The New Product Development Map

by Steven C. Wheelwright and W. Earl Sasser, Jr.

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Mapping is a medium and also a message:
Get together on new products sooner and smarter with…

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No business activity is more heralded for its promise and approached with more justified optimism than the development and manufacture of new products. Whether in mature businesses like automobiles and electrical appliances, or more dynamic ones like computers, managers correctly view new products as a chance to get a jump on the competition.

Ideally, a successful new product can set industry standards – standards that become another company's barrier to entry – or open up crucial new markets. Think of the Sony Walkman. New products are good for the organization. They tend to exploit as yet untapped R&D discoveries and revitalize the engineering corps. New product campaigns offer top managers opportunities to reorganize and to get more out of a sales force, factory, or field service network, for example. New products capitalize on old investments.

Perhaps the most exciting benefit, though, is the most intangible: corporate renewal and redirection.

Make new products build on your investments in R&D and sales.

The excitement, imagination, and growth associated with the introduction of a new product invigorate the company's best people and enhance the company's ability to recruit new forces. New products build confidence and momentum.

Unfortunately, these great promises of new product development are seldom fully realized. Products half make it; people burn out. To understand why, let's look at some of the more obvious pitfalls.

1. *The moving target.* Too often the basic product concept misses a shifting market. Or companies may make assumptions about channels of distribution that just don't hold up. Sometimes the project gets

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into trouble because of inconsistencies in focus; you start building a stripped-down version and wind up with a load of options. The project time lengthens, and longer projects invariably drift more and more from their initial target. Classic market misses include the Ford Edsel in the mid-1950s and Texas Instruments' home computer in the late 1970s. Even very successful products like Apple's Macintosh line of personal computers can have a rocky beginning.

2. *Lack of product distinctiveness.* This risk is high when designers fail to consider a full range of alternatives to meet customer needs. If the organization gets locked into a concept too quickly, it may not bring differing perspectives to the analysis. The market may dry up, or the critical technologies may be sufficiently widespread that imitators appear out of nowhere. Plus Development introduced Hardcard®, a hard disk that fits into a PC expansion slot, after a year and a half of development work. The company thought it had a unique product with at least a nine-month lead on competitors. But by the fifth day of the industry show where Hardcard® was introduced, a competitor was showing a prototype of a competing version. And within three months, the competitor was shipping its new product.

3. *Unexpected technical problems.* Delays and cost overruns can often be traced to overestimates of the company's technical capabilities or simply to its lack of depth and resources. Projects can suffer delays and stall midcourse if essential inventions are not completed and drawn into the designers' repertoire before the product development project starts. An industrial controls company we know encountered both problems: it changed a part from metal to plastic only to discover that its manufacturing processes could not hold the required tolerances and also that its supplier could not provide raw material of consistent quality.

4. *Mismatches between functions.* Often one part of the organization will have unrealistic or even impossible expectations of another. Engineering may design a product that the company's factories cannot produce, for example, or at least not consistently at low cost and with high quality. Similarly, engineering may design features into products that marketing's established distribution channels or selling approach cannot exploit. In planning its requirements, manufacturing may assume an unchanging mix of new products, while marketing mistakenly assumes that manufacturing can alter its mix dramatically on short notice. One of the most startling mismatches we've encountered was created by an aerospace company whose manufacturing group built an assembly plant too small to accommodate the wingspan of the plane it ultimately had to produce.

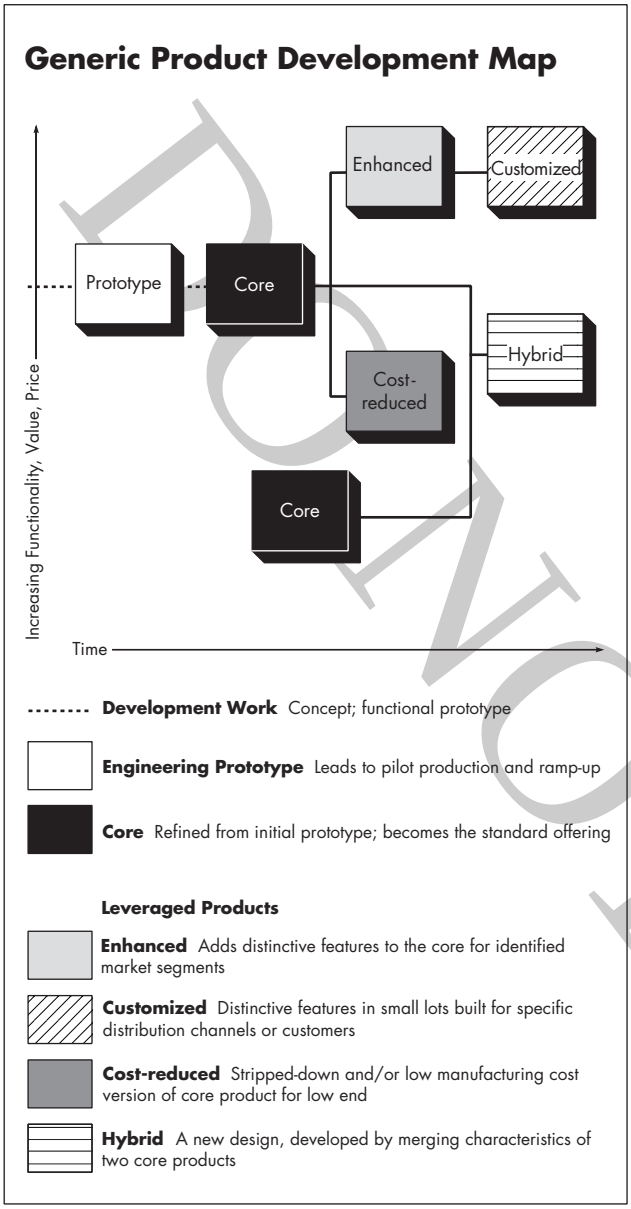
Thus new products often fail because companies misunderstand the most promising markets and channels of distribution and because they misapprehend their own technological strengths or the product's technological challenges. Nothing can eliminate all the risks, but clearly the most important thing to do early on when developing a new product is to get all contributors to the process communicating: marketing with manufacturing, R&D with both. Products fail from a lack of planning; planning fails from a lack of information.

