation media. We refer to them as a *horizontal market* application in that they are general purpose solutions for a large class of customers.

Insert Figure 3 here

Management assembled a study group of ten managers, all actively involved in the product family for many years and representing business, technology, and marketing functions. Producing the product family map shown in Figure 3 required several intensive meetings with the group. The top half of Figure 3 is the summary, and the bottom half the detail, showing the market introduction and termination date for each product. The product family is represented in four hierarchical levels:

- The product *family* itself. Figure 3 shows one product family.

- *Groups* within a *family* that are encapsulated in rectangular boxes in the top half of Figure 3. The three groups shown are based on departmental boundaries.

- *Product platforms* are denoted by oval forms starting at the beginning of the research and ending with the cessation of active marketing of products based on the platform. We considered "skunk works" projects, having no commercial product offspring, separate platform initiatives because they were the source of technology and market knowledge for subsequent products. The first product group in Figure 3 has had three successive platforms; the second, two; and the third, three.

- Specific *products* (numbered here to disguise real product names) are placed at their market introduction dates, and in the bottom half of Figure 3, extend out to the date of marketing termination.

Product family maps convey organizational information. For example, in Figure 3, why have there been three separate overlapping product groups aimed at the same target market rather than one continuous group? The original development team chose not to abandon its initial analog platform in favor of a newer digital platform. The older products became obsolete. Management tried to short cut its lack of competitive product with two quick private-label initiatives, comprising the second product group. Meanwhile, two product champions resurrected the technical initiative by recruiting from corporate research. The result, after years of determined technical effort and marketing development, has been the delivery of what many would call world-class digital products.

Figure 4 includes the product family map described above with maps for two other related businesses in the same company. The first family in Figure 4 is a turnkey system made for a vertical market. It is sold primarily through the company's own direct sales force, and requires systems integration at the customer's site. The second family is the horizontal application described above. The company sells these products through distribution channels. The third family consists of peripherals and components. These products are sold through a number of different channels and have been aimed at both industrial and consumer market segments. The differences among these three product families provided an arena for testing our ideas.

Insert Figure 4 Here

Assessing Core Capability

The product family idea serves as a basis for assessing the evolution of a firm's core capabilities. Figure 5 presents a core capability assessment for the horizontal electronic imaging family. We generated similar charts for the other two families. The chart has four basic parts:

A) The product family map as a legend is plotted against time. Key product events serve as anchors for subsequent data gathering and analysis; [11]
B) The product family team's strengths were assessed in relation to existing competition for specific core capabilities within the basic dimensions of product technology, understanding of customer needs as reflected by products sold at that time, distribution, and manufacturing.[12] The solid line running across the measurement strips is a mean of responses from team members, the details of which will be described shortly;
C) A summary section that shows the means for responses for the core capabilities within the four basic dimensions, and
D) A final summary of core capability strength as embodied within the product family.

All four parts show the ebbs and flows of core capabilities over time for the product family. [13]

Insert Figure 5

The process of gathering data started with a group meeting of the team members of product family. These groups consist of managers and senior technical staff.[14] At this initial meeting, team members defined the product families, groups, generations, and specific products under a product scope established earlier by executive sponsors for the study. This process required several iterations, using recollections of product histories to create product maps. We also noted key products events, some made by the company itself or others by its competitors. These served as anchors for gathering information and then presenting it.

The study team was then reconvened in a second series of meetings to identify the general product technologies, the major customer segments, the distribution channels used over time, and the key manufacturing processes required for the product. [15] These are the specific core capabilities embodied

in a product family and are the vertical legend running down the left side of Figure 5.

For example, the respondents who provided the data for Figure 5 developed a consensus that three technologies were central in their products. These technologies were higher level groupings of more numerous individual technologies. Participants must determine the appropriate level of grouping using its understanding of the technologies used in a product family: for example, "signal processing" or "circuit packaging" or "networked computing." Everyone understood that the purpose of the study was to facilitate *managerial* analysis and action. Too much detail would obfuscate major trends in past and needs in the future.

Figure 5 also shows that this particular product family had one major industrial customer group. The company sold these products through independent dealers and original equipment manufacturers. The team felt most comfortable combining specific manufacturing processes into one "Internal Manufacturing" core capability, and relationship management with suppliers and manufacturing subcontractors into a "External Subcontractors" capability.[16]

We produced blank survey forms for each product family. These blank survey forms appeared exactly as shown in Figure 5. Each measurement strip has five levels. These levels represent the degree of capability (from Best in Class to Worst in Class) *relative to competitors at that time,* for each of the years in the product family's history as perceived by respondents. [17] Figure 5 also shows that measurement strips can be extended into the future to learn a team's expectations .

Respondents then completed the survey forms, using the same response scale for all core capabilities. We instructed them to indicate levels of strength relative to existing competitors for capabilities for just those years where they had worked on the product family. We also asked respondents to assess capability strength for the key product anchor points and then fill in the intervening years for which they had knowledge. Averages of responses are shown in Figure 5. [18]

Figure 6 summarizes with unweighted means the company's capabilities in product technology, market understanding, distribution, and manufacturing. [19] Then, we plotted a grand average of these capabilities at the bottom of Figure 6.

Insert Figure 6 Here

Figure 7 shows the core capability assessments for all three product families in the study. We represent use the thickness and shading of line to represent levels of strength in core capability (rather than measurement strips) to allow the reader to more quickly and clearly surmise meaning. The core capability in the turnkey system family has gradually increased over the years to a moderate level of strength. The horizontal applications family experienced strong initial strengthening, then a strong decline, and more recently, an even stronger rebound in its embodied core capability. Lastly, the company has yet has yet to build significant core capability in the peripherals family.

Insert Figure 7 Here

Core Capabilities and Performance

Higher levels core capability should be associated with sustained success, be it in terms of product development effectiveness, financial performance, or learning and employee satisfaction.[20]

We asked divisional management of the sponsoring company to provide their assessment of the *success of the product family over its history relative to other new business developments undertaken by the company at that time.* Using a scale representing levels of performance, six senior vice presidents completed a measurement strip chart for each product family, basing their assessments on financial return. [21] We asked them to assess product families only for those years in which they had actively monitored and otherwise participated in the management of the product family. We plotted an average of these responses in Figure 8.[22]

Insert Figure 8 here

Data for core capabilities and performance are compared in Figure 9, using width of line and shading to convey degree. Higher levels of core capability have tended to precede and remain concurrent with higher levels of performance. For example, the horizontal application family gained moderate levels of core capability 1985, and better performance came in 1987. The obsolete analog platform of this family for the two year period between 1987 and 1989 did not depress performance, because the obsolescence was not immediately noted by customers. However, participants indicated that the new digital platform arrived just in time in 1990. By 1991, the product family achieved very high levels of performance. The history of these three product families appears to support the cause and effect relationship between core capability and performance. Obviously, we must study product families in more companies to generalize this finding and compute meaningful statistics.

Insert Figure 9 here

Achieving high levels of capability can be expected to have less impact in declining markets. We have recently completed a similar analysis for an electronic capital equipment company where, despite continuously growing core capability in its traditional mainstream product line, declining market conditions (slower growth and more competitors) have nonetheless yielded poorer performance relative to prior years. This company must find new market applications for its core technologies.

Market dynamics temper the relationship between core capability and performance. We asked each family study team to indicate changes in the rate of market growth[23] , the level of competition[24], and the effective product life cycle for their product families[25]. Figure 10 shows the results for the horizontal application family. For all three product families, market growth rates in their target markets are now moderate to fast and competition has intensified. Product life cycles have also shortened.

Insert Figure 10 here

These pictures summarize an enormous amount of data, and emphasize changes that have occurred over the course of time. The dynamics of innovation and product development simply cannot be well understood using a single project lens. We need full motion video, time-phased to understand the evolution of capabilities and of success and failure over a span of years.

Core Capabilities as a Basis for Improving Management

A company must continue to invest in renewing product platforms, particularly for markets with accelerating rates of product introduction and competitive intensity. For example, if management does not continue to invest to renew the platform for the horizontal application family for a third time, the "dip" experienced before will probably occur again.

How is management to choose which requests to satisfy fully, or if the resources requested are indeed sufficient? Many, if not most firms allocate resources by individual product effort on an annual basis. Further, allocation requests tend to be summarized by functional area (R&D versus marketing versus manufacturing). Single product funding impedes the development of a core for product families and therefore inhibits creation of the type of leverage that we have discussed throughout this paper. Summarizing by functional area obfuscates the what, when, and how much behind the funding requested for a new product effort.

What does a product family need to do to achieve best in class status in technology, market knowledge, distribution, manufacturing, and service? Product family maps may be useful in this regard.

Insert Figure 11 here

For example, Figure 11 shows the computed means of the core capability assessments for the turnkey systems family. While the first two technologies have risen above the industry average, the third (which is software and

systems integration) continues to be well below par. The company must address this area of weakness to be more successful. In all three product families studied here, the more detailed core capability assessment charts clarify this type of tactical decision making.

Explaining the Ebb and Flow of Core Capabilities

Our study illustrates the idea that core capabilities are dynamic. They result from the efforts of individuals, and are thus affected by the organization of teams, the selection of products and markets, and the nature and quality of those markets.

