Managing product families: The case of the Sony Walkman

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Abstract

Success in fast cycle industries (e.g. consumer electronics) can depend both on rapid model replacement and on model longevity. Although Sony was as fast as any of its chief competitors in getting new models to market, an important explanation for the wide variety of models offered by the firm is the greater longevity of its key models. This finding adds an important insight to the conventional literature on time-based competition which emphasizes rapid innovation exclusively. Sony’s special understanding of the US market enabled it to respond more effectively to life style differences by locating industrial designers in its key markets. Sony’s strong design capability and effective division of labor (engineers lead generational and incremental projects, industrial designers and market personnel lead topological projects) allow for parallel model development. Investment in manufacturing flexibility amortized over multiple models within the product family make the rapid model changeover possible.

I. Introduction

The virtues of speed to market and product line breadth have been extolled in both popular and scholarly literature. Several scholars have noticed that many successful firms competing in fast product cycle industries (e.g. consumer electronics and computers) were those that combined model variety and high rates of technological change (Stalk and Hout, 1990; Von Braun, 1990, 1991). This is especially true for the personal portable stereo market, pioneered by Sony when it introduced the first Walkman in 1979 (Sanderson and Uzumeri, 1992).

Many observers consider Sony to be one of the most consistent and impressive innovators of consumer and industrial products (Cope, 1990; Fairhead, 1988; Cianarca et al., 1989; Nozu, 1991; Schlender, 1992). Within Sony, there has been no greater success than the Walkman. Sony has dominated the personal portable stereo market, worth $1 billion worldwide, for over a decade and has remained the leader, both technically and commercially, despite fierce competition from world-class competitors. Sony has competed against outstanding firms such as Matsushita, Toshiba, Sanyo, Sharp and Philips – consumer electronics giants with marketing savvy, financial strength, excellent engineering skills, a strong technology base, and world-class manufacturing. In this paper, we describe how Sony’s unique approach has made it possible for the firm to
receive a price premium for its models (up to $20 more than competing firms) while retaining a 50% revenue market share for over a decade in this highly contested market.

The Walkman is an example of outstanding product family management. Sony's strategy employed a judicious mix of design projects, ranging from large team efforts that produced major new model ‘platforms’ to minor tweaking of existing designs. Throughout, Sony followed a disciplined and creative approach to focus its sub-families on clear design goals and target models to distinct market segments. Sony supported its design efforts with continuous innovation in features and capabilities, as well as key investments in flexible manufacturing. Taken together, these activities allowed Sony to maintain both technological and market leadership.

Previous studies have suggested that the combination of technological leadership and the systematic spinning out of models leads to success in consumer product markets (Stalk and Hout, 1990). Firms' product line breadth has been attributed to their ability to introduce new models quickly (Bower and Hout, 1988; Schlie and Goldhar, 1989). We suggest that success in fast cycle industries like consumer electronics depends both on rapid model changeover and on model longevity. In this paper we show that Sony was consistently as fast or faster than any of its competitors in getting new models to market. Yet Sony also offered many models that enjoyed much longer market lives than competing models. We suggest that it was the combination of novelty and longevity that allowed Sony to fashion its decade-long dominance in this highly competitive industry. We believe that Sony's example illustrates the potential for more sophisticated product planning. If firms follow Sony's lead, they can go beyond an obsession with speed to a more subtle understanding of product diversity and timing.

2. Genesis of the Walkman product family

Although accounts of the events surrounding the Walkman's development differ in certain particulars, all versions agree that the first Walkman model was anything but a radical technological change (Morita, 1986; Klein, 1989; Sony, 1989a; Amanuma, 1990). The founding member of the Walkman product family was based far more on market insights than on technological breakthroughs.

In 1978, Sony shifted responsibility for the design of tape recorders from their audio group to a group that has since made cassette decks and boom boxes (Sony, 1989a). At the time, the engineers in the audio group were forced to scramble to generate new tape-based products. As it happened, several engineers were working on a stereo cassette recorder based on the compact, high performance Pressman recorder that had been launched in 1977. The Pressman was a handy device designed to be used by reporters to record interviews. In trying to master the technique for installing recording the playback mechanisms in small spaces, Sony engineers decided first to develop a prototype equipped only with a playback mechanism. This prototype reproduced sound of such high quality that the engineers felt there might be a potential market for the player alone. Music lovers were already buying prerecorded music cassettes, but the tape recorders available at the time were large and only marginally portable.

Meanwhile, another research team was working in the same building on a set of lightweight headphones. This was part of an ongoing research effort to miniaturize components of all kinds. The program was driven by Sony's twin design goals of greater audio fidelity and greater portability for all of its products. At the time, the lightest headphones in the world weighed about 100 g (3.5 oz.). The team had decided to produce headphones weighing about half that and they had already developed a prototype model. The miniature headphone and cassette player teams were unaware of the others' work until the spring of 1979 when Masaru Ibuka (Sony's Honorary Chairman) dropped by and made the connection between the two projects.

The first model weighed slightly less than a pound and was basically the Pressman without recording capabilities. When Sony's engineers
married the Pressman, stereo circuitry and the small headphone, each component was already fully developed. Sony did not even remove the RECORD button from the Pressman case. Instead, the engineers put in twin headphone jacks so two people could listen at the same time and changed the RECORD button to a MUTE button so the couple could stop the music while talking to one another.

Production of a prototype Walkman began in Japan in 1978. Sony introduced the Walkman to the Japanese market in July 1979. 30,000 units of this model were produced and the entire stock was sold within 3 months. The Walkman was a stunning hit and production could not keep up with demand. The first full production model, the TPS-L2, sold 1.5 million units in just 2 years.

Although Sony’s Japanese competitors can usually introduce high quality imitations very quickly, it took them a year to offer a similar product. Sony has led the worldwide market for personal stereos with its worldwide market share on a unit basis hovering around 40% for over a decade (Fig. 1). On a revenue basis Sony’s market share has remained around 50%. As shown in Table 1, Sony has comparable market shares in both the US and Japanese markets.

Sony has dominated the worldwide market despite the competence of its competitors. General Electric held about 10% of the market in the US, but was primarily a distributor of lower priced models made overseas. Among manufacturers, Panasonic’s 6–8% market share is less than a fifth of Sony’s US sales. In the Japanese market, Sony’s dominance appears to be challenged by Aiwa, but this is misleading, since Sony owns just over 50% of Aiwa. The individuals we interviewed reported that Sony and Aiwa compete aggressively with one another at the operating level. At the corporate level, however, Sony plays an active role in Aiwa’s management and influences Aiwa’s strategic direction (New York Times, 1992). Aiwa has historically been perceived as offering slightly upscale models, while Sony was considerably more aggressive in its exploration of new market segments. If Aiwa’s sales are combined with Sony’s, their market shares easily exceeded 50% in both the US and Japan.