Developing a new generation of products is a lot like taking a journey into the wilderness. Who would dream of setting off without a map? Of course, you would try to clarify the purpose of the journey and make sure that needed equipment is available and in order. But once committed to the trip, you need a map of the terrain, something everybody can study – the focus for discussion, the basis for planning alternative courses. Knowing where you've come from and where you are is essential to knowing how to get where you want to go.

Mapping Existing Products

We have often used this analogy of a map with corporate managers involved in product development, and gradually it has become clear to us that an actual map is needed, not just an analogy. Managers need a way to see the evolution of a company's product lines – the "where we are" – in order to expose the markets and technologies that have been driving the evolution – the "where we've come from." Such a map presents the evolution of current product lines in a summarized yet strikingly clear way so that all functional areas in the organization can respond to a common vision. The map provides a basis for sharing information. And by enabling managers to compare the assumptions underlying current product lines with the ideal assumptions of new research, it points to new market opportunities and technological challenges. Why, for example, should an organization build for department stores when specialty discount outlets are the emerging channels of distribution? Why bend metals when you can mold ceramics?

The first exhibit illustrates a generic map that indicates how the product offerings in one generation may be related to each other. These relations are the building blocks that allow us to track the evolution of product families from one generation



to another.

The map categorizes product offerings (and the development efforts they entail) as "core" and "leveraged" products, and divides leveraged products into "enhanced," "customized," "cost reduced," and "hybrid" products. (These designations seem to cover most cases, but managers should feel free to add whatever other categories they need.) A core product, first in white for the engineering prototype, then in black, is the engineering platform, providing the basis for further enhancements. The core product is the initial, standard product introduced. It changes little from year to year and is often the benchmark against which consumers compare the rest of the product line.

Enhanced products, in light gray, are developed from the core design; distinctive features are added for various, more discriminating markets. Enhanced products are the first products leveraged from the capabilities put in place to produce the core, and the first aimed at new or extended market opportunities. Often companies even identify them as enhanced versions; for example, IBM's DisplayWrite 3.1 is an enhanced version of DisplayWrite 3. But a leveraged product isn't necessarily more costly; the idea is simply to get more out of a fixed process – more "bang for the buck." As companies leverage high-end products, they may customize them in smaller lots for specific channels or to give consumers more choice (shown with diagonal stripes). The cost-reduced model (shown with medium gray) starts with essentially the same technology and design as the core product but is a stripped-down version, often with less expensive materials and lower factory costs, aimed at a price-sensitive market. (Think of the old Chevrolet Biscayne, which was many times the vehicle of choice for taxicabs and business fleets.)

Finally, there is the hybrid product (shown with horizontal stripes), developed out of two cores. The initial two-stage thermostat products – accommodating a daytime and nighttime temperature setting– were hybrids of a traditional thermostat product and high-end, programmable thermostat lines.

On the generic map, from left to right is calendar time, and from bottom to top designates lower to higher added value or functionality, which usually also means a shift from cheaper to more expensive products.

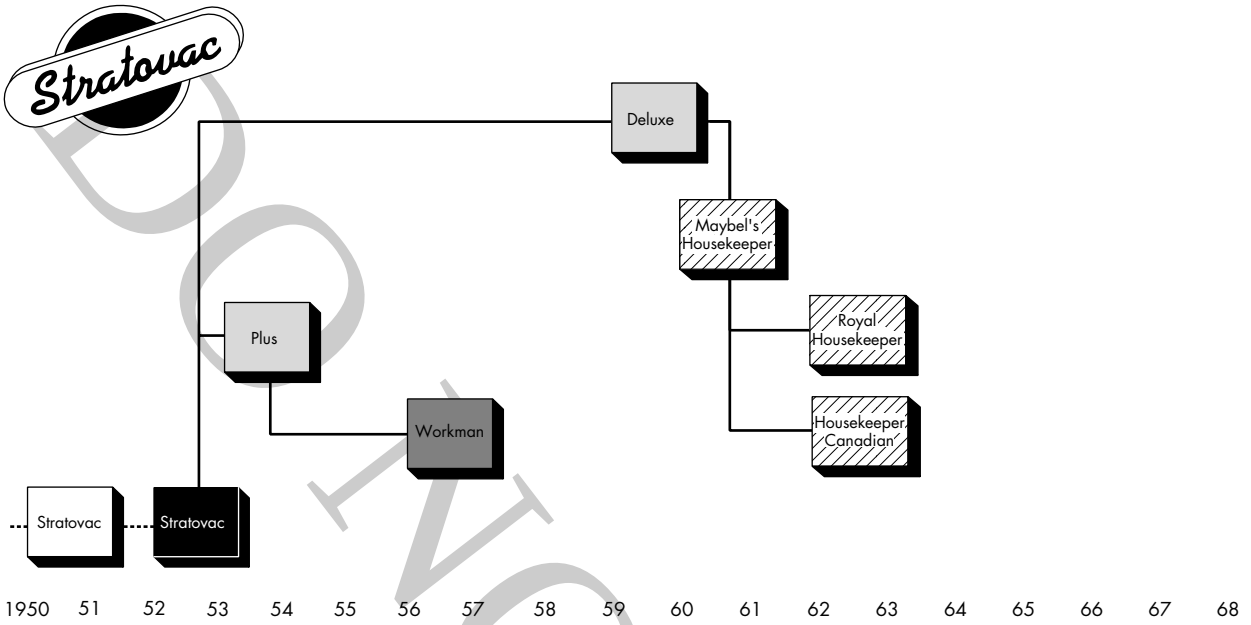
These distinctions –core, hybrid, and the others – are immediately useful because they give managers a way of thinking about their products more rigorously and less anecdotally. But the various turns on the product map – the various "leverage points" – also serve as crucial indicators of previous management assumptions about the corporate strengths and market forces shaping product evolutions.