Once gained, competence can be readily lost. Ill-considered policies and approaches adopted by management can destroy hard won capabilities, impede learning, hurt the effectiveness of product development, and ultimately, damage the profitability of the company. Four fundamental inhibitors of core capability creation have emerged as common themes in our work:

A lack of patience: Using unrealistic, short time horizons for the development of new businesses invariably leads promising technical and marketing development efforts to be killed before capability, visible on the horizon, is realized and exploited. How long should it take to achieve excellence in the relevant core capabilities in a new area?

A visual presentation of a product family powerfully conveys the nature of the embodied core capabilities, how painstakingly they may be gained and how quickly lost. Of the three product families studied, the company achieved competitive levels of capability in only one family, and in that case only after approximately 10 years. This particular experience is by no means atypical. Other studies have produced time ranges from 7 to 20 years. [26]

A failure to adopt innovations and new architecture. Technological discontinuities can quickly obsolesce a company's products.[27] Dominant firms in technology-based businesses have been and continue to be

vulnerable to discontinuous innovations by new competitors. Planned renewal of product platforms combined with sustained development of core capabilities as presented here is a defense against technological surprises and obsolescence. The renewal we observed for one product platform in the company studied occurred with considerable conflict and organizational dislocation.

Coasting on Success: Management can dissipate the firm's capabilities by failing to invest in product and manufacturing technology required to maintain the competitive distinctiveness of its products. Members of our study groups called this the *coast mentality.* Once a product family reaches high levels of success, management allocates to it only maintenance level resources and shifts resources to other product families in earlier stages of development. It is a strategy prone to disaster.

The coast mentality is probably more a result of a portfolio management approach to new product development than anything else: diversify, spread risk, and invest by stage of maturity. It leads to large corporations having too many irons in the fire. As shown in other research, rather than produce many successful products, this approach yields a portfolio of mediocre products.[28] Thus, strategic focus and aggressive reinvestment are essential to leading rapidly changing markets with high levels of technological change.

Breaking up Design Teams: The staffing of business and technical teams has a strong bearing on the development of core capabilities. Surely core capabilities cannot be developed nor maintained if key individuals do not have the chance work with one another in a concentrated way for extended amounts of time. In many companies, while management brings multifunctional "hit teams" together to design and complete a product, once that product is finished, management disbands the team and assigns its personnel to other high priority product efforts.

Perhaps there is another way. Is it possible for firms to keep the heart of a multifunctional design team together for at least a generation of a product family? Will this not provide the momentum behind a product platform that meets customers' needs and is amenable to effective manufacturing and

sales? At the same time, management might rotate into the development effort more frequently persons to implement the product platform and create specific variations using the latest skills and techniques. These ideas represent a product family approach to staffing projects and argue for a delineation between design and technical implementation.

Managing Towards a Better Future

Companies can manage themselves toward a better future by thinking in terms of the product family, multidimensional product cores, and the policies required to achieve and sustain core capabilities. Management must fashion planning horizons and financial commitments towards periods longer than current practice in many companies. Management must also provide multifunctional design teams to stay together longer than current practice. The more diverse a corporation's various businesses, the greater will be the pressures *not to do these things.*

We present a framework for managing new product development in Figure 12. Product families consist of a common core and variations that are refinements and extensions of that core for specific market niches. Different functional aspects of the product core undergo substantial improvements on a periodic basis. More flexible and powerful product platforms, new manufacturing processes to improve unit costs and quality, new techniques and technologies to provide service, and channel improvements become part of a new generation of the product core. The improvements contained within a new generation improve all the products within the family that use the product core. If a company can enhance the capabilities under girding the product core, the result should be better products. Conversely, if core capabilities dissipate, the product core will loose its competitive edge as will its product offspring. Ideally, the percentage of the product core's contribution to individual products as whole should increase from generation to generation.

Insert Figure 12 here

For the product family idea to have impact, we believe that the firm must consider several basic steps. First, management must transform product planning into product family planning that includes generations of product cores, the product platforms within these cores, and the market niche product variations within a family. Second, management must adapt its budgeting to this type of planning. In many companies, individual new product efforts compete for resources. In our way of thinking, a company must try to consolidate these individual efforts into basic product families. Each family requests *multiple year* commitments from senior management based on its plans -- a major part of which is for product core development, and the other major part, for the completion and marketing of specific products.

The development of product cores, if well managed, presents a compelling basis for achieving rapid delivery cycles in the creation of new products. If one adopts a product family approach to making new products, then a strategy to "speed management" emerges. A company must be patient and forward thinking in developing product cores. The completion of a strong product core then facilitates the far more rapid development of new product variations. In fact, rather than release a single new product, the firm may simultaneously introduce many products, each aimed at a specific market niche. Concurrently, the company must begin designing the product platform for the next generation of the family. Product obsolescence is inescapable. The issue is who takes control of the process. Winning companies retire their own products rather than let competitors do it for them.

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[1] Teece, D., "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," *Research Policy*, Vol. 15, No. 6, 1986, Pp. 285-306; Prahalad, C. K. and G. Hamel, "The Core Competence of the Corporation," *Harvard Business Review*, Vol. 68, No. 3, May-June, 1990, Pp. 79-91.

[2] Quinn, J.B., T. L. Doorley and P. C. Paquette, "Technology in Services: Rethinking Strategic Focus," *Sloan Management Review*, Vol. 32, No. 2, Winter 1990, Pp. 79-87.

[3] Sanderson posited that "virtual designs" serve as the basis for a series of "product realizations" within particular generations of a product family. See: Sanderson, S., "Cost Models for Evaluating Virtual Design Strategies in Multicycle Product Families", Center for Science and Technology Policy, Rensselaer Polytechnic Institute, 1991 and forthcoming in *Journal of Engineering and Technology Management.*.

[4] Henderson, R. and K. Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", ***Administrative Science Quarterly,*** Vol. 35, 1990, Pp. 9-30

[5] Freeman, C., ***The Economics of Industrial Innovation (Second Edition),*** MIT Press, Cambridge, MA, 1986; Cooper, R. G., ***Winning at New Products,*** Addison-Wesley, Reading, MA, 1986; Maidique, M. A. and B. J. Zirger, "The New Product Learning Cycle," ***Research Policy,*** Vol. 14, No. 6, December, 1985, Pp. 299-314.

[6] Utterback, J. M., "Innovation and Industrial Evolution in Manufacturing Industries," in Bruce R. Guile and Harvey Brooks (Eds.) ***Technology and Global Industry: Companies and Nations in the World Economy,*** Washington, D.C.: National Academy of Engineering - Series on Technology and Social Priorities, 1987, Pp. 16-48; Roberts, E.B. and M.H. Meyer, "New Products and Corporate Strategy, "Engineering ***Management Review,*** Vol. 19, No. 1, Spring 1991, Pp. 4-18.

[7] Sanderson and Uzumeri, *op cit.*

[8] The four major innovations were miniature stereo headphones, miniature super flat motors, disk drive mechanisms, and small, rechargeable Ni-Cd batteries.

[9] Lehnerd, A., "Revitalizing the Manufacture and Design of Mature Global Products," in Guile, B. and Brooks, H. (Eds.), ***Technology and Global Industry: Companies and Nations in the World Economy,*** Washington, D.C.: National Academy of Engineering Press, 1987, Pp. 49-64.

[10] By simply varying the length of the motor field, power from 60 to 650 Watts could be achieved.

[11] The use of events and years to anchor data gathering and analysis over a span of time has been used to study and illustrate that successful R&D teams pursue a number of alternative technical solutions before arriving at final solutions: Allen, T. J., ***Managing the Flow of Technology,*** Cambridge, MA: MIT Press, 1977, Pp.. 13-26.

[12] A fifth basic dimension, *service,* has been made part of our research with other companies.

[13] For a discussion of the use of graphical display techniques to present quantitative information see: Tufte, E., ***The Visual Display of Quantitative Information,*** Graphics Press, Cheshire, CT, 1983.

[14] For the turnkey systems family, seven individuals participated in the study. For the horizontal application family, ten individuals participated. The study team for the peripherals family had nine individuals. In our new work with companies, we are applying the same method to long term customers of a company's products to validate self assessments and gain new perspectives on competitive competencies.

[15] We settled on these four dimensions of core capability based on the literature. We are also examining core capabilities in a fifth Service dimension in our current work.

[16] In our work with other firms, major internal manufacturing processes involved in a product family have been identified as core capabilities for data gathering and analysis.

[17] The metric used to assess capability was as follows:
5. Best in class – industry leadership
4. Above par
3. On Par
2. Below Par
1. Worst in class

In our current work, this assessment scale is being further anchored by having participants identify competitors who represented "best in class" or close to it for each core capability during the years included in the study.

[18] The underlying databases for these studies can be quite large. For example, over a thousand data points were gathered for horizontal application family alone. We computed standard deviations to examine the variance in responses among participants for each core capability. These have been left out of this article to simplify the presentation.

[19] In our work for other firms, participants have requested that we weight certain core capabilities more heavily than others to reflect their importance in the products being studied.

[20] Prahalad and Hamel, *op cit.*; Quinn, Doorley, and Paquette, *op cit.*

[21] The scale for performance was:
5. Amongst the most successful new business development efforts in the company
4. Above par
3. On Par
2. Below Par
1. Amongst the least successful new business development efforts in the company

[22] In another study at the same company, we have gathered data on individual product performance for recent years. Grouping individual products into their respective families provided a cross check on the validity of the executives' relative assessments. Cross checks for earlier years were not feasible because performance data for individual products were not recorded.