3. Patterns of product competition

Given the caliber of Sony’s major competitors, how did Sony maintain its dominance in this product family for more than a decade? Moreover, Sony was widely acknowledged to have charged premium prices for its Walkman models. How did Sony maintain this practice for more than a decade? To try to answer these questions, we collected and analyzed product data from the major firms in order to reconstruct a detailed history of the Sony Walkman product family. To build this history, we relied on three types of data.

- **Models, features, and prices.** We extracted and coded model and price data from newspaper advertisements on a quarterly basis from 1980 to 1991. We used this data to identify the models that are available in the US market and the prices at which these models were offered. Information on the design, features and specifications of each model was obtained from manufacturers’ sales brochures supplied by the manufacturer. More than 550 models of personal stereos appeared on the US market during the 1980s. While it was possible to get technical information on many of them, documentation for others was difficult to obtain. We had particular difficulty obtaining information for many low-priced models that were manufactured in Southeast Asia and

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Table 1

Personal stereo revenue market share (1989–1990)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Firms</th>
<th>US market share a (%)</th>
<th>Firms</th>
<th>Japanese market share b (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sony</td>
<td>45–50</td>
<td>Sony</td>
<td>46</td>
</tr>
<tr>
<td>2</td>
<td>General Electric</td>
<td>10–12</td>
<td>Aiwa</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Panasonic</td>
<td>6–8</td>
<td>Matsushita</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Sanyo</td>
<td>4–6</td>
<td>Toshiba</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Aiwa</td>
<td>4–6</td>
<td>Sanyo</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>25</td>
<td>Others</td>
<td>13</td>
</tr>
</tbody>
</table>

a Source: conversation with Integrated Marketing Intelligence, confirmed by conversations with marketing managers at Sony.

sold under private labels. Consequently, we focused on the personal stereo models produced by the major consumer electronics firms. Sony, Panasonic, Toshiba, and Aiwa. Detailed information was obtained for 260 models sold in the US between 1980 and 1991. This set also included a number of stereo-like radios. We also gathered data and published materials on models offered for sale in Japan, the home market for the five major manufacturers. This was supplemented by model descriptions from Sony’s European product brochures. This data was used to compare Sony models across international markets.

- **Interviews.** Interviews were conducted with industrial designers, product managers, marketing and sales managers with Sony and its major competitors in the United States and in Japan. In addition, we visited Sony’s Bonson factory in

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**Fig. 1.** Worldwide headphone stereo market.

**Fig. 2.** Personal stereos in US and Japan (1989–1990).
Japan where much of the production for the Japanese market takes place and spoke at length with the director of manufacturing and the chief engineer.

- **Supplementary published information.** We collected data from company records and newsletters, trade and industry journals, conference proceedings and academic journals reporting engineering advances and market share data.

### 3.1. Sony's product variety

In personal portable stereos, as well as in many other product categories, the number of customers buying consumer products in the US and European markets is larger than in the Japanese market. For example, 42% of Sony's Walkman units were sold in North America, 40% in Europe, 11% in Japan and 7% in the rest of the world in 1988. To be successful in markets outside their home base, firms must have models that appeal to customers around the world. Porter has suggested that if firms must have their headquarters in markets that anticipate the demands of markets elsewhere, they are likely to be more successful (Porter, 1991). We looked at this issue by comparing personal stereo models sold in the United States and Japan.

Table 2 shows the price and size of the personal portable stereo models sold by the five major Japanese manufacturers in US and Japanese markets during 1989–1990. The Japanese prices were converted to comparable New York discount prices by using price data on identical models sold in both markets to estimate an effective exchange rate.

The majority of personal stereo models in the US sold for $55–$60, while Japanese models typically cost between $130 and $150. Fig. 2 shows that these price differences are generally related to the physical sizes of the models sold in each market. The Japanese models in Fig. 2 are generally smaller and have higher sound quality than the average model sold in US. Nonetheless, small models display similar prices in both markets. Larger models cost less, but are not offered for sale in Japan. This suggests that the differences in average selling price are due to sales mix differences, rather than pricing differences.

The differences in the model mix between Japan and the US are visible in the product features (Table 2). From conversations with product managers in the US and Japan, it would appear that the explanation for the different product mix lies with differences in consumer lifestyle. Japanese consumers tend to have more urbanized lifestyles. They live in cramped (by American standards) accommodation and commute long distances to work, often by subway or train. Not surprisingly, Japanese consumers prefer small, high performance, rechargeable models. Japanese models tend not to have a radio tuner, as there are far fewer radio stations in Japan than in the US. Finally, many Japanese models have remote controls that allow the tape to be controlled from a wand built into the headphone cord. This feature means little to most American joggers, but has great value to a Japanese commuters packed into subway cars so tightly that they cannot move their hands. Finally, the shapes and colors of models sold in Japan by all manufacturers are quite similar to one another but distinctly different from those sold in the United States. Only the features and performance are significantly different.

By contrast, models in the US market were much more diverse. American consumers are more likely to participate in active sports such as exercising, jogging, or cycling. Others spend leisure time in outdoor areas or at beaches. While

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1 Product managers at each of the major manufacturers confirmed this observation.
Sony’s rugged, water resistant models were extremely popular in the US, they were not even offered for sale in Japan. In the United States, most models had radio tuners and US models tended to stress low price over small size.

Although we did not conduct a systematic analysis of the European market, we learned from Sony designers that European models differ from both American and Japanese models. European customers tend to demand higher quality sound and classic design styles, with less emphasis on either cost or size. In Germany, for example, all of Sony’s models were designed to be sturdy and many had dark metal cases.

To satisfy these markedly different preferences, all major manufacturers made models exclusively for the US market. While the models that Sony and its competitors sold in Japan looked very similar, Sony far outstripped its competitors in bringing varied and unique models to the United States and Europe. Table 3 shows the number of models offered by each manufacturer in the US and Japanese markets. Sony’s broad product line is evident in both cases. In the US market, Sony consistently offered more models than any of its competitors. Only Aiwa approaches Sony’s variety and, as late as 1988, Aiwa offered only nine models in the US market.

Sony’s variety did not develop overnight. Each symbol in Fig. 3 represents the median value of the prices listed for a model in the discount electronics advertisements. The increasing breadth of Sony’s product line is striking. Over the period, Sony is represented by 572 points, more than the total offerings from Aiwa, Toshiba, Sanyo and Panasonic combined. In fact, Fig. 3 understates Sony’s model variety. An inspection of the sales catalogs from the various manufacturers shows that the model–time–price points for the other manufacturers in Fig. 3 include many models that compete directly against one another. Sony’s competitors produced mainly generic models that were aimed at the large market segments and tended to be larger and less expensive than those sold in Japan.