"Leveraged" products show what you know – and had better know.

A map that shows a proliferation of enhanced

CHARTS BY DIANE McCAFFERY

The First Generation of Coolidge Vacuum Cleaner (1952–1968)



products toward the high end, for example, says something important about the market opportunities managers identified after they introduced the core. A map's configuration raises necessary questions about dominant channels of distribution – then and now. That products could have been leveraged in particular ways, moreover, says something important about in-house technological and manufacturing capabilities – capabilities that may still exist or may need changing. The map generates the right discussions. When managers know how and why they leveraged products in the past, they know better how to leverage the company in the present.

The First Generation

How can managers plan, develop, and position a set of products – that is, how do they build a dynamic map? With the generic map in mind, let us track offerings from generation to generation. (Exhibit 2 shows the first generation.) Imagine a very simple line of vacuum cleaners, Coolidge Corporation's "Stratovac," introduced, say, in 1952. The core product, the Stratovac, was a canister-type appliance with a 2.5-horsepower motor. Constructed mainly from cut and stamped metals, it was distributed through department stores and hardware chains.

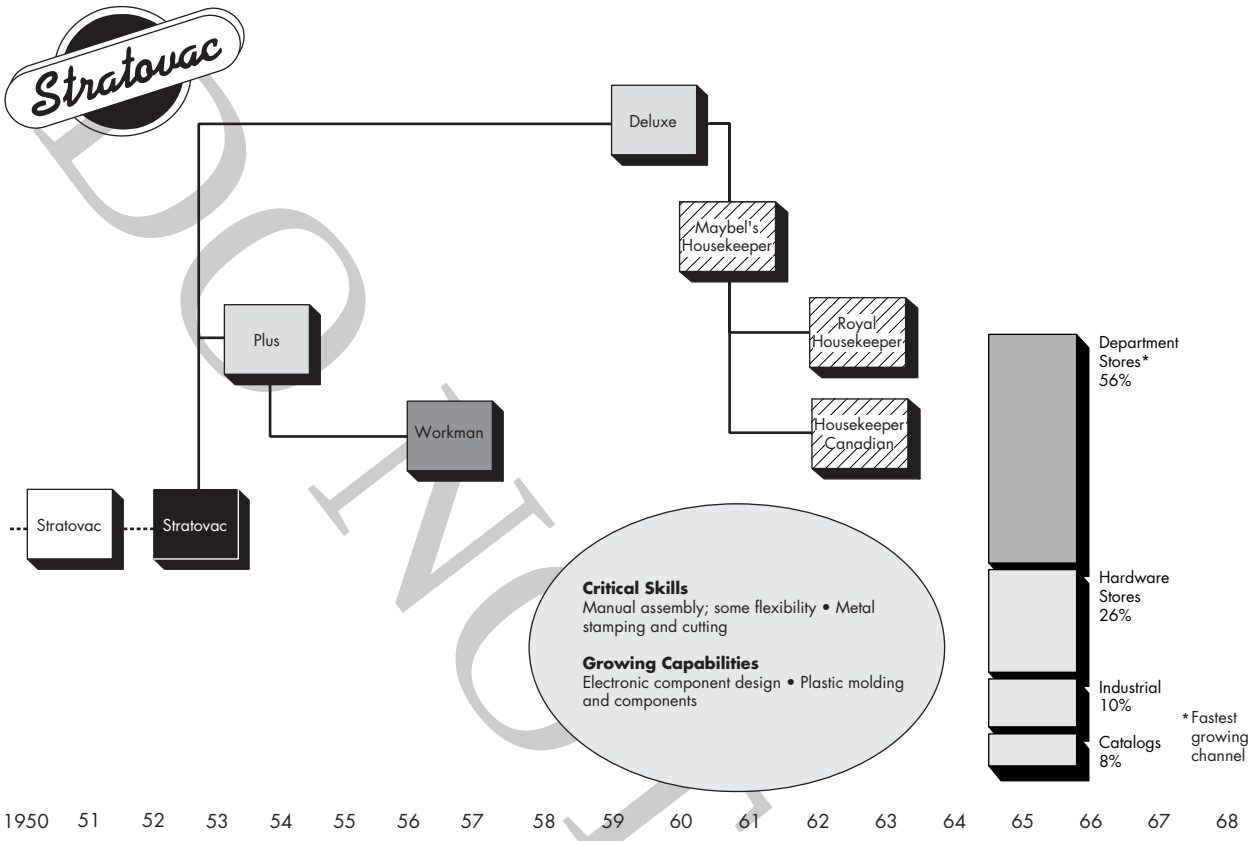
The following year, reaching for the somewhat more affluent suburban household, Coolidge brought out the "Stratovac Plus," an enhanced Stratovac delivered in a choice of three colors, with a 4-horsepower motor and a recoiling cord. In 1959, the company introduced the "Stratovac Deluxe" – a Stratovac Plus with a vacuum resistance sensor (which cut off the power when the bag was full) and a power head with a rotating brush for deep pile or shag carpeting. By 1959, the basic Stratovac cost $89, the Stratovac Plus, $109, and the Stratovac Deluxe, $159.

To reach the industrial market at $79, Coolidge had decided to offer the "Stratovac Workman," a stripped-down Plus model – one color, no recoiling cord. That was introduced in 1956. And when Deluxe sales rocketed, Coolidge offered Maybel's department store chain a customized version of it, the Stratovac "Maybel's Housekeeper." This came out in 1960, in Maybel's blue-gray, with the power head. The price was "only" $129. (Coolidge eventually customized the "Housekeeper Canadian" for the Simpton's chain in Canada, and the "Royal Housekeeper" for the Mid-Lakes chain in England.)

Again, this is a simple product line, but even so, the map raises interesting questions, especially for younger managers who came after this era. Why the Stratovac Plus? Why a proliferation of products toward the high end?