[23] The scale for market growth was:
5. > 25% per year: rapid growth
4. > 10% and < 25%: fast growth
3. > 5 and < 10%: moderate growth
2. >= 0% and < 5% : slow growth
1. < 0% : contracting market

[24] The scale for level of competition was:
5. Many competitors, with several dominant firms
4. Many competitors, but no dominant firms
3. A few large competitors
2. A few small competitors
1. No competitors

[25] The scale for effective product life cycle was:
5. 5 or more years
4. 4 years

3. 3 years
2. 2 years
1. 1 year

[26] Sony spent approximately twenty years in basic research for the development of its video camera products: Cusumano, M., Y. Mylonadis, and R. Rosenbloom, "Strategic Maneuvering and Mass-Market Dynamics: The Triumph of VHS over Beta," International Center for Research on the Management of Technology, Working Paper 40-91, 1991.

[27] Abernathy, W.J. and J.M. Utterback, "Patterns of Innovation in Technology," ***Technology Review***, Vol. 80, No. 7, 1978, Pp. 40-47; Foster, R.N., "Timing Technological Transitions," in M. Horwitch (ed.), ***Technology in the Modern Corporation***, The MIT Press, Cambridge, MA, 1986; Abernathy, W. J. and K. B. Clark, "Innovation: Mapping the Winds of Creative Destruction," ***Research Policy***, Vol. 14, No. 1, 1985, Pp. 3-22; Tushman, M. and P. Anderson, "Technological Discontinuities and Organizational Environments," ***Administrative Science Quarterly***, Vol. 31, 1986, Pp. 439-465.

[28] Meyer, M. and E. Roberts, "Focusing New Product Strategy for Corporate Growth," ***Sloan Management Review***, Summer 1988, Vol. 29, No. 4, Pp. 7-16; Quinn, Doorley, and Paquette, *op cit.*