Sony, on the other hand, offered numerous models that were designed specifically for the US market. The Sports Walkman was an excellent example. Characterized by its bright yellow water-proof case, the ‘sports’ theme was used in other Sony product lines such as compact disk (CD) players, ‘Karaoke’ units (sing-along tape players), camcorders, and walkie-talkies. Because of this diversity, many of Sony’s designs, especially those sold in United States and Europe, face little direct competition from other firms. This also helped Sony to avoid cannibalization among its own designs.

### Table 3

<table>
<thead>
<tr>
<th>Firm</th>
<th>United States</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sony</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>Panasonic</td>
<td>8 a</td>
<td>15</td>
</tr>
<tr>
<td>Sanyo</td>
<td>8 a</td>
<td>8</td>
</tr>
<tr>
<td>Aiwa</td>
<td>20</td>
<td>n/a</td>
</tr>
<tr>
<td>Toshiba</td>
<td>10 a</td>
<td>n/a</td>
</tr>
<tr>
<td>Sharp</td>
<td>n/a</td>
<td>7</td>
</tr>
<tr>
<td>Kenwood</td>
<td>n/a</td>
<td>5</td>
</tr>
</tbody>
</table>

n/a = Not available.

a Data from 1989 product lineup.

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2 The number of models in Fig. 3 is larger than the variety of models that each firm was actually producing, since retailers sometimes advertise units that linger in the distribution channel after the manufacturer has ceased production.
models from Sony’s major competitors was 1.2 years. This difference is significant at the $p < 0.001$ level, based on a $\chi^2$ test.

The data show an interesting pattern. Sony was widely considered the most innovative of the four firms and was the undisputed market share leader, yet its models survived almost twice as long as its competitors (Gomory, 1989; Kekre and Srinivasan, 1990; Delacroix and Swaminathan, 1991). Of particular interest are the long-lived models in the upper tail of the curve in Fig. 4(a). We have labeled these ‘classic’ and listed them
separately in Fig. 4(b). ³ Sony generated more classic models than any of its competitors. Most of these were designs that were so well adapted to the needs of their target market segments that Sony felt little market pressure to redesign them. Several models enabled Sony to make an early entry into key market segments and effectively preempt them. With the WMF45 Sports Walkman®, for example, Sony identified a specific consumer lifestyle and its basic solution remained unchallenged throughout the decade. In 1990, the WMD6C (a high quality professional model) had been on the market for over 6 years.

The long-lived models allowed Sony to keep more models on the market with the same level of design effort that its competitors expended on models with shorter lives. Sony’s competitors were apparently unable or unwilling to invest in new models for market niches that would have permitted their product lines to achieve comparable longevity and sustainable variety. They elected to compete in the undifferentiated, price sensitive markets where the design changes tended to be minor and easy to copy. This increased the pressure for frequent redesign and led to rapid model attrition. When its models competed directly against designs of other manufacturers, Sony changed the designs as often as its competitors.

The importance of long-lived models has not been fully recognized by innovation researches. The Sony example shows that model longevity can have a major impact on the evolutionary development of product families. Sony’s longer lived models extended its product line and multiplied the impact of any investment in new model design. If firms are to plan and effectively manage rapidly evolving product families, it is important to identify and catalog these mechanisms and effects.

4. Sony’s technological evolution

Although Fig. 3 seems chaotic, the evolution of Sony’s Walkman product family has actually been
very systematic and disciplined. By examining their cost and novelty, it is possible to classify the design changes that produced the pattern in Fig. 3. The framework by Wheelwright and Clark provides a convenient starting point for this task, but requires elaboration. Design changes in personal stereos can be placed in two of Wheelwright and Clark's five categories. A small number of 'platform projects' provide the foundation for 'derivative projects' that elaborated and diversified the product line (Wheelwright and Clark, 1989).

Discussions with product managers in the competing firms confirmed that all personal stereo makers relied heavily on platforms. In Sony's case, the design process for platforms differed substantially from the process for managing derivative designs. With platforms, there is generally a sharp break from preceding designs that we have termed a generational design change. Sony's generational design changes entailed substantial technical novelty, required a major design effort and often required major changes to the manufacturing process. Generational designs were not technological discontinuities, since they retained crucial links to the dominant design. Although materials, component technologies, features and performance were altered significantly, the underlying family resemblance remained intact. Consequently, generational platforms were able to coexist within the Walkman product family and support the development of important sub-families.

Surprisingly few generational design changes were made during the first decade of the personal stereo and all of those were pioneered by Sony. According to Sony's published account, five significant innovations occurred in the Walkman product family. These fall into two categories: (1) those producing new electromechanical platforms, and (2) those creating key component technologies. These milestones are shown in Fig. 5.

In 1981, Sony launched a full-scale worldwide sales campaign for the second-generation WM2. The WM2 was the first major technological innovation in the Walkman family. It was more compact and had superior sound quality. The body of the WM2 weighed 9.9 oz. and the headphones weighed only 1 oz. At the time, it was the lightest product of its kind in the world. Despite the WM2's success, managers and engineers at Sony continued to innovate. The next generational innovation was the WM20. It was half the thickness of the WM2. To reach this size goal, miniature parts were developed and the model was designed to run on just one 1.5 volt AA battery. This meant that the mechanism had to consume half the power of the WM2. The project team developed a revolutionary flat motor, together with numerous minor improvements. The team took 2 years to finish their work and Sony introduced the WM20 in October 1983.

While one team worked on the WM20, another team sought to improve sound quality. In the WM2, a belt connected the motor to the flywheel that dampened the tape drive. The second team developed a direct drive mechanism that used a friction coupling to transmit the motor's rotation directly to the flywheel. The resulting WMDD model also incorporated a servo system that precisely controlled the speed of the capstan. The system minimized the sound distortion that results from uneven tape speed and external vibration. This technology first appeared in the Walkman Professional (WMD6), introduced in February 1982. The immediate successors of the WMD6 (the WMD3 and WMD6C) were still in production in 1990.

The WM2, the WMDD and the WM20 were the basic platforms on which all subsequent Walkman models were built. The basic mechanisms in each platform were continually refined and remained in production through the end of the decade. A fourth platform was introduced in 1989 to support the development of low priced models. The generational changes in Walkman platforms required major advances in the battery and motor technology. Battery advances allowed further miniaturization without loss of performance. The rechargeable NiCd battery, called the 'chewing gum battery,' was first used in 1986 in the WM101 and WM501 models and later in the classic WM701C. Together with the superflat motor, it became a key component in all of Sony's smaller units.