In fact, during the 1950s, most companies marketed home appliances through department stores with product families visibly shaped by the distribution channels. Products stood side by side in the stores, to be demonstrated by a salesperson. The

The First Generation of Coolidge Vacuum Cleaner (1952–1968)



markup was similar for each product on the floor.

What differentiated products in product families at the time was an appliance manufacturer's reach to satisfy more or less obvious customer segments – customers differentiated by factors like income and marital status. (In the 1950s, most vacuum cleaner purchasers were women, with more or less money, time, and patience.)

How Coolidge leveraged its products also points to certain fixed–and not especially unique–manufacturing capabilities. During the 1950s, company engineers designed appliances for manual assembly and traditional notions of economies of scale. By the end of the 1950s, Coolidge acquired new vacuum sensor innovations from the auto industry. It also learned certain flexible manufacturing techniques, making different colors and options possible.

By 1958, Coolidge had solved most of the technical problems of the Stratovac line and had recruited a number of ambitious design engineers to integrate vacuum sensor and power heads into the line. The life cycle of the products – including development time, which stretched back to 1949 – was typical for core products of that time: 10 to 15 years. Demand for the Stratovac remained strong throughout the 1950s, and Coolidge sold to department stores in roughly the same proportion as its competition, except for companies organized around the door-to-door trade.

The company's increased (and not fully utilized) technical competence and the steadiness of its key distribution channels are crucial pieces of information to add to the map (see the third exhibit). The map summarizes technical competence in the oval beneath the product lines, and Coolidge's gross sales by distribution channel in the box graph. The fastest growing distribution channel in the industry – in this case, department stores – is shaded for emphasis.

The Second Generation

With so much technical talent in-house, and a society growing increasingly affluent, Coolidge could not be expected to rest on the Stratovac's success indefinitely. Sales were steady, but by the mid-1960s customers assumed there would be some innova-

tions. The age of plastics was dawning; the vanguard of the baby boom was taking apartments; it was the "new and improved" era.

Moreover, marketing people at Coolidge began to detect a new potential market at the low end. People who had relied on their Stratovacs for a decade were looking around for a second, lighter-weight appliance for quick cleanups or for the workroom or garage. Lighter-weight and cheaper naturally meant more reliance on plastic components.

In the early 1960s, Coolidge managers decided on two product families, each with its own core product (see the fourth exhibit). The design team that had brought out the old core Stratovac would handle the "Stratovac II," and company new hires would design a second line, the all-plastic, mass-produced "Handivac" ("any color, so long as it's beige").

> Products are supposed to change as customers and distribution channels change.

The Stratovac II, introduced in 1968, was heavier and had a 4.3-horse-power motor, resulting in a slightly noisier operation, "jet noise," which the marketing people reasoned would actually increase respect for its power. Half of the case was now plastic for a "streamlined" appearance. The core Stratovac II boasted a new dust-bag system, which virtually eliminated the need for handling dust. A retractable cord was also standard.

The Stratovac II "Sentry," an enhanced version of the core, included electronic controls for variable speed and came in many colors. The Stratovac II "Imperial," like the old Deluxe model, came with the power head. The Stratovac II Workman continued to sell steadily to the light industrial market, as did the Stratovac II Housekeeper line to the department store chains that still sold the vast majority of units.

Most notable about the Stratovac II was how little changed it was, certainly on the manufacturing end. Assembly was still chiefly manual, along the lines of the 1950s–no priority given to modularity, design for manufacturability, or any of the considerations that would drive designers later on. There was some outsourcing of components to Mexico and Taiwan but no real attention to automation. The only significant change in the Stratovac II came in 1973, when inflationary pressures pushed management to develop a fully plastic casing and critical plastic components –in effect, a hybrid developed by merging technologies of the high-end vacuum cleaner with the low-end Handivac.

Handivac, the second core product, introduced in 1969, was something of a disappointment – mostly because of the inexperience of the team managing its development. Reliability was a problem, given Handivac's almost complete dependence on plastic components, components subjected to higher than expected temperatures from an old, slightly updated 2.5-horsepower motor. Weight was also a problem: it was not as light as promised. Mass-production lines, which were partially automated, were considered a success when they were finally debugged.

Perhaps the greatest problem with the Handivac, however, was the fact that, like the Stratovac II, it was sold mainly through department stores and hardware chains, where markups were too large to permit it a significant price advantage over the more expensive core product. Handivac sold for $79, while the Stratovac II sold for $99. Handivac managers tried to cut costs by going to an overseas supplier for a lighter-weight, somewhat less powerful motor–over the vehement objections of Stratovac II designers, who had depended on Handivac's participation in their motor plant to keep their own costs in line.

Eventually, Handivac introduced a cost-reduced "Handivac 403," which sold for $69, importing a 3.0-horsepower motor and cord subassembly from Japan. The enhanced "405" sold for $83. Handivac engineers began at this time to interact with Japanese manufacturing managers. But there were still no distribution channels where Handivac could enjoy the "price busting" opportunity it needed. The most promising channel, though hardly dominant, was the growing chains of catalog stores, which sold the Handivac 403 for $63, a 10% reduction from the department store price.

The Third Generation

During 1976 and 1977, a number of external and internal pressures led to a redesign of the entire product line. Department stores were still the major source of revenue, but competitors were proliferating and the Stratovac II group felt the need to offer an increasing number of more enhanced and more customized products to maintain demand at the profitable high end. Consumers would pay a premium, marketing people believed, only if the company could produce so many versions that all customers felt they were getting the right color with the right options. More-

over, Coolidge had canvassed Stratovac II customers, who hadn't appreciated the "jet sound," as designers had assumed. Bulk was also a problem, as was the vacuum's unattractive look.

Inside the company, Coolidge's two design teams had become more cooperative, particularly as the advantages of molded plastic became obvious to everyone. The hybrid Stratovac II, which had been redesigned in plastic wherever possible, was something of a victory for the young Handivac designers over the more traditional group. Flexibility and cost were the keys to satisfying many markets, and plastics answered both needs. Eventually the more traditional designers also came to see the advantage of going to Japan for a smaller, lighter, more reliable motor–and for a number of subassemblies critical to the company's goal of offering arrays of options.