Figure 1
Patterns in Product Strategy
Product Family Approach

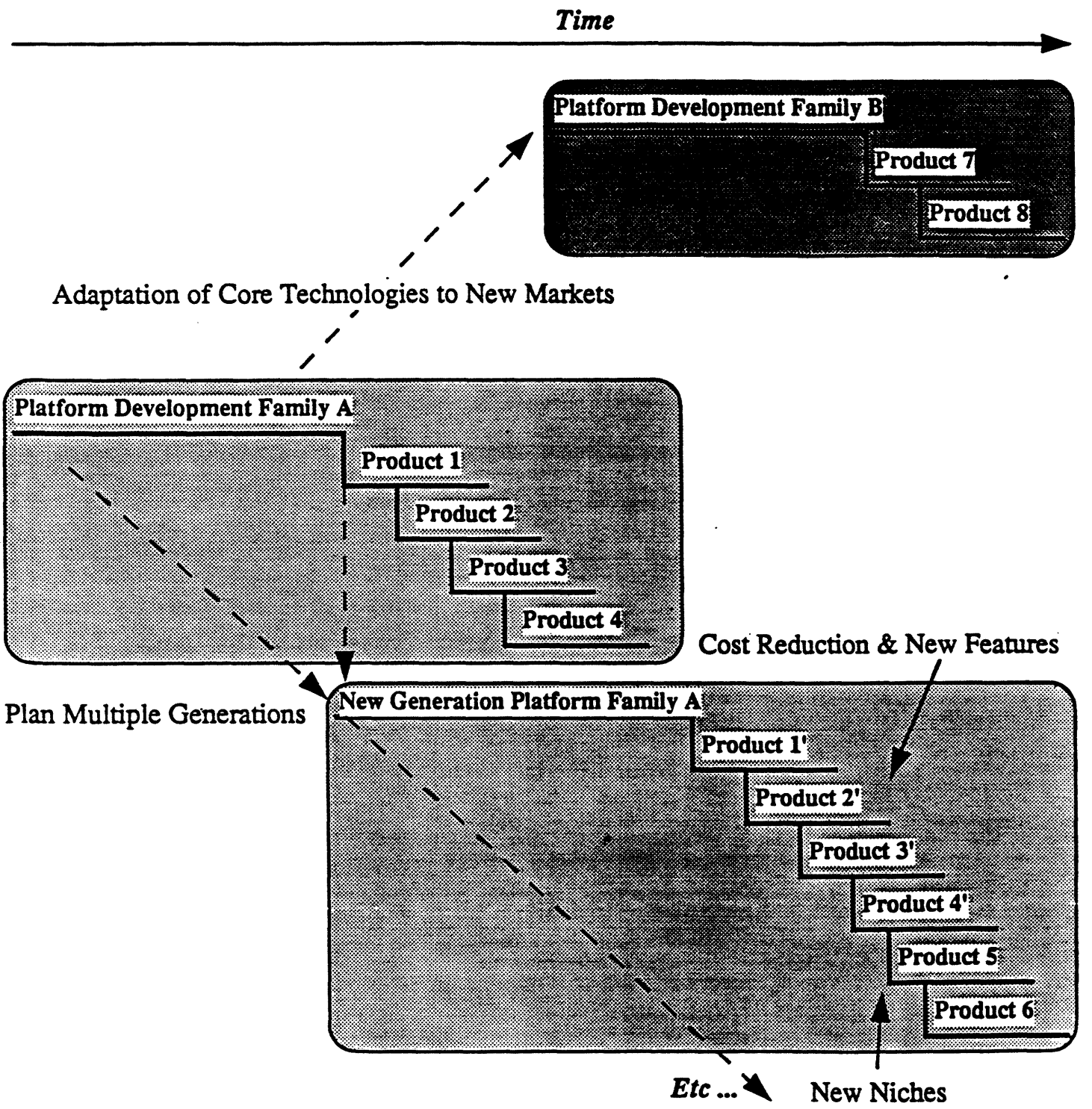


Figure 2
The Product Family
The Product Core and Market Niche Applications

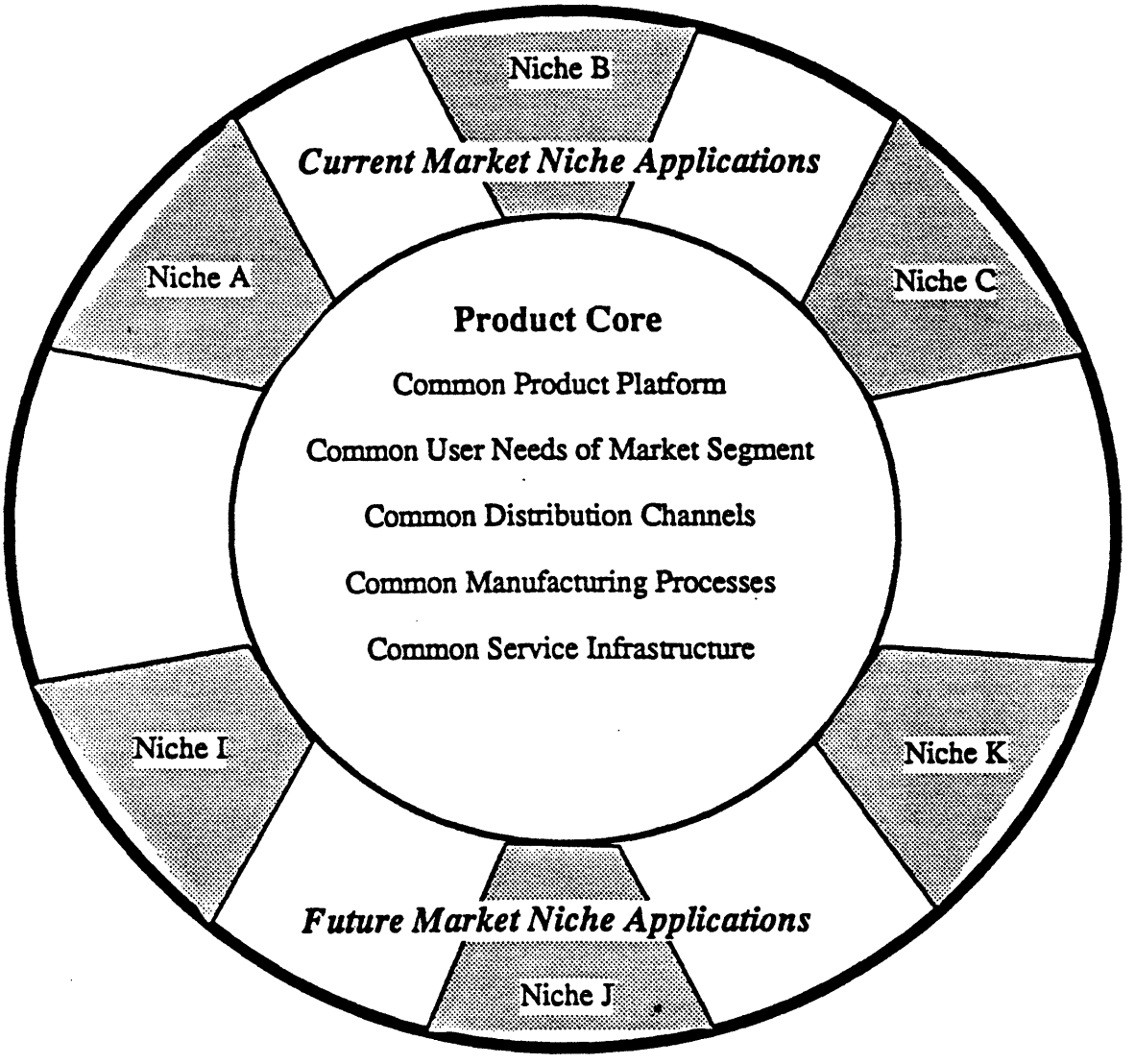


Figure 3
Product Family Map
Two Alternative Representations

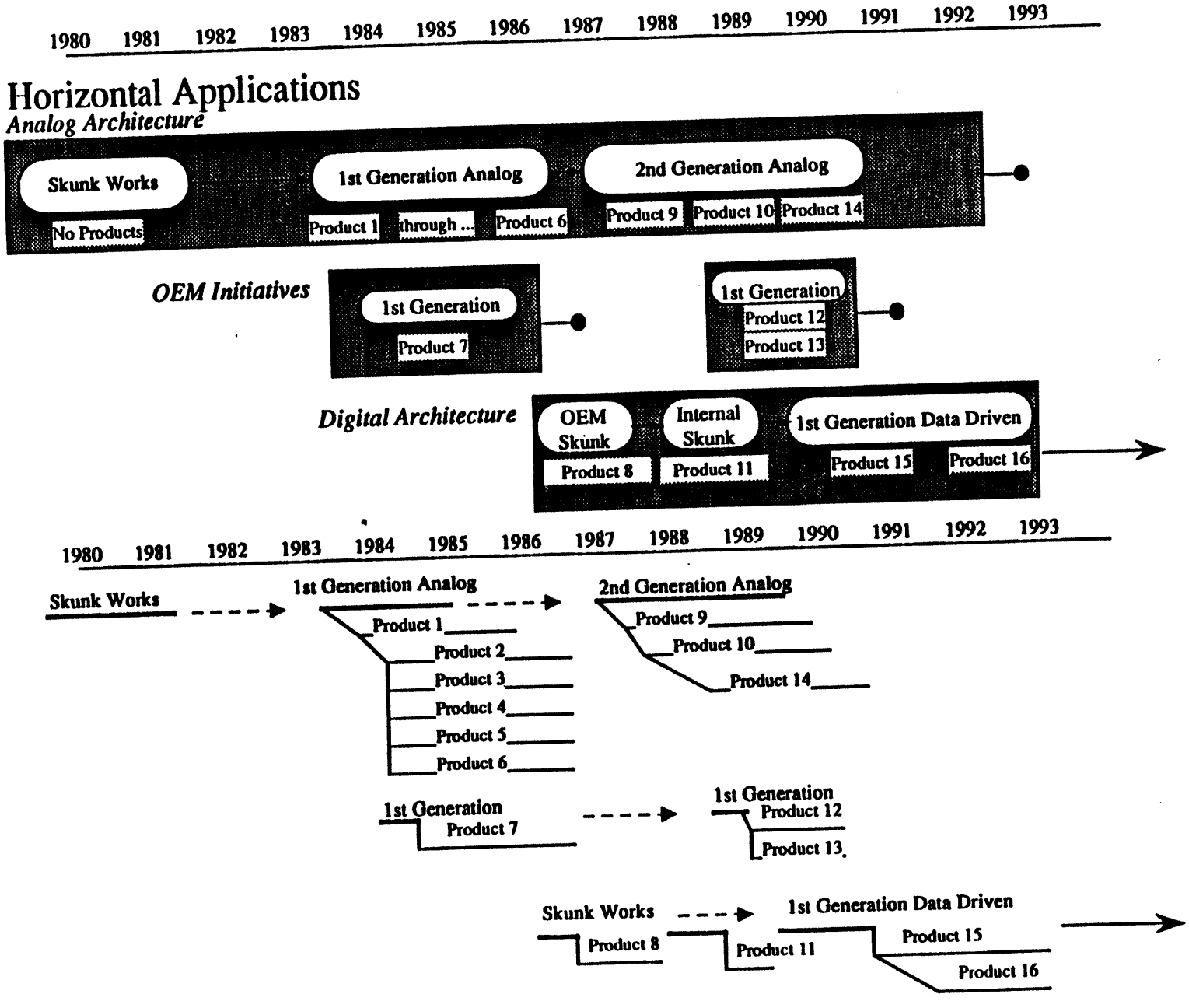


Figure 4
Three Product Family Maps

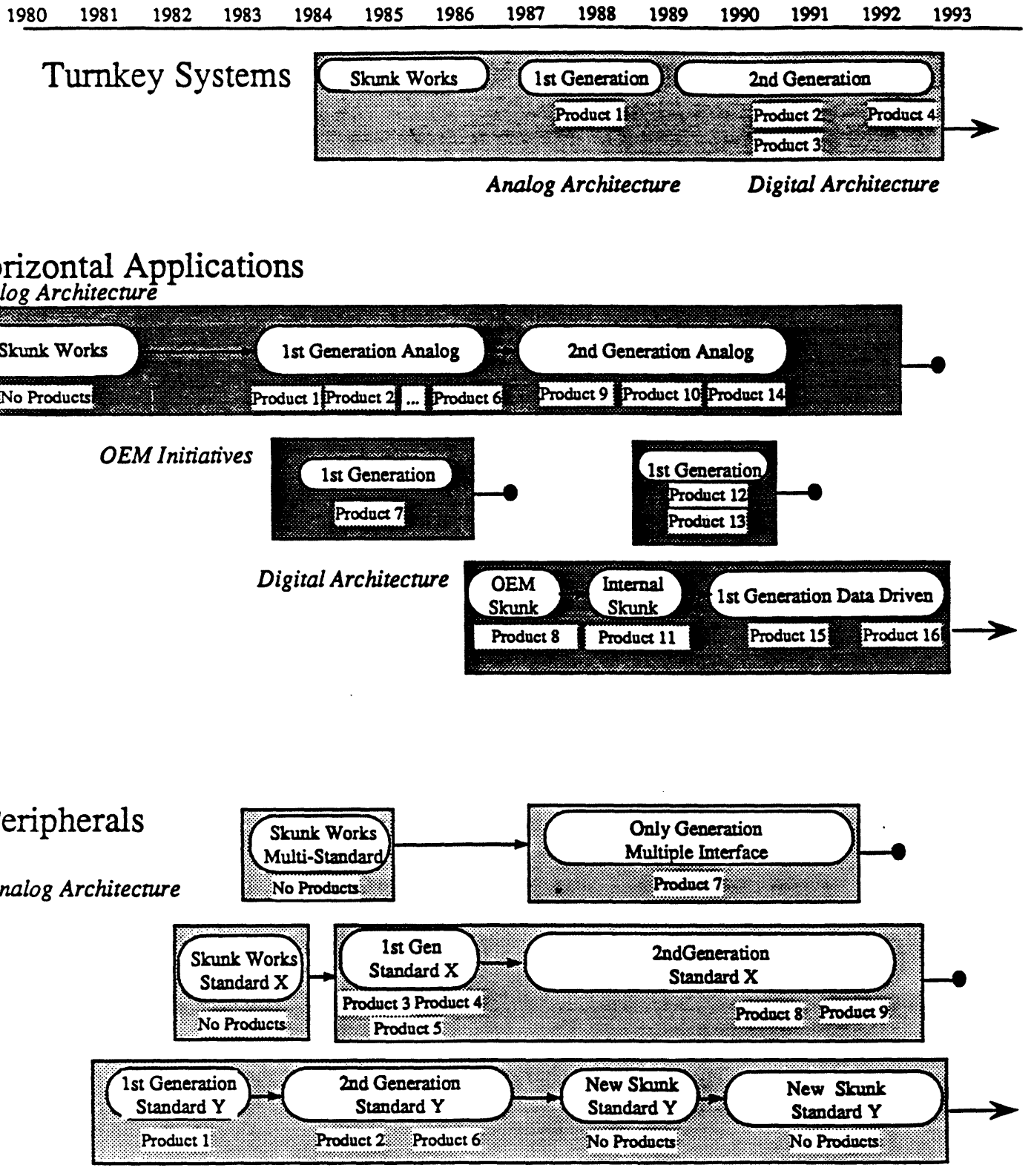
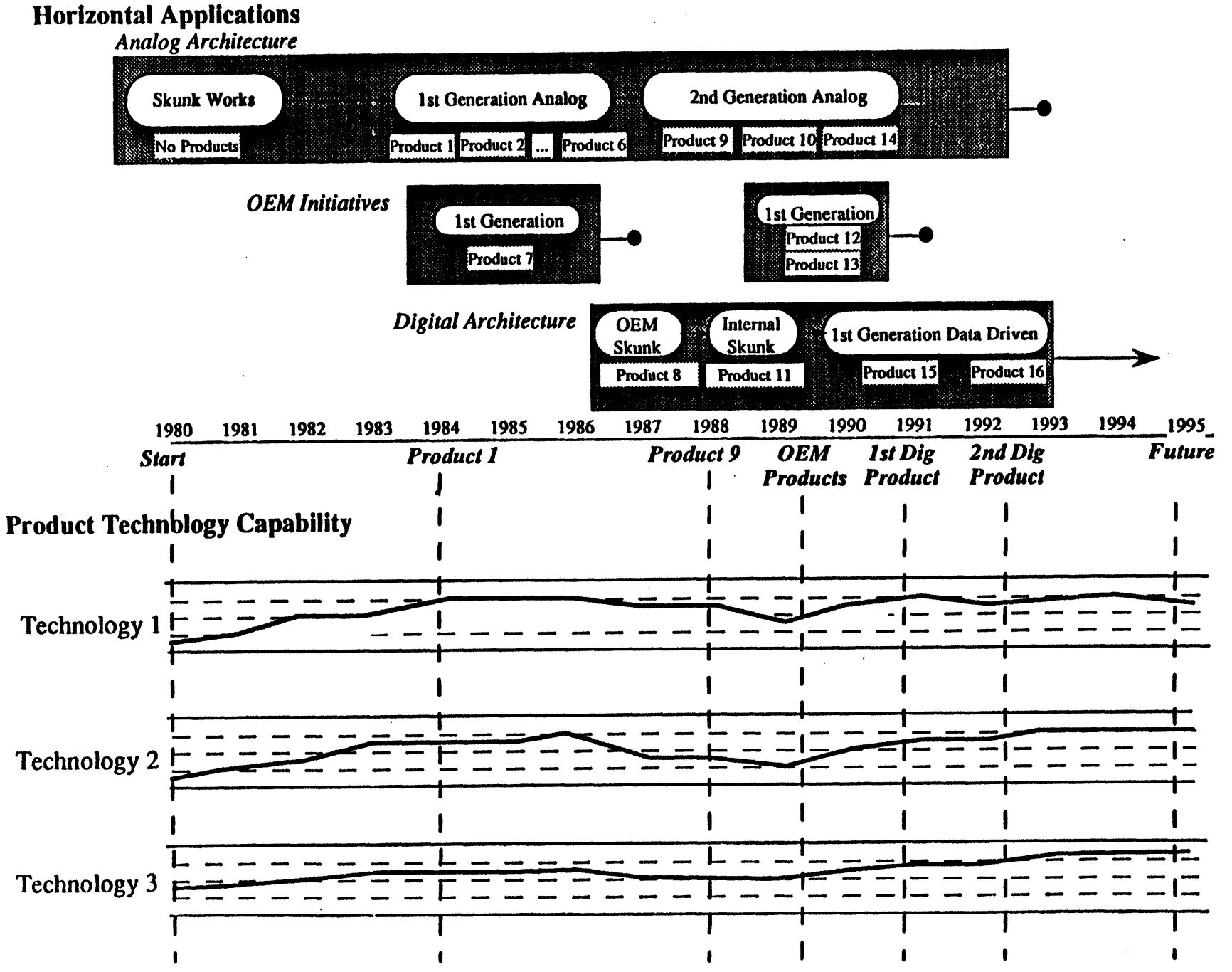