Wheelwright and Clark suggest that the devel-
opment of generic technologies should be characterized as R & D, not product engineering (Wheelwright and Clark, 1989). This would seem appropriate for some of Sony’s innovations, but not for all. Sony relied on an R & D project to develop the miniaturized headphone that was the key to the first Walkman. However, the ‘super-flat’ motor and the ‘chewing gum’ battery were designed by the same teams that created new platforms. Sony’s process of generational design change was primarily guided by its focused view of the portable consumer electronics market. From the outset, Sony’s designers pursued superior sound quality and the smallest, most portable package possible. By consistently pursuing these twin goals of audio quality and miniaturization, Sony was able to coordinate the development of platforms with the development of enabling technologies.

However, the platforms are only a small part of the story. Sony offered as many as 20 new models each year and almost 250 models during the 1980s in the US market. With the platforms as a basis, most of these models were achieved by making small changes in features, packaging and appearance. Wheelwright and Clark’s ‘derivative’ project neatly describes the relationship between individual models and the platforms they were based on. At the same time, Wheelwright and Clark’s derivative category is still very broad. If all non-platform projects were labeled ‘derivative’, 99% of Sony’s personal stereo innovations would fall into that one category. To develop a better understanding of the dynamics of Sony’s product line management, we divided non-platform design changes into two further categories: incremental and topological innovations.

Table 4 lists the incremental changes that have appeared in the US market. These models generally did not require retooling and carried little technical risk for the firms involved. Many features (e.g. Dolby noise reduction) were widely used in other consumer electronics products and could be implemented with a minor redesign of the electronic circuits. With a few notable exceptions, these innovations were also easy to copy. When Toshiba introduced a cassette-shaped FM tuner to fit into playback-only units, the other manufacturers added radio reception in less than a year.

Although incremental changes were less demanding than generational changes, Sony consistently led in this innovation category as well. Of greater importance is the fact that several of Sony’s incremental innovations were never copied by competitors. The Sports Walkman was introduced in 1983, but remained unchallenged through the end of the decade. Sanyo, Panasonic and manufacturers in Southeast Asia offered similar models at various times, but each manufacturer quickly backed off and dropped those models from their lines. Given the simplicity and popularity of the sports series, it is interesting that Sony’s competitors did not seriously attempt to imitate it.

Despite Sony’s aggressive pursuit of incremental design changes, such models only accounted for 20–30 of the 250 odd new models that Sony introduced in the US during the 1980s. The remaining 85% of Sony’s models were produced from minor rearrangements of existing features and cosmetic redesigns of the external case. Sony generated these designs much as a child would build with Lego®. We refer to this final category as topological design changes.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Firm</th>
<th>Date</th>
<th>Imitated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>First ‘Walkman’</td>
<td>Sony</td>
<td>79</td>
<td>Y</td>
</tr>
<tr>
<td>AM/FM stereo radio</td>
<td>Sony</td>
<td>80</td>
<td>Y</td>
</tr>
<tr>
<td>Stereo recording</td>
<td>Sony/Aiwa</td>
<td>80–81</td>
<td>Y</td>
</tr>
<tr>
<td>FM tuner cassette</td>
<td>Toshiba</td>
<td>80–81</td>
<td>Y</td>
</tr>
<tr>
<td>Autoreverse</td>
<td>Sony</td>
<td>81–82</td>
<td>Y</td>
</tr>
<tr>
<td>FM headphone radio</td>
<td>Sony</td>
<td>81–82</td>
<td>Y</td>
</tr>
<tr>
<td>Dolby</td>
<td>Sony/Aiwa</td>
<td>82</td>
<td>Y</td>
</tr>
<tr>
<td>Shortwave tuner</td>
<td>Sony</td>
<td>83</td>
<td></td>
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<td>Remote control</td>
<td>83</td>
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<td>Y</td>
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<tr>
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<td>Y</td>
</tr>
<tr>
<td>Child’s model</td>
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<td></td>
</tr>
<tr>
<td>Enhanced bass</td>
<td>Sony</td>
<td>88</td>
<td>Y</td>
</tr>
</tbody>
</table>
Once the platforms, components and incremental innovations are in place, topological changes can be made with little cost or risk. Sony standardized its basic design elements and relied on flexible, automated manufacturing processes to keep the costs of these changes to a minimum. At the same time, topological changes often appear to be totally novel to the customer. Topological changes keep product lines fresh and help producers deal with the proliferation of markets, distribution channels and market segments. Seiko Epson, for example, offers more than 1000 watch models and introduces 200 new ones each year based on just four or five basic watch movements (Young, 1991). Carried to extremes, topological changes can lead to dysfunctional ‘product churning’. Faced with frequent model changes from competitors, firms may accelerate their own introductions of new topological designs. Some observers have suggested that Japanese consumer electronics companies, including Sony, have fallen into this trap (Johnstone, 1991). As noted in the previous section, however, an inspection of Sony’s product line during the 1980s shows that the firm often created topological designs that were more than a meaningless reshuffling of components. A Sony sales brochure from 1986–1990 is visibly more diverse than its counterparts from other firms.

During the 1980s, the Sony Walkman organized its topological evolution around three basic platforms: (1) an effort to miniaturize the Walkman started by the WM20; (2) direct-drive models targeted to audiophiles; (3) the low cost models targeted to price sensitive consumers. The pattern that emerges is summarized in Fig. 6. The shaded regions in the figure show the range of model prices supported by the three platforms and can be compared to the models represented in Fig. 3.

Fig. 6 illustrates the difficulty that can arise in predicting the effect of a specific design change. The WM20, for example, was seen by its designers as the logical successor to the WM2 (Sony, 1989a). It served the same market, but was smaller and better in every way. Although this would seem to be an argument for one design to replace another, the WM20 did not replace the WM2. Instead, Sony took the WM2 platform and steadily refined its manufacturability so that it became the basis for a whole series of low-priced units. By changing its mission, Sony retained the WM2 platform through the end of the decade. The WMDD and its successors, by contrast, show

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**Fig. 6.** Evolution of prices for generational platform innovations in the US market.
what a generational design can do to widen a product line. Their superior sound quality and high prices created an entirely new product that customers were unlikely to confuse with any of Sony's other models.

Ideally, the next step in analyzing the competitive pattern of product evolution would be to examine the profitability of the various features, models and product families. Unfortunately, this sort of historical data is generally not gathered or retained at the necessary level of disaggregation and the firms involved were reluctant to release the data that they did have.