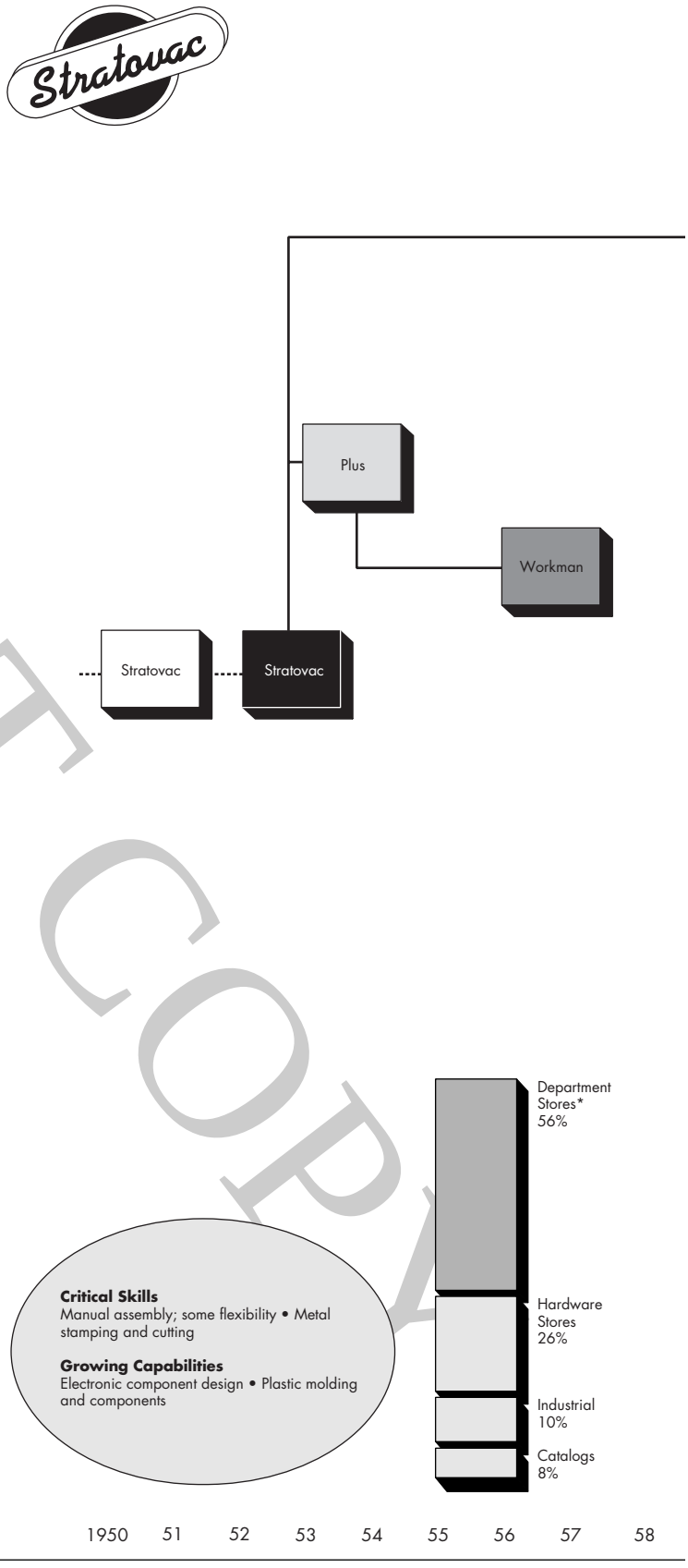
Concurrently in the mid-1970s, the Handivac designers were pressing for a complete merging of the design engineering teams and for studying Japanese manufacturing techniques. They argued that if flexibility, cost, and quality were going to be crucial, the manufacturing people would have to become more involved in product design. The young guard also believed that Coolidge could produce motors domestically – at required levels of quality – if it adopted certain innovations in machine tool and winding automation and instituted statistical process control at its existing motor plant.