Figure 5
Core Capability Assessment for a Product Family



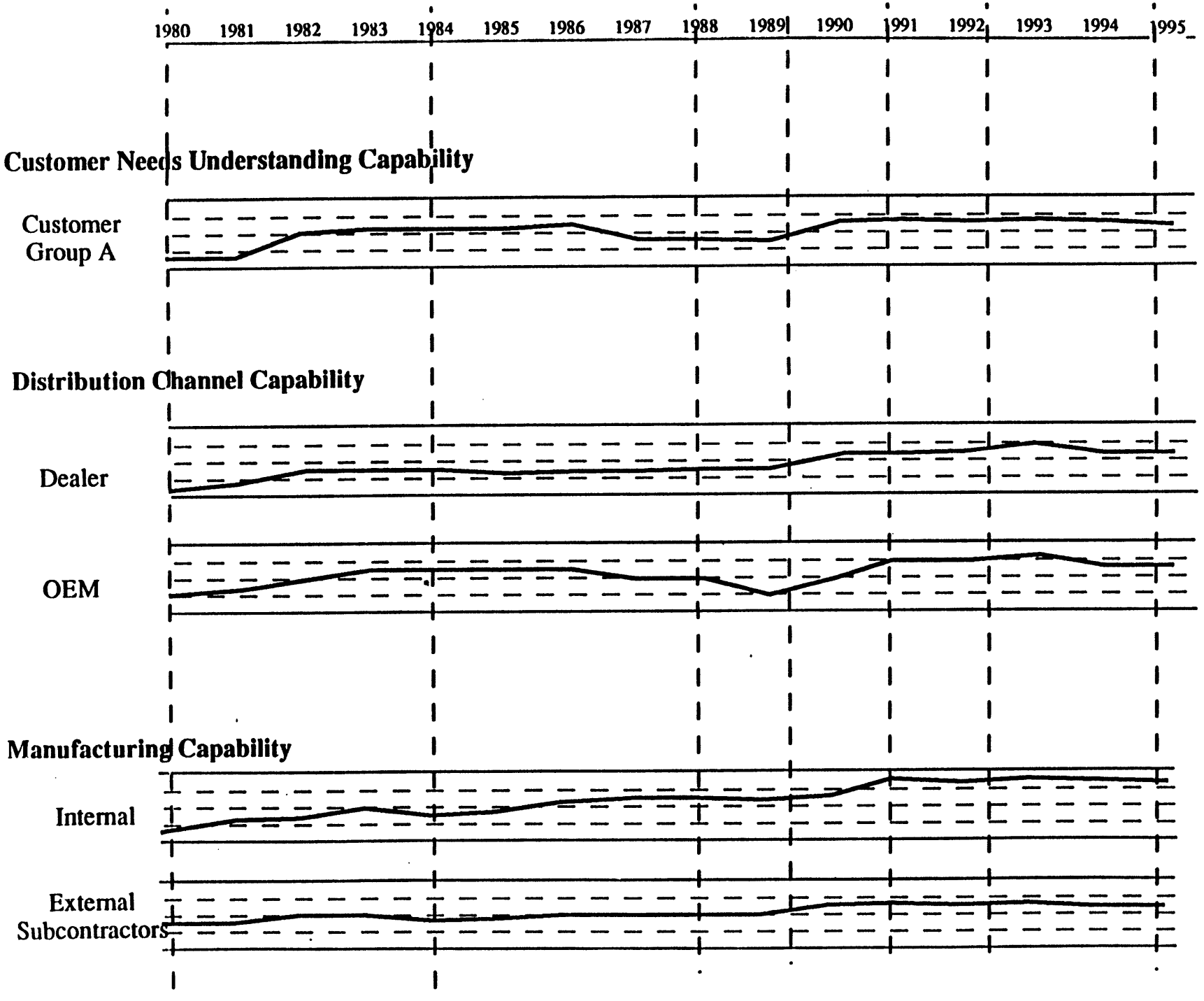

1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
Customer Needs Understanding Capability
Customer Group A
Distribution Channel Capability
Dealer
OEM
Manufacturing Capability
Internal
External Subcontractors