Instead, we conducted a 'hedonic' price analysis to explore the relationship between the sales prices and design features (Saviotti, 1985; Berndt and Griliches, 1990). The model price at a specific point in time was used as the dependent variable. The independent variables included the model’s measurable characteristics or features. Most features, with the exception of size, were represented by binary indicator variables. In addition, the major brand names were noted by indicator variables and two time variables were calculated from the database of price quotes: (1) the year that the model was first introduced (vintage); (2) the number of years that the model had been offered for sale when the price quote was advertised (age). Finally, interaction terms between the features and the two time variables (vintage and age) were added to the model. A MLS regression model was fitted to this data over time period 1980–1990. The model explained several important aspects of the variance in the published discount prices.

From the resulting model, it is possible to impute the price increment that was charged for each variable in the model. Some features (e.g. digital tuners, water resistance, and FM radio) appear to have earned a price increment that did not change with either vintage or age. More com-

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5 The personal stereos' characteristics were obtained from manufacturers' sales brochures, although information on some models from obscure manufacturers was gleaned from advertisements. The relationship was fitted only for personal stereo models whose features were fully described. Altogether, 883 price quotes for 129 different models were used to estimate 61 model parameters. The analysis used SAS Proc REG and the CP model selection method to select the ten best subsets from the available independent variables (using Mallows’ Cp criterion (Neter et al., 1989). The overall best-fit model had an adjusted $R^2$ of 0.8714 and, among the ten best models, the coefficient estimates showed good stability in both magnitude and sign.
mon were features (e.g. graphic equalizers, Dolby™, and enhanced bass) whose imputed price increments diminished in value as time went by.

There were a few features (autoreverse, AM radio, the Panasonic brand name and remote control) that actually seemed to become more valuable (or at least less of a liability) as vintage increased. Finally, there were features (e.g. Aiwa and Toshiba brand names) that seemed to command high prices only when the individual model was successful enough to survive in the marketplace to a reasonable age.

The key point about this analysis is its empirical support for the view that design features drive prices in complex ways over time. This provides further support for our view that Sony's product planning decisions were critical to its success. For example, the results suggest that Sony's long-lived "sports" models enjoyed a price premium in the range of $15–$20 over the entire study period. Given the inexpensive topological innovations required for this design change, it is hard to see how Sony could have failed to make a substantial profit with its sport models.

5. Sony's management of technology

A strong case can be made that Sony's pattern of innovation was well suited to achieving dominance in personal portable stereos. This section examines the organizational structures and managerial practices that Sony used to generate that pattern. Fig. 7 shows how the elements in Sony's Walkman business network relate to one another. Marketing, product planning and industrial design functions are located in Sony's major regions: the United States, Japan, and Europe. Product and manufacturing engineering is done entirely in Japan, while manufacturing occurs in Japan, Singapore and Malaysia.

All Walkman engineering is done at Sony's audio products division in Japan. Sony's flagship manufacturing plants are in Japan. These plants make the small, highly sophisticated models that sell to Japanese consumers. Sony's factories in Taiwan and Malaysia manufacture the larger, more price sensitive and rugged models that are shipped to the United States and the rest of the world (Goldstein, 1988).

The engineering and manufacturing facilities are connected to a worldwide network of marketing and sales offices. To exploit its strong brand image, Sony maintains close links with consumers in each market. Since each market area has its own distribution and retail infrastructure, Sony sales and marketing functions are needed to provide the necessary access and support. Marketing and sales link the Sony innovation system with the retail outlets for their products. Sony's Industrial Design Center, with branch operations in New Jersey and Europe, is the final element in the Walkman network. This organization provides Sony with a means to understand the lifestyle trends that influence the way customers use personal stereos.

When we interviewed Sony employees, we had no difficulty in piecing Fig. 7 together, but it was almost impossible to get a simple answer from Sony as to how this system worked. We kept wondering who was in charge, who approved design decisions, and what the reporting relationships were. Each time we asked, we would get a different answer, or no answer at all. It took time and much discussion for the realization to sink in (confirmed in later discussions with Sony managers) that Sony does design in several different ways, depending mainly on the nature of the design change. Generational changes are led by engineering, with keen interest by top management. Marketing and sales lead for certain classes of topological changes. Finally, numerous incremental and topological design changes that do not fall into either category are the province of Sony's industrial design organization.

6 Sony was the base case brand name in the regression models. When the indicator variables for Aiwa, Panasonic, Toshiba and the various minor manufacturers are set to zero, the parameter coefficient estimates for the remaining variables described Sony models. The interaction terms between brand name and feature indicator variables were not considered in the model. If more data were available, that might offer an interesting line of inquiry.
5.1. Generational platform teams

We reviewed published accounts of the projects that created Sony's generational innovations. We also interviewed members of Sony's American and Japanese design centers and manufacturing operations who had firsthand design experience with the Walkman. The major platforms were the products of intense engineering efforts, involving fully dedicated, multi-disciplinary design teams that Sony assembled from among its best design and manufacturing engineers. Sony routinely has several of these teams working in parallel on key technologies to support its audio products.

The accounts of these projects agree that the leadership of these generational efforts rested with the senior management and with Sony's design and manufacturing engineers. Projects took a year or more to complete and were supported at the highest management levels. Teams were given clear development targets. In the case of the WM20, the project team made a wooden model in order to visualize the final size. The model was barely larger than the standard cassette tape the unit would have to play. However, within these parameters, engineers had considerable freedom to find a workable solution.

Sony's generational design teams typically developed the manufacturing processes to produce each platform. Sony's philosophy has been to manage design and manufacturing of product families, assuming and planning for modifications over time and making up front investments in manufacturing systems to ease model changeover. In assembling its high end tape transport mechanism in Japan, Sony used robotics for the assembly of precision mechanical components such as gears, flywheels, and other control buttons. With its highly automated and flexible system and judicious use of assembly and testing labor, Sony could produce a new Walkman every 20s from each production line (Hitakawa, 1988). The goal of this flexible system was not only to assemble a Walkman quickly, but to rapidly change from one design to the next, even when the design changes were significant. The Sony assembly system is sufficiently flexible that Sony used it to assemble VCR mechanisms and even marketed it to other firms (Hitakawa, 1988).