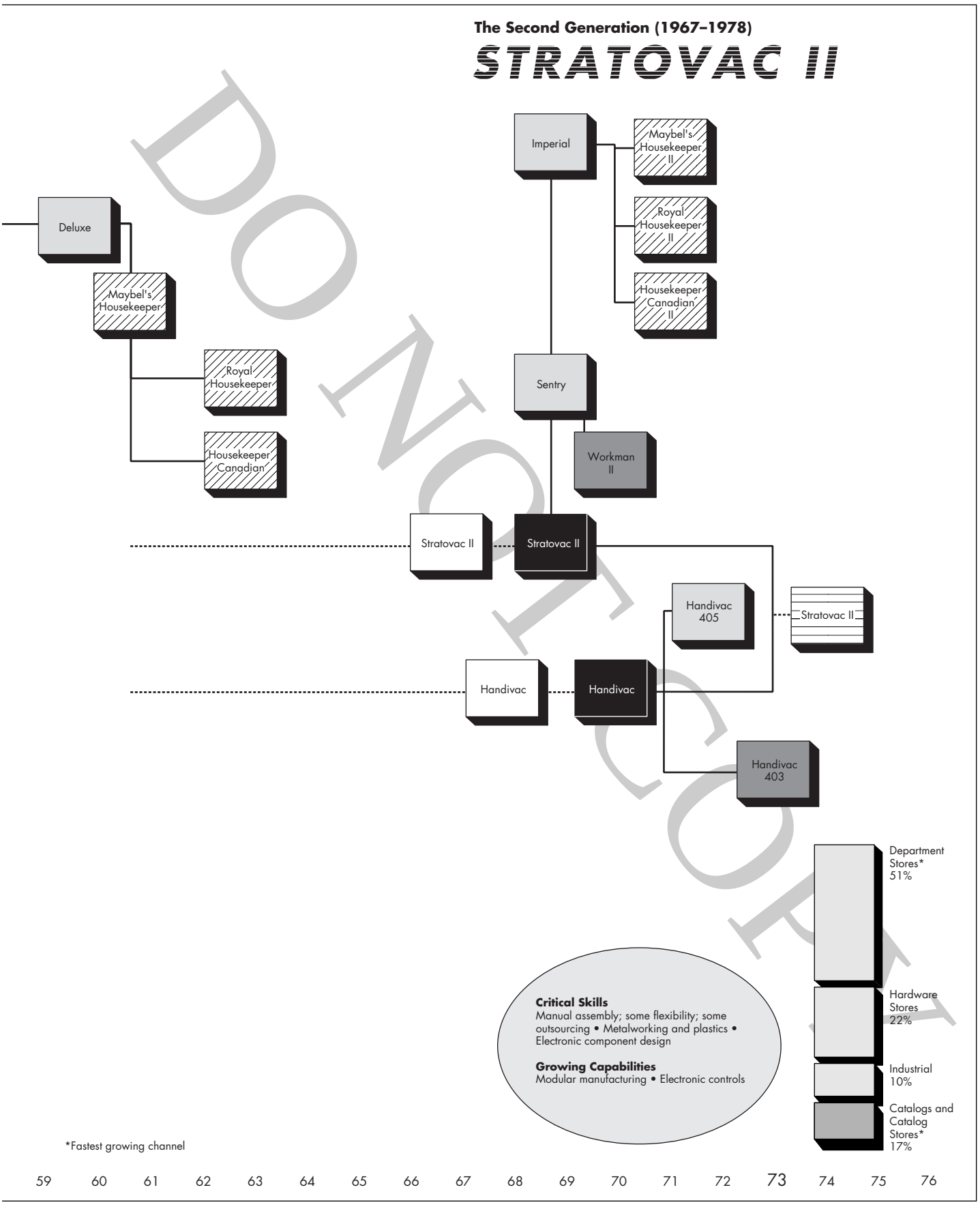
Where the younger design group still lacked credibility, however, was on the bottom line. Top management was reluctant to give up on a two-track approach when the Handivac group had failed to deliver an appliance that made even as much as the Housekeeper line. The number of catalog stores was growing, and newer discount appliance chains were springing up in big cities, but the Handivac faced intense competition. Could the younger designers hope to come in with enough products, offering enough features, and at low enough costs to meet this competition?

In the end, Coolidge management decided to develop two core product families in its third generation (see the gatefold). The Stratovac II team redesigned the high-end vacuum cleaner in six models, the "Challenger 6000" series. All appliances in this series came with a power head and a new bag system. By steps–6001, 6002, and upward–consumers could buy increasingly sophisticated electronic controls. And they could order the 6004 and 6005 in an array of colors.

The 6000 series was constructed almost entirely of molded plastic. Manufacturing came up with an automated way of applying hot sealant to critical seams, and the Challenger's motor was quieter.

The First Generation of Coolidge Vacuum Cleaner (1952–1968)



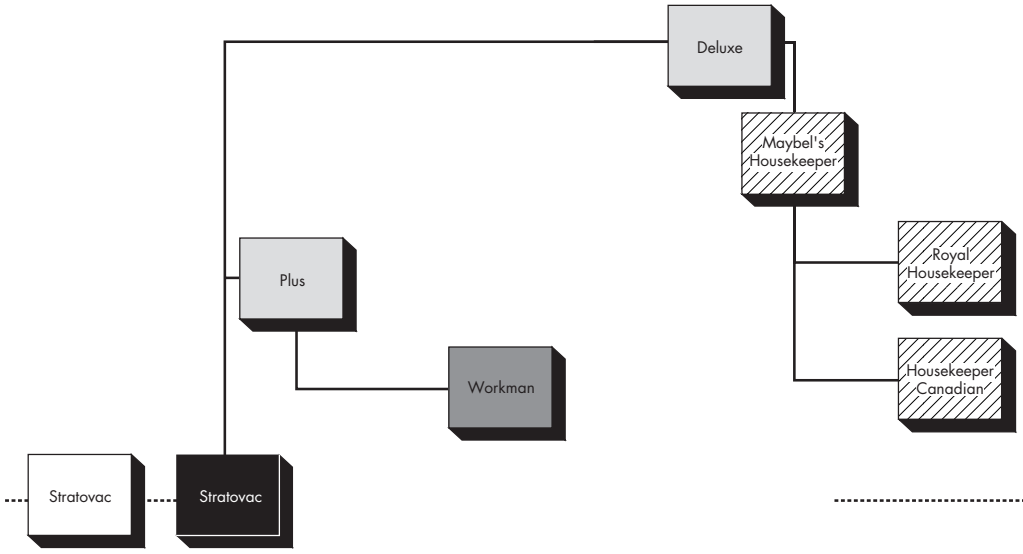

The Second Generation (1967–1978)
STRATOVAC II
Imperial
Maybel's Housekeeper II
Royal Housekeeper II
Housekeeper Canadian II
Deluxe
Maybel's Housekeeper
Royal Housekeeper
Housekeeper Canadian
Sentry
Workman II
Stratovac II
Stratovac II
Handivac 405
Stratovac II
Handivac
Handivac
Handivac 403
Critical Skills
Manual assembly; some flexibility; some outsourcing • Metalworking and plastics • Electronic component design
Growing Capabilities
Modular manufacturing • Electronic controls
Department Stores* 51%
Hardware Stores 22%
Industrial 10%
Catalogs and Catalog Stores* 17%
*Fastest growing channel
59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76

The Coolidge Vacuum Cleaner

The First Generation (1952–1968)

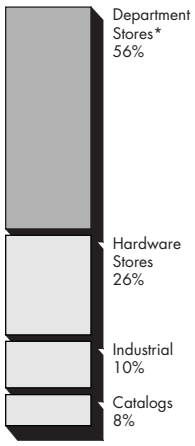
Stratovac

- Product family evolved for department store segments
- Product cycle: 10 to 15 years
- Aggressive marketing