Figure 6
Core Capability Assessment for A Product Family: Summary

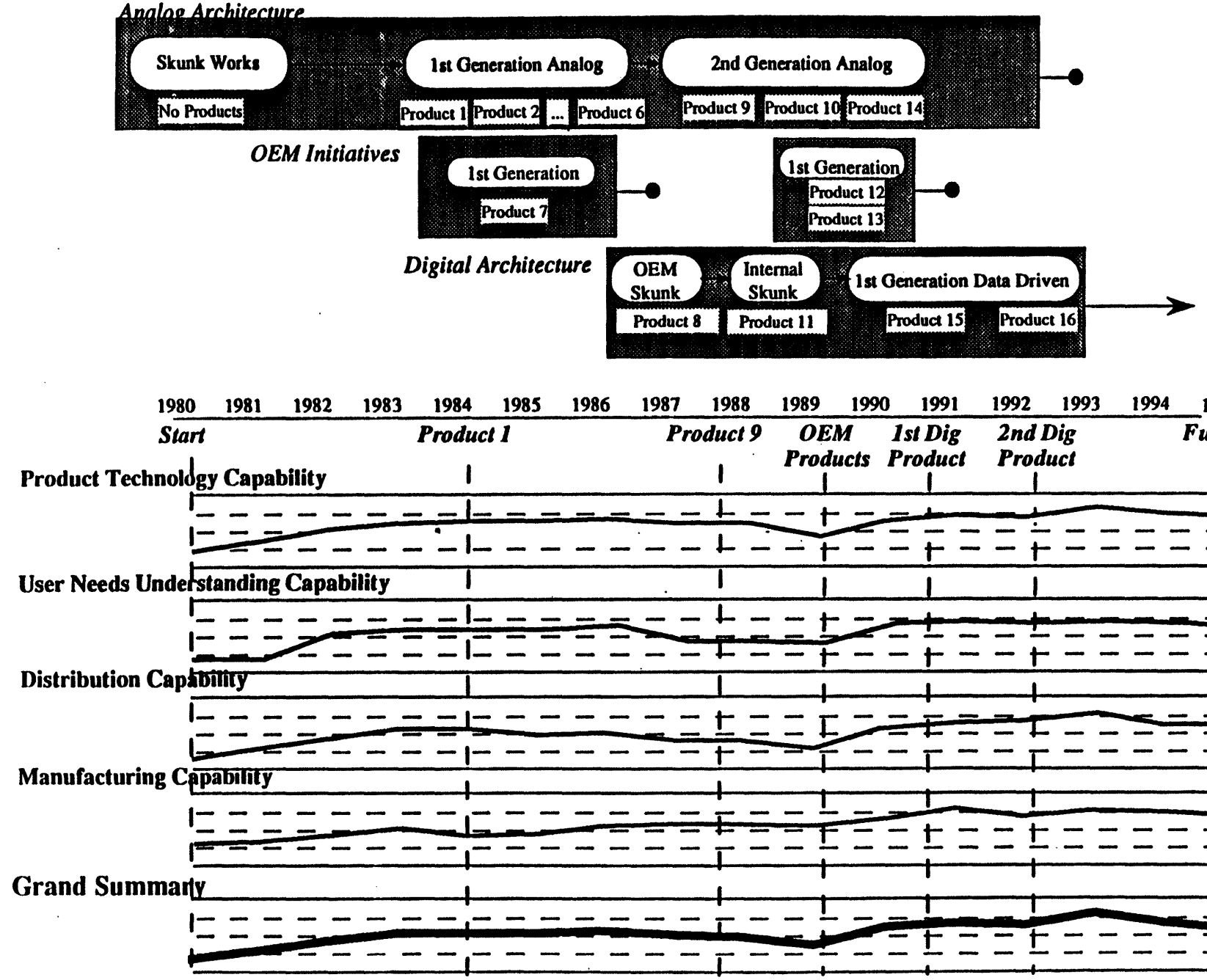
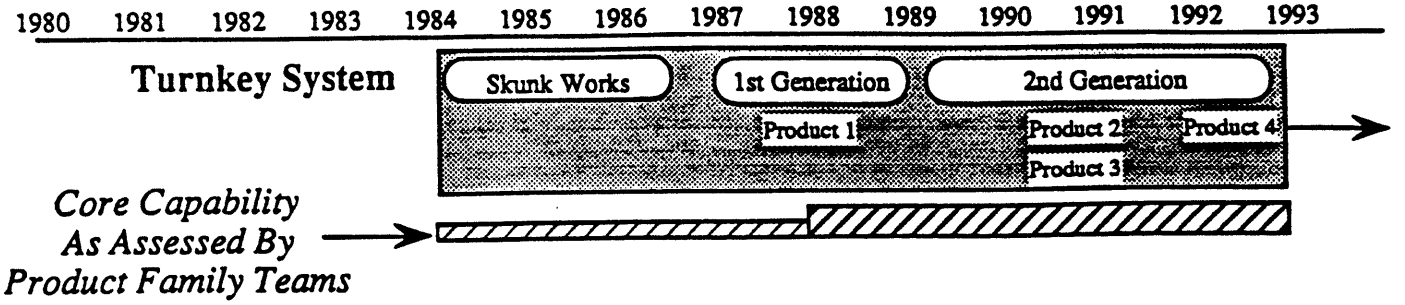
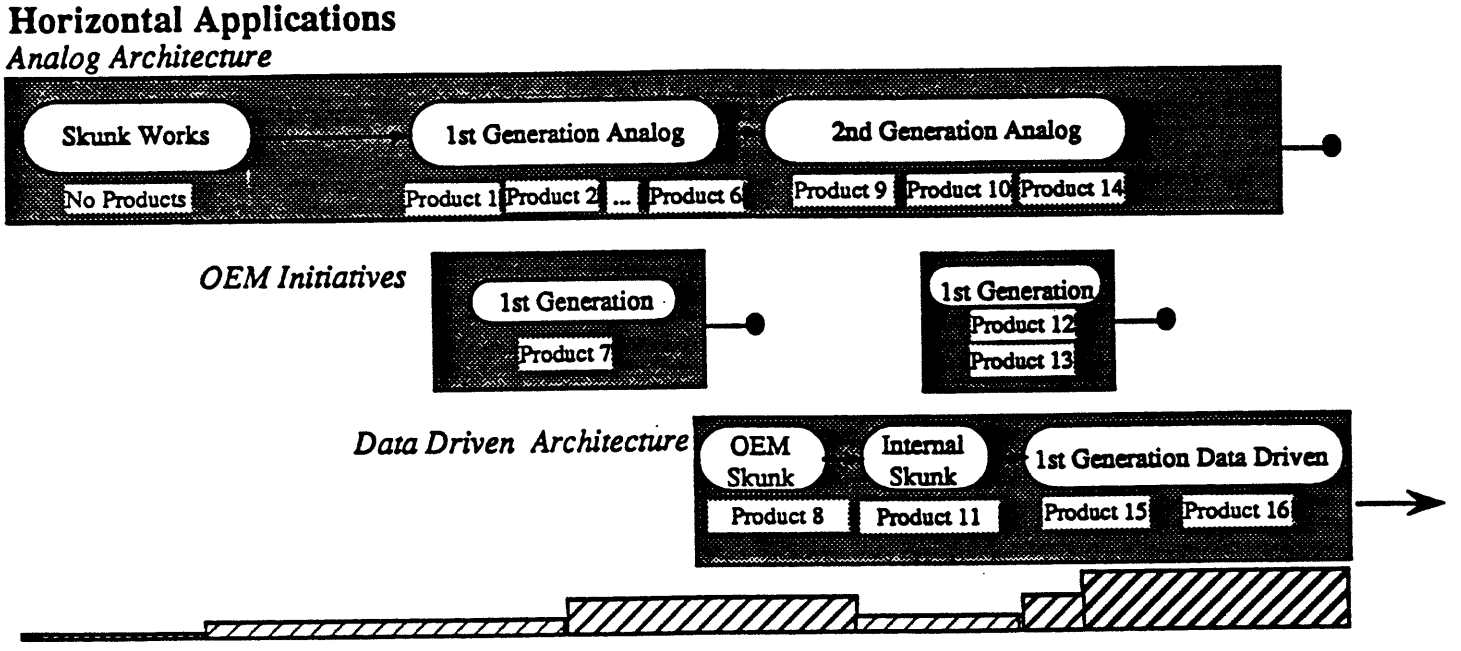