5.2. Flexible Manufacturing

In pursuing its goals for innovation and variety, Sony developed a flexible assembly system call SMART (Sony Multi-Assembly Robot Technology) and the Advanced Parts Orientation System (APOS) designed specifically with flexibility and small-lot production in mind. The SMART and APOS systems were created for ease of model change. Although the multi-function machine cost almost twice as much as a comparable single-function machine, the greater flexibility possible using manufacturing equipment designed with multiple products and rapid changeover in mind offsets its initial cost. Single-purpose machines have other disadvantages. Single-function machines make complicated assembly difficult. Although firms frequently use simple machines to perform simple tasks and manual assembly for more complicated tasks, these mixed lines have certain disadvantages. If there are two or three shifts, substantial labor costs may result. In addition, when simple and advanced machines are mixed together, it is difficult to change product mixes. Simpler automated assembly lines can be developed but they have the disadvantage in increasing material handling and loading. Finally, equipment life is longer for a multi-function machines because it is more flexible and able to cope with product changes (Hitakawa, 1988).

The development of Sony's multi-function assembly system required a breakthrough in parts acquisition and orientation. To solve the problem of parts acquisition for the multi-function machines, Sony developed an advanced parts-orientation system (APOS). The APOS is a flexible, automatic parts-orienting machine that uses vibration to align parts automatically on pallets. The APOS handles parts and components of various shapes and sizes for easy product changes. A part that has been correctly positioned in a cavity will remain there while misaligned parts will fall out. The APOS was designed for small and medium lot production and can handle up to six different parts on one machine.
By itself, however, Sony's manufacturing system gave Sony few direct competitive advantages. Matsushita (Panasonic), for example, operated systems with similar capabilities (Hartley, 1988). Nor was Sony able to escape pressure from low-cost manufacturers in Southeast Asia. Sony's low-cost units are increasingly manufactured in Taiwan and in a new (1988) facility in Malaysia. The manufacturing systems at these plants emphasize less flexible techniques for high volume, low cost models.

6. Sony's approach to understanding customer lifestyle

Apart from the five or six generational changes, the vast majority of Walkman design changes were either incremental or topological in nature. The challenge for these designs lay in Sony's ability to effectively read the minds of its customers. In this respect, Sony's design changes appear to fall into two categories: (1) channel-driven changes; (2) lifestyle-driven changes.

6.1. Sources of design changes

Sony uses its marketing and sales organization to keep track of channel needs in each of its major market regions. Ideas for new models come from many sources, including customer inquiry cards, contacts in distribution channels, direct customer surveys as well as sales force meetings with their distribution accounts. Sony is often pressed to provide models with subtle differences that appeal to particular channels. These changes are identified and championed by the marketing and sales organization. Sony sells through a variety of outlets, including department stores, mass merchants, and catalogs. A department store may want a model with more expensive features that it can use to justify higher margins. A catalog store may prefer a lower cost model that appeals to price conscious customers.

While some of Sony's low cost competitors try to satisfy these requirements by private branding (i.e. offering models customized for a single distributor), Sony has avoided this practice and seeks to meet channel needs with its official product line. According to product managers at Sony and several competitors, pressure for variety is also generated by the wholesale pricing practices in the American consumer electronics industry. Large retailers typically receive price discounts that are based on the total dollar value of their order, rather than on the volumes of the individual models that they buy. This provides an incentive for retailers to purchase all of their models from one or two manufacturers. With its large product line, Sony was well positioned to attract the business of these larger retailers. With its ability to make topological changes rapidly, Sony was also in a position to be responsive to their needs.

Sony's marketing organization rarely proposes a new model that requires anything more than a topological design change. For their purposes, a subtle difference in color or minor features (e.g. adding a stop watch to the digital AM/FM channel tuner) is often enough to customize a model for a customer or channel. The marketing groups and sales forces collect ideas about the needs of the regional markets and work with Sony's local industrial design groups to create versions of the Walkman that address those needs. Together, these teams feed information about special needs in their respective markets to product planning and engineering in Japan.

Lifestyle design changes are a traditional Sony strength and industrial designers are Sony's masters of incremental and topological change. By changing the shape or color of a product's case, the arrangement of its functions, an industrial designer can make a product appeal to an entirely different customer, often at minimal cost or risk. Industrial designers were both creative and systematic in spinning out new Walkman models. According to Liz Powell, former Director of Sony America's Design Center:

'each time we embark on a project, the design process begins with an analysis of the product that's already out there that we are selling and what other people are selling and also new technologies and new possibilities that people haven't thought of yet.'

Sony's Industrial Design division traces its roots to designers who were assigned to each
production unit in the late 1950s and early 1960s, making it one of the pioneering efforts in the consumer electronics industry. These designers were integrated into a Design Division in 1960, and a US design unit was established in 1969. The division was dissolved back into the production units during the 1970s, resurrected during the early 1980s and given expanded responsibility in the late 1980s. Currently, the Design Center is an equal partner with engineering and marketing in the Consumer System Products and Design Group, which is the major corporate entity charged with product innovation. Fig. 8 shows Sony's view of the role played by industrial design. The placement of the Industrial Design Center (ID Center in the diagram) at the heart of the Sony corporate structure illustrates the extraordinary emphasis that it has received.

In contrast to similar groups in its competitors, the Sony Design Center has received top level support from its inception. As a result, it has acquired a level of credibility within Sony that exists in few other major manufacturers (Fairhead, 1988). Industrial designers contribute an ability to visualize, as well as an understanding of mechanics, new technology, product planning, consumers and the marketplace. In addition, Sony expects its designers to negotiate with engineers, work on improvements in production tools with manufacturing, educate subcontractors about the critical role of product design and to hold up their end of corporate commitments to reduce costs. Sony also sees designers as filling a very special role with respect to marketing. Sony believes that marketers cannot be designers, but designers can be marketers. Sony looks for industrial designers who have capabilities of expressing corporate policy and corporate identity through designing (Sony, 1989b). In order to keep ideas fresh, industrial designers and design engineers are rotated from one product family to another.

The Industrial Design Center also places a strong emphasis on the quality of the design. According to Liz Powell, designers are expected to design models that adhere to Sony 'look'. While the guidelines are not formally written, industrial designers hold continual discussions to maintain a consensus about what that look is and is not. According to Powell, the designer must consider what the customer really wants to use. The designer must also understand what the engineer is saying about technical and cost factors. The engineers reflect the pressures from manufacturing and it is the synthesis of aesthetics and engineering that produce the beautiful, high quality products for which Sony is known.

From an engineering point of view, the design changes that produced the original Walkman were barely incremental. Nonetheless, it created a new product family for consumers and a worldwide market for Sony. Customers could go anywhere and listen to fine stereo music. Later Walkman models had similar impacts. The Sports Walkman...
allowed customers to hear stereo music in new locations (e.g. at the beach). The professional series of Walkman offered unprecedented sound quality in any location. The My First Sony gave stereo sound to children in a fascinating and (hopefully) indestructible case. These lifestyle-driven design changes were neither engineering challenges nor were they first suggested by Sony's customers or distributors.