Critical Skills
Manual assembly; some flexibility • Metal stamping and cutting

Growing Capabilities
Electronic component design • Plastic molding and components



*Fastest growing channel

1950 1955 1960 1965

The Second Generation (1967–1978)

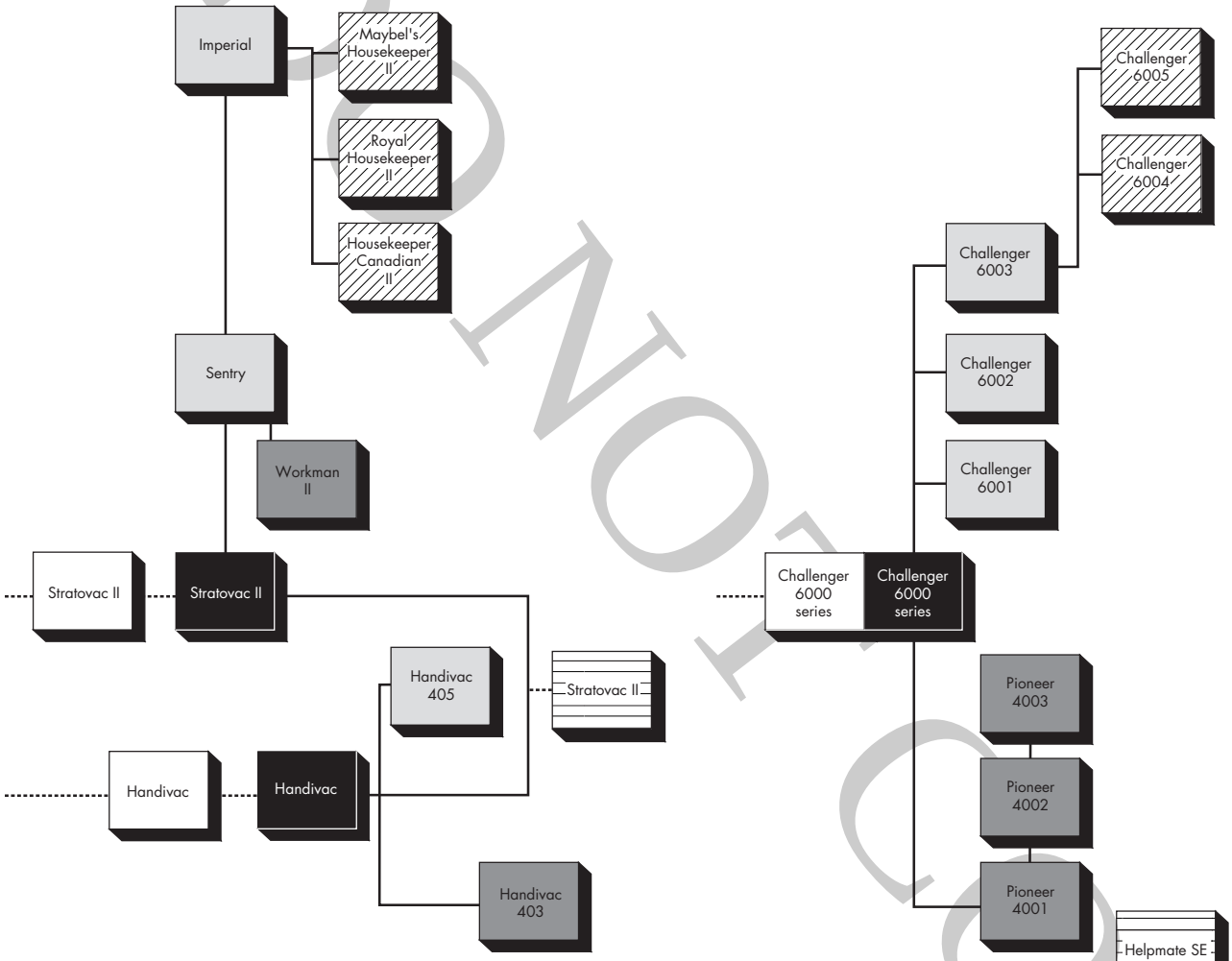
STRATOVAC II

- Product family extended for discount channels
- Product cycle: 8 to 10 years
- Aggressive financial control

The Third Generation (1977–1985)

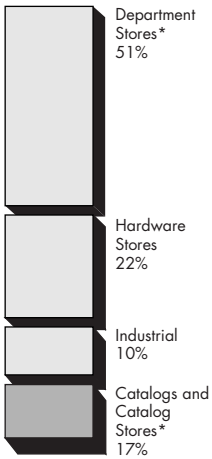
Challenger 6000

- Product family proliferated for all segments and channels
- Product cycle: 5 years and shortening
- Aggressive manufacturing



Critical Skills
Manual assembly; some flexibility; some outsourcing • Metalworking and plastics • Electronic component design

Growing Capabilities
Modular manufacturing • Electronic controls

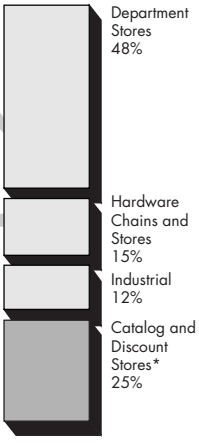


1970

1975

Critical Skills
High productivity manual and automated assembly; cellular manufacturint • Outsourcing • Plastics • Electronic controls

Growing Capabilities
Computer-aided design and assembly • integration of design and manufacturing enginnering • Quality: conformance to increasingly tight specifications



1980

1985

Top management agreed with the younger engineers that a more advanced motor factory could be constructed in the United States. The design teams didn't merge, but they found themselves working more closely together and increasingly with manufacturing.