Figure 7
Core Capability Assessments for Three Product Families





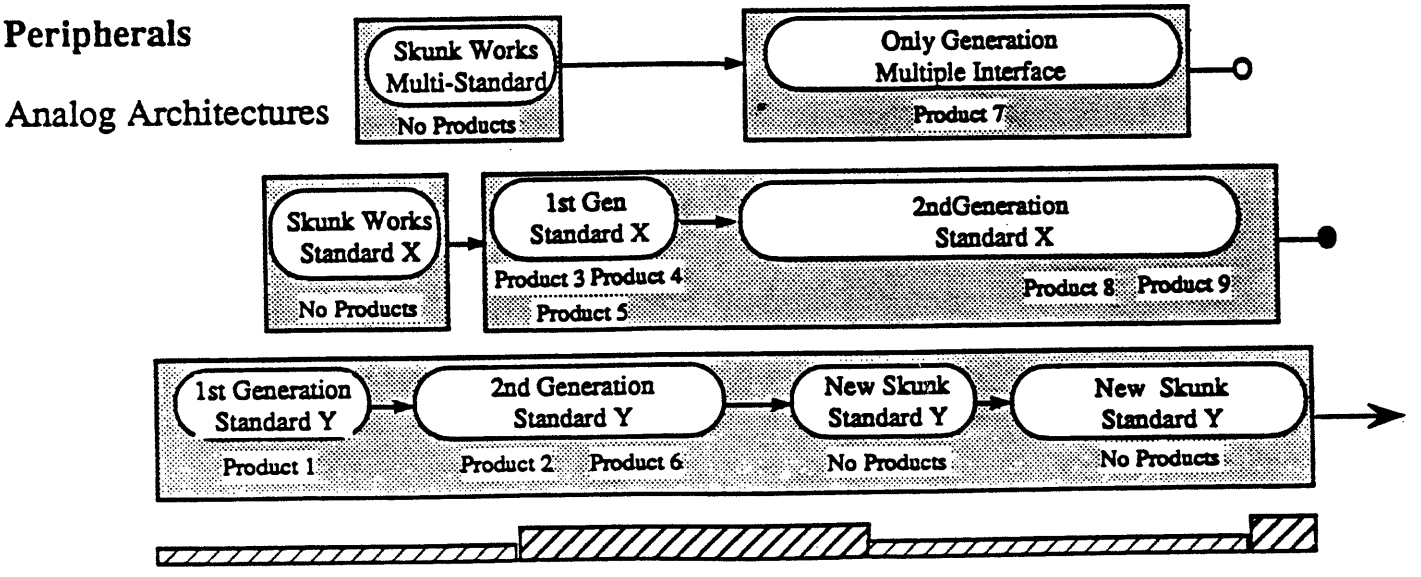


Figure 8
Performance Assessments for Three Product Families

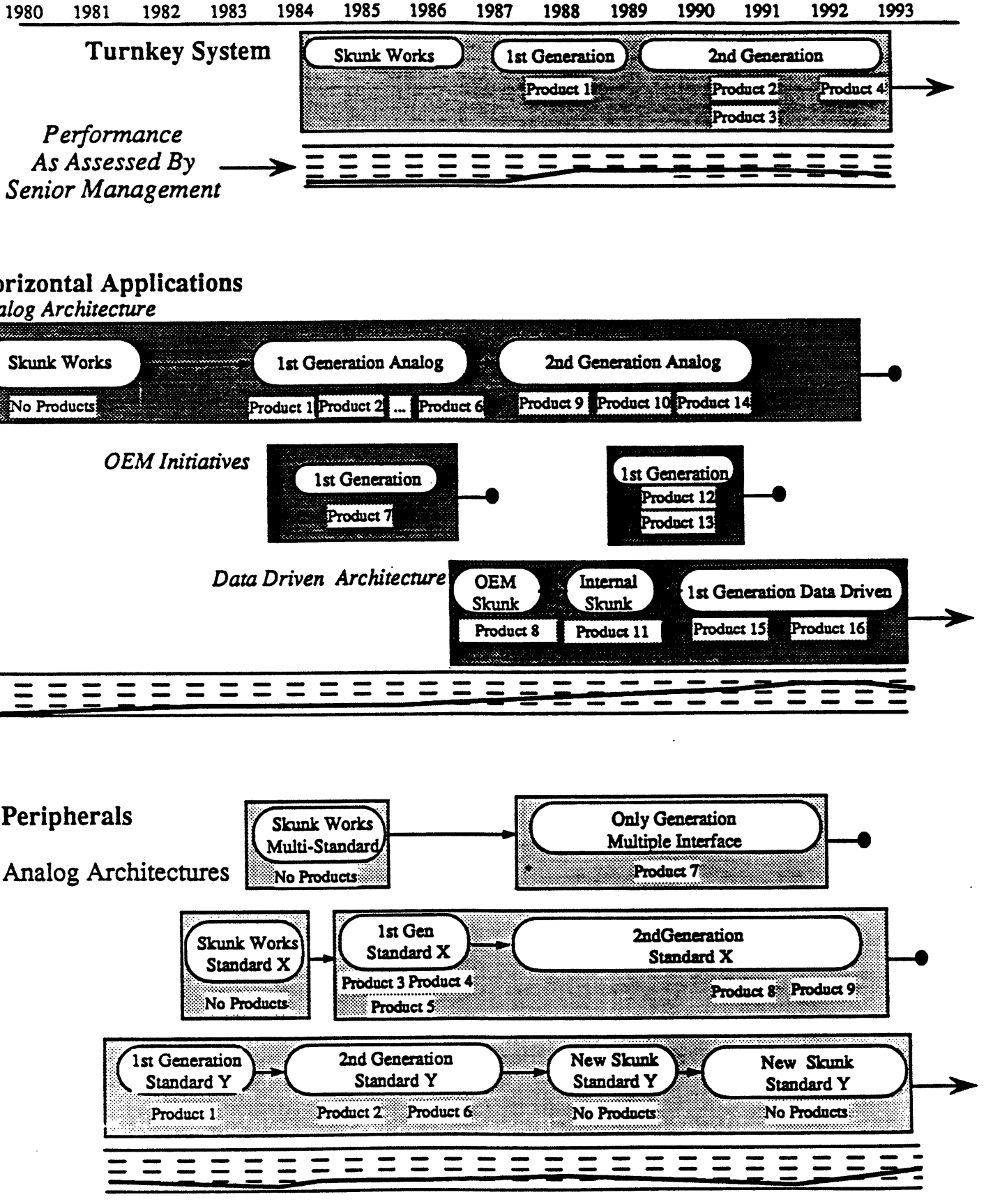


Figure 9
Core Capability and Performance for Three Product Families

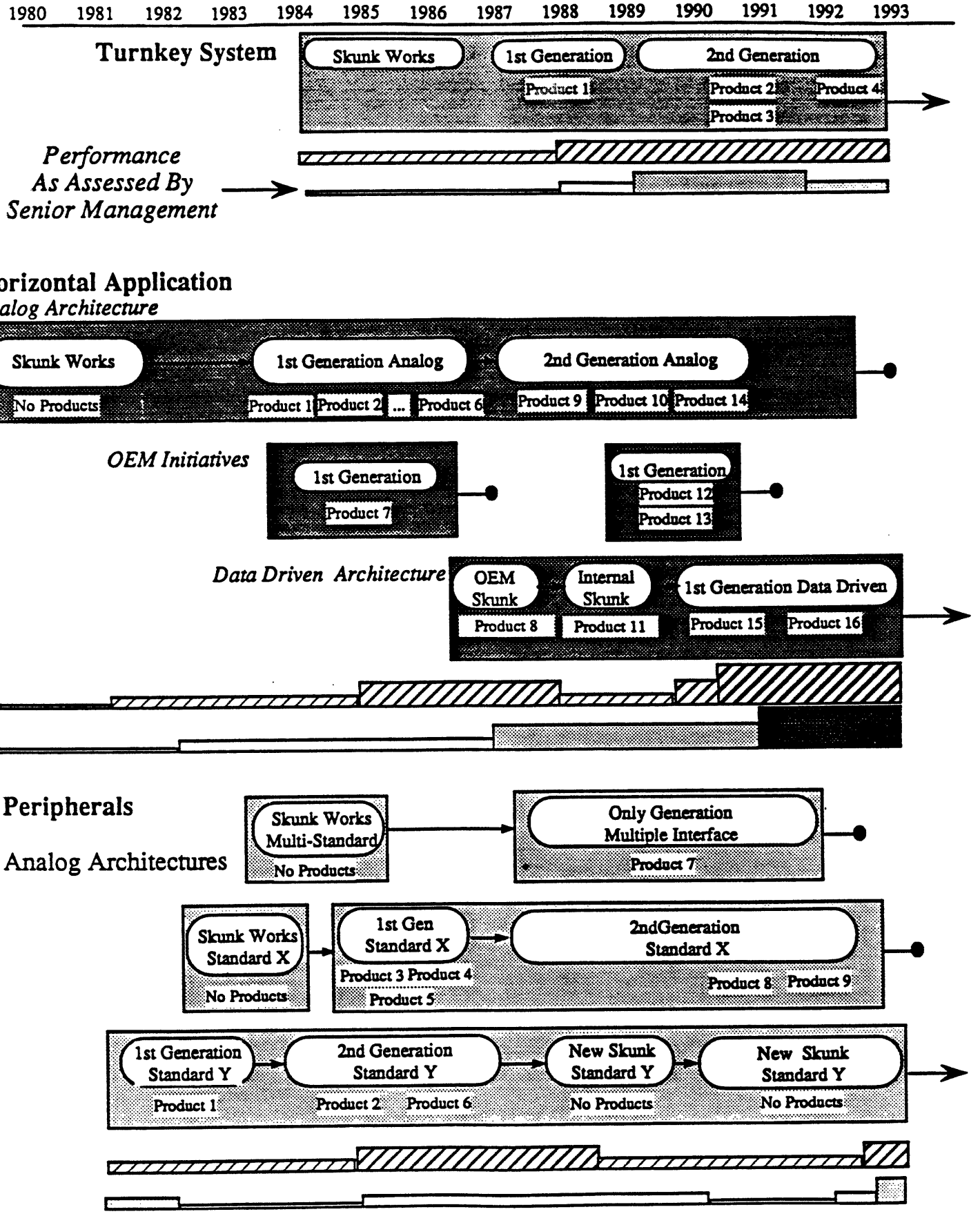


Figure 10
Core Capability, Performance, and Market Assessments for a Product Family