Designers try to come up with a product that nobody realized they wanted or needed by looking at how people live, how they spend their leisure time, what they presently do with a Walkman and what they might like to do with Walkman that they can’t do now. The combination of topological design changes and manufacturing flexibility meant that Sony's designers could take chances that other firms might not be able to afford. Each topological change cost so little to design, that Sony only need to sell 30,000 units worldwide to break even on a new model (Amanuma, 1990). When designers are trying to understand complex customer lifestyle choices, even failed models are immensely valuable (Maidique and Zirger, 1985). An example of a failed product was the WM8000. This was a dual cassette Walkman that was motivated by the success of using two cassette drives in 'boomboxes.' It survived on the market for about 6 months. Even so, by reducing the cost of failure, Sony could afford to fail more often and hence learn more quickly (Sitkin, 1992).

The lower risk also allowed Sony to take more chances. Sony could throw a model into an unfamiliar or marginal market segment with little fear of major loss. As Raubitschek has pointed out, inherent market uncertainty means that these marginal markets will occasionally produce a pleasant surprise (Raubitschek, 1987). By keeping down the costs of introducing new models, Sony had a built-in incentive to expand its variety. It never knew when its designers might next hit the jackpot.

6.2. Industrial design outposts: Understanding foreign markets

Sony's product lines in Japan, Europe and the US differed far more than did the product lines of its competitors. One of the key reasons for Sony's leadership in markets outside of Japan has been its ability to interpret foreign market preferences to its design and engineering operations in Japan. Sony relied on the Industrial Design Centers in Japan, New Jersey and Milan to bridge the gap between the sales network's understanding of customer requirements, and the new product opportunities that were latent in Sony's technology. None of Sony's major competitors locate their industrial design staffs outside of Japan.

Sony's US design group developed the concept and prototype for the Sports Walkman. By putting its standard Walkman in packages that were sealed and ruggedized, Sony made personal stereos more useful for customers who wished to take them to wet or dusty environments, or who might subject them to wear and tear in the course of strenuous athletics. The 'My First Sony' line was first developed by a joint product planning, marketing and industrial design team in the United States. 'My First Sony' is a line of Sony products for children that was first introduced as a Walkman in 1987 and then extended to other Sony products. The team, led by Aki Amanuma, former Director of Design for Sony's US subsidiary, came up with the idea and convinced key management at Sony headquarters to support it. Because these products were built on platforms, Sony was able to launch the products in record time. In the case of 'My First Sony Walkman,' it took less than 1 year from inception to market. Sometimes the impetus for a new model comes from Sony America Design, and the Sony America team will prepare a prototype and present it to the engineers in Japan. At other times, the American product planners will go directly to the Japanese engineers and say that they would like an updated version of a specific model in order to satisfy particular market needs. On those occasions, the Japanese engineers prepare the sketches and develop prototypes that they present to the American designers and product planners. The marketing and industrial designers must agree on a new line up of products that is presented at meetings in Tokyo in the fall and in the spring. The design review meetings are held both in English and Japanese and typically last a week,
with a day devoted to each product family. A full day may be devoted to the Walkman, or to tape recorders, or to micro cassette recorders.

Line up meetings are opportunities to review new product ideas and to review the entire market situation including forecasts of where the industry is heading. Both Sony America and the home office make presentations describing what is happening in their respective markets. They review each model in each product family and discuss ideas for new models. Industrial designers show sketches indicating what the new models will look like. The product planner consider the possible features that the new products will have. Generally, there is general agreement before the meeting among the US team and often there has been some consultation in advance with industrial designers and engineers in Tokyo. In addition, the engineers and industrial designers in Japan may have ideas for models they believe will appeal to the American market. Finally, all of the models, both old and new, are reviewed and a negotiation takes place over which models will remain the same, which will be changed, what will be added and what will be dropped. Timing of new model introduction, as well as price, is negotiated.

Sony's distributed approach offers several advantages and may have contributed to Sony's dominant position in markets outside Japan. Industrial designers combine their creative skills with intelligent product planning and market research to design models targeted for specific national markets. By linking industrial designers with product planners and marketing specialists and by making design mockups in regional design centers, Sony can tailor models more effectively than if it centered its design activities exclusively in Japan. When the industrial designer brings a mock up of the proposed new model to Japan and discusses the design in great detail with the engineering staff, both the concept and the form are communicated directly.

7. Alternative explanations

Commenting on earlier versions of this paper, several reviewers have wondered about alternative explanations for the Walkman success. It is not uncommon to view innovative success as the natural result of managerial leadership and effective marketing. Many observers have admired the leadership achievements of the Sony leadership, especially its founders, Akio Morita and Masaru Ibuka. Others have been impressed by Sony's marketing skills and internationally respected brand name. Why, then, should one believe that these are not sufficient to explain the Walkman success?

While we believe that Sony's strengths in these areas are extremely important, we began this study with an interest in patterns of innovation and the structure of the innovation system. As we gathered information about the competitive history of the Walkman, we came to the conclusion that the system view offers a better explanation of the observed variance in competitive behavior. In effect, we made a conscious decision to allocate more time to the study of the system and less to the study of traditional leadership and marketing issues. This decision was not taken lightly.

Senior managers played key roles in launching the first Walkman, redesigning the WM2 platform, and deciding to market 'My First Sony'. However, as we examined various written and interview accounts of the Walkman's birth, the stories differed significantly as to the persons involved, the rationales and even the events (Morita, 1986; Klein, 1989; Sony, 1989a; Amanuma, 1990). It would seem that success has many mothers, even at Sony. We concluded that the ground was too badly trampled for us to fully unravel top leadership actions over a 10 year study period.

At the same time, it became clear that top management had little need to be involved on a day-to-day basis. In Sony's system, most innovations are topological, or at most incremental. In conversations with Sony managers, both in the US and in Japan, we found evidence of considerable movement among the individuals responsible for the Walkman's success. Project teams had been formed and disbanded and managers had moved around. Yet, Sony followed a consistent pattern of innovation for over a decade. This suggested that the real answer lay in the structural organization of innovation.
Finally, empirical support for the system view came from the analysis of model lives and prices. We do not believe that any leader, however inspired, could personally have created Sony's decade-long string of classic designs (see Fig. 4). Similarly, our hedonic price analysis found that the imputed price premium for the Sony brand name was modest compared to the values created by its long string of design innovations.