The traditional design group simultaneously came out with the "Pioneer 4000" series. This was a middle-range product, somewhat smaller than the Challenger 6000 and not offering a power head. The marketing people felt that department stores would want a cost-reduced model to compete with the proliferating "economy" products that discount chains were now offering. (The 4001, 4002, and 4003 were distinguished, again, by electronic controls.) The Pioneer 4000 series was leveraged largely from the Challenger 6000 as a cost-reduced version.

Since both series offered stripped-down models, Coolidge did not introduce a specific industrial product and eliminated the Workman. Coolidge executives also believed that it was no longer worthwhile to customize models for particular department stores where margins were shrinking, so they eliminated the Housekeeper line.

A year after they introduced the Challenger 6000, the Handivac team brought out its new series of products, the "Helpmate." With minor modifications, Helpmate was customized as "Helpmate SE," targeted at different low-end market segments – college students, apartment dwellers, do-it-yourselfers, and the industrial market. The cleaner was lightweight. Attachments varied, as did graphic design: the company expected a Spartan gray color and a longer hose to appeal to commercial customers and bright pastels and different size brushes to appeal to college students.

The key to the Helpmate line, however, was its manufacturing. The motor was no longer outsourced, and designers worked with manufacturing engineers on modular components and subassemblies. Top management agreed to set aside manufacturing space in the assembly plants for cellular construction of the Helpmate so that the company could respond quickly to demand for particular models. And Helpmate came in at two-thirds the price of the Pioneer 4000.

There was still some debate among Helpmate's product development team members about most likely channels. Some saw it designed only for discount chains and catalog stores, which by 1978 had pretty much eclipsed hardware stores. Others saw the Helpmate as a low-end product for department stores too. In the end, Helpmate was a smash in the discount stores and all but disappeared from department stores.

The Next Generation?

Imagine that it is 1985 and Coolidge managers are gathered to consider the company's future. Their three-generation map has simplified a great deal of information – information the managers might intuitively understand but could not have looked at so clearly before. Where can they go from here?

Looking at their map, it's clear that Coolidge's product offerings are not appropriately matched to the new environment. They have aimed most of their products at department stores, and now discount chains are growing at a tremendous rate. They had devoted too much attention to figuring out how to leverage products at the high end, when the big battle was shaping up at the low end. Now Coolidge's managers wonder how long it will be before power options and accessories show up on cheaper, sturdier import lines distributed to high-volume outlets.

More growth in the company's manufacturing capabilities is obviously very important now. The map indicates the growing reciprocity between design and manufacturing engineers, owing largely to the initiatives of the younger design group. It would not be hard to imagine a merging of all engineering groups and the use of temporary dedicated development teams at this point. Product life cycles have obviously been shrinking; designers have to think fast now and cooperate across functional lines. To bring out a new line of inexpensive products that are both reliable and varied in options, Coolidge will need automated, flexible manufacturing systems. This development means bringing all parts of the company together – designers with marketing, and manufacturing with both. It means, interestingly enough, a need for even clearer, more complete new product development maps.

The finished product development map presented here may appear elementary, but managers who have mapped their products' evolution have experi-

Product life cycles are short. Don't let families evolve one product at a time.

enced substantial payoff in several areas. First, the map can be extremely useful to product development efforts. It helps focus development projects and limit their scope, making them more manageable. The map helps set specifications and targets for individual projects, provides a context for relating concurrent projects to one another, and indicates how the sequence of projects capitalizes on the company's previous investments. These benefits do much to minimize the likelihood of encountering two of the pitfalls we identified at the outset of this article: the moving target and the lack of product distinctiveness.

A second important benefit is the motivation the map provides the various functional groups – all with a stake in effective product development – to develop their own complementary strategies. As illustrated in the Coolidge Corporation example, the product development map raises a number of issues regarding distribution channels, product technology, and manufacturing approaches that must be answered in all parts of the company if the map is to represent the organization's agreed-on direction.

This point brings up the need for "submaps" in each functional area. In the Coolidge case, the first couple of product generations may not have shown the need for a more careful distribution channel map, but by the third the need is painfully clear. Capturing other strategic marketing variables in, say, a price map, a competitive product positioning map, and a customer map would enable the marketing function to identify and present important trends in the marketplace, define targets for future product offerings, and provide guidance for developing and committing sales and marketing resources.

Equally apparent by the third generation is the need for supporting maps in design engineering. A set of design engineering submaps can produce a clearer sense of the mix of engineering talent the company requires, how it should be organized and focused, and the rate at which the company should bring new technologies into future product generations. These maps would not only help managers integrate design resources with product development efforts but would also ensure that they hire and train new employees in a timely and effective manner and that they focus new project tools (such as computer-aided engineering) on pressing product development needs. The key is achieving technical agreement in advance of product development.

Toward the end of the third generation at Coolidge, the map reveals the need for more detailed manufacturing functional maps to bring out issues raised in the "critical skills" box. Such maps would focus on strategic issues relating to manufacturing facilities, vendor relationships, and automation technology.

Again, the development of such functional submaps not only benefits manufacturing but also helps the company maximize the return on new product development resources. The most interesting and useful benefits will come out of debates about what to put in the submaps.

Submaps capture the essence of the functional strategies and, when integrated with the new product development map, serve to tie those functional strategies together and provide both a foundation and a process for achieving a company's business strategy. The whole process facilitates the cross-functional discussion and resolution of strategic issues. How often have well-intentioned functional managers met to discuss their various substrategies only to have those from other functions tune out within the first two minutes, as the discussion becomes too technical, too detailed, or simply too parochial to comprehend?

The map shows what the product line is not doing.

Mapping provides a process for planning that avoids too much detail (like budgeting) and too much parochialism (like traditional functional strategy sessions). Managers will inevitably develop linkages across the organization by going through the steps of selecting the resources or factors to develop into a map, identifying the key dimensions to capture in the map, reviewing historical data to understand the relationships of those dimensions, and examining what is likely to drive future versions of the map. Functions can share their maps to communicate, refine, and agree on important product strategy choices. It is the sharing of functional capabilities – capabilities applied in a systematic, repetitive fashion to product development opportunities – that will become the company's competitive advantage.

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