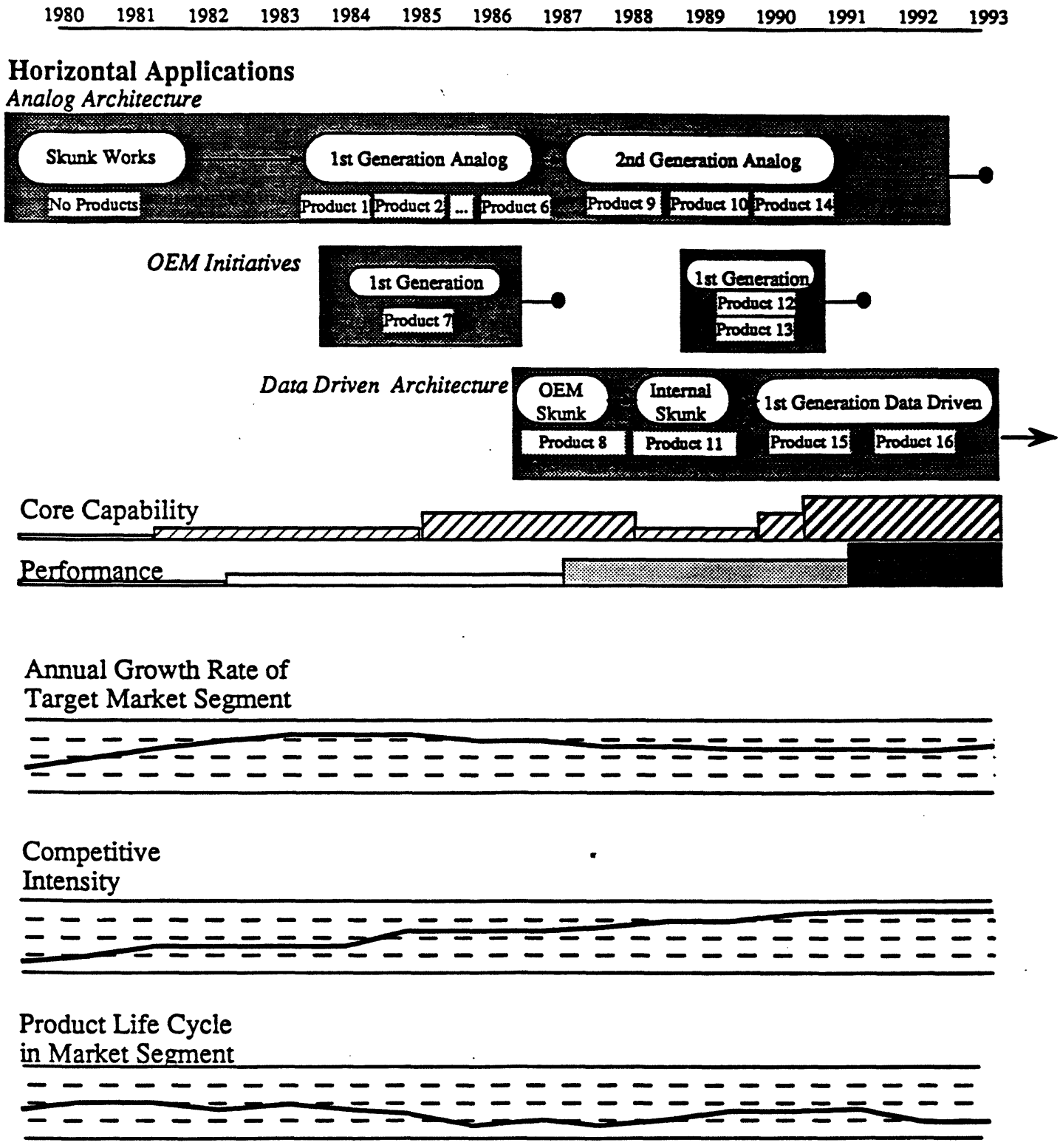


Figure 11
Identifying Problem Areas in a Product Family

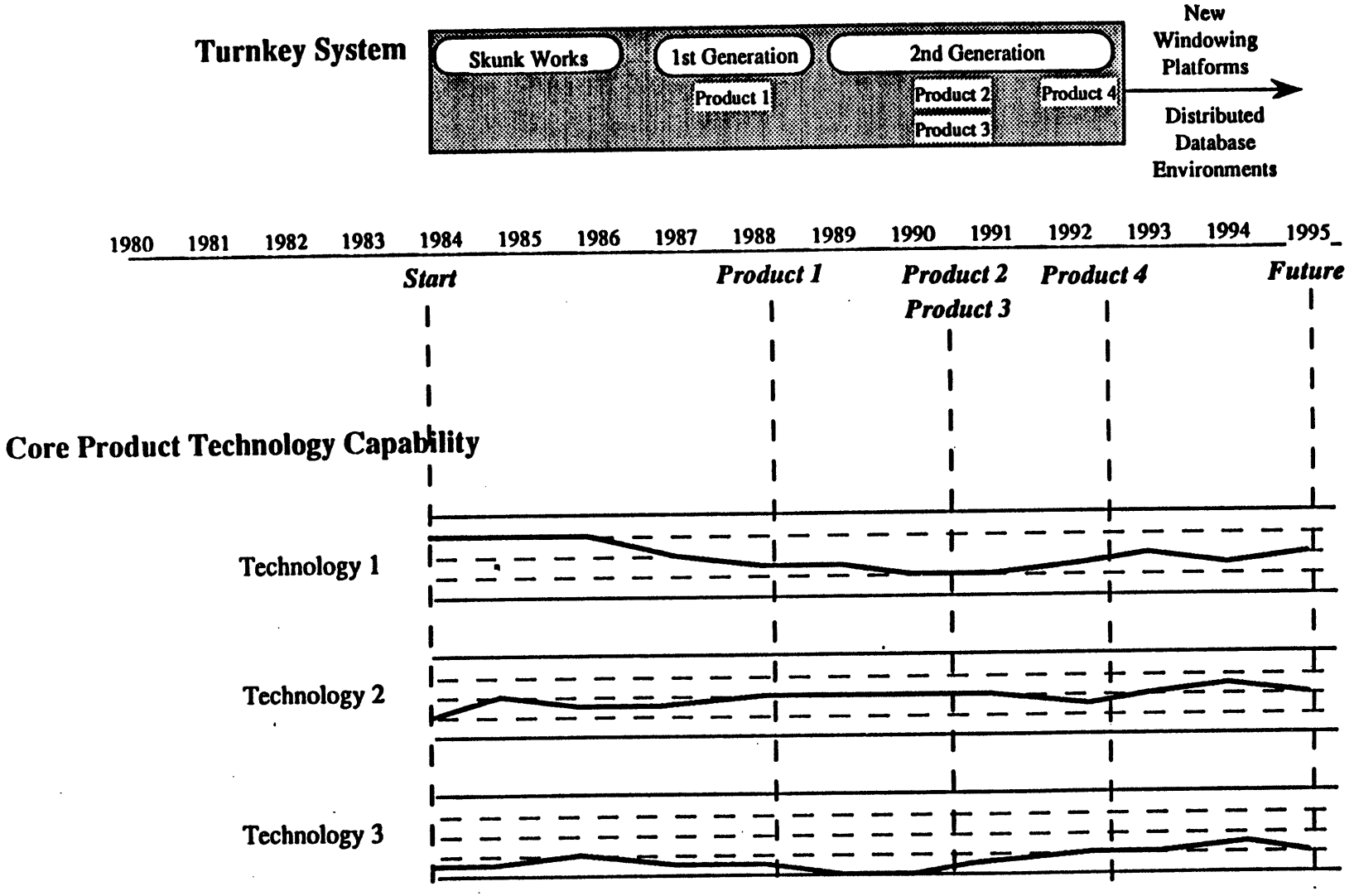
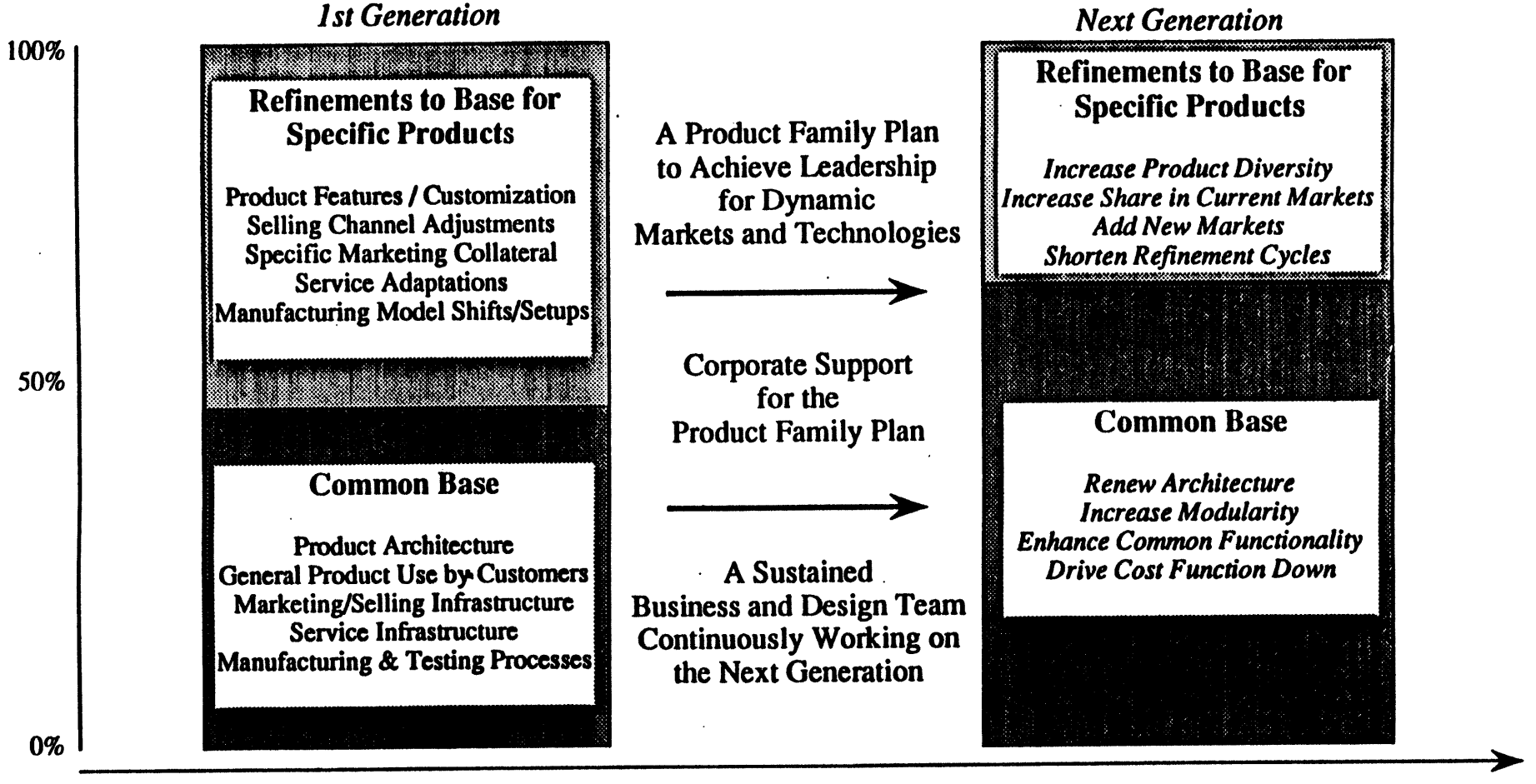


Figure 12
The Product Family
The Common Base versus Product Refinements



Increase the Contribution of the Common Base to Individual Products

Improve the Quality of the Common Base

Product Refinement Cycle Time Continously Shortened

Marketing Emphasizes Good Products Today, Better Ones Tomorrow