8. Conclusions

Our interest in the Walkman story began with a desire to understand why Sony was so successful, even though it lacked the traditional forms of sustainable competitive advantages generally required by management theorists. Sony's major Japanese competitors have equally fine engineering staffs, world-class manufacturing plants, international marketing organizations, broad consumer electronics product lines, strong financing, and educated, highly committed workforces. Sony's competitors have fared well against Sony in several other, closely related consumer electronics categories. In the case of the Walkman, moreover, Sony held no determining patents and was unable to defend any technological barriers to entry. While Sony's brand name undoubtedly carried weight, its major competitors (Panasonic, Toshiba, and Sanyo) were also well known and highly regarded.

As we assembled and analyzed historical data on the Walkman, we began to suspect that Sony's handling of the Walkman represented something more interesting and complex than we initially imagined. The Walkman story displays a rich complexity that we believe is characteristic of effective management of product families. If Sony's methods are indications of emerging best practice, future competitive survival in this, and similar industries, will be a daunting task. Firms will have to acknowledge and deal with the parallelism, the differences in designs and design processes and, ultimately, with the complex interactions that exist among incremental design changes.

In examining Sony's decade-long dominance, we believe there is reason to suspect the existence of an important new form of competitive advantage, namely a firm's skill at managing the evolution of its product families. In fact, Sony's founder, Akio Morita, recently made the following comment:

Japanese business and government leaders, like many of their American counterparts, continue to believe that the United States must address its agenda of domestic economic challenges more vigorously and with more attention to enhancing the competitiveness of U.S. business over the long-term. My personal view is that as long as MBA's lawyers, and financial wizards are valued over engineers and product planners. American society will be in danger of moving in the wrong direction. (emphasis added) (Morita, 1992)

Mr. Morita places the 'product planner' on the same footing as financiers, engineers and lawyers. We believe that our review of the history of the Walkman makes it is easier to understand his choice of words. Managers, designers and engineers at Sony faced a challenge of managing the complex technologies, perceptions and organizational interactions that ultimately shaped the evolution of the Walkman product family. In response, they marshaled a pattern of incremental innovation that was coherent, efficient and extremely productive. The persistence and internal consistency with which Sony's pursued the development of the Walkman constitutes a strong argument for Mr. Morita's prescription.

Sony started with a long-term plan of miniaturization and performance improvement that predated the Walkman. It aggressively invested in key component technologies to support progressively smaller consumer electronics designs. It invested in the development of key generational platforms that simplified the task of introducing large numbers of incremental and topological design changes. To support its large variety, Sony developed its own system of flexible manufacturing so that it could make money on small production runs.

Sony relied on its industrial design centers to understand lifestyles outside Japan and to exploit
the potential for incremental and topological changes to serve customer perceptions and lifestyles. By combining industrial design with manufacturing flexibility, Sony generated designs that had large market impacts and little marginal cost. This approach ultimately allowed Sony to create a climate of design freedom that fostered risk taking by its industrial designers.

The creativity, low cost and low risk associated with Sony's incremental and topological designs were crucial to Sony's variety-intensive strategy. By creating a model for many different customer perceptions and lifestyle, Sony preempted several important market segments. These niches were too small to attract challenges from other firms and Sony did not have to refresh the designs of these models as rapidly as it did for more competitive segments. The long-lived models in these niches further eased Sony's design burden.

In achieving its success with the Walkman, Sony capitalized on several factors that may not be present for other products or firms. Sony started with an important first-mover advantage that it was careful not to relinquish. Sony carefully maintained its mastery of the Walkman technology. In addition, the personal stereo is particularly sensitive to lifestyle considerations, a fact that was to Sony's particular advantage. Finally, Sony was able to develop the personal stereo secure in the knowledge that international acceptance of the standard audio cassette tape guaranteed the Walkman product concept would remain viable for a considerable period of time. Despite these peculiarities, there are important elements in Sony's handling of the Walkman that deserve consideration by other manufacturing firms. In particular, Sony's management of the Walkman family highlights four specific tactics of product planning that may be applied to other manufacturers operating in an environment of incremental change.

The first element is Sony's variety-intensive product strategy. Sony pushed hard to create a large model variety. Sony preempted market segments that competitors have still not contested. These segments include the market associated with outdoor lifestyles (Sports Walkman), audiophiles (WMD6C and other direct drive models) and children (My First Sony). Since models in these segments required less frequent redesign, they did not call on design resources that were needed elsewhere to update models in more competitive segments.

A second tactic was Sony's multilateral management of product design. By locating marketing, product planning and industrial design resources in each of its major markets, Sony placed responsibility for design changes in the hands of the people who could best perform them. Japanese engineers led the development of generational platforms. Marketers carried requests for new models from the sales channels. Industrial designers in key markets around the world led the development of models that tapped into local lifestyles. While Walkman development teams always included engineers, marketers and designers, the focus of the leadership shifted. Engineers led when technology was the hurdle. Marketers led when appealing to specific customers was the goal. Industrial designers led when the challenge was to understand and respond to a potential lifestyle. By decentralizing its leadership, Sony was able to bring more contributors into the design process for the incremental and topological designs. This made it easier to generate the large number of models and made them more relevant.

A third element in Sony's strategy was its judicious use of industrial designers. By fully exploiting their talents, Sony built a bridge between the varied and changing needs of customers and the relatively stable technical capabilities embodied in its platforms. The industrial designers found creative ways to use the platforms to enter new market niches using incremental and topological design changes.

The fourth element was Sony's commitment to minimizing its design cost. In a world where variety and change interact to increase designers' workloads, Sony carefully controlled the costs of new models by building all of their models around key modules and platforms. Modular design and flexible manufacturing allowed Sony to produce a wide variety of models with high quality and low cost. What is more important, by keeping down the design and manufacturing costs of new vari-
ants, Sony gave its designers the creative freedom they needed. Moreover, the greater longevity of several of the models contributed to the variety of models available to customers. Rapid model turnover was combined with greater model longevity of key models to provide greater model line breadth.

We believe that the Walkman example makes a significant contribution to our understanding of innovation. Sony’s management of the Walkman product family is consistent with, but goes deeper than, the normative product planning process proposed by Wheelwright and Clark (1989). While their framework contains powerful insights, it does not capture the rich interactions and dynamics that occur in and among the topological design changes. Nor does it acknowledge the impact of customer perceptions, something Sony’s industrial designers do so well.

Sony’s focus on the design process has not waned now that the Walkman technology has become mature. Sony introduced the compact disk in 1982. Several months later, it introduced four more products (two priced higher and two lower). In less than 2 years, Sony introduced eight new low-priced models. It took substantially longer for other competitors to get comparable models into the market place. As the price of CD players dropped, demand for compact disk players soared and 30 companies eventually entered the market, but many of those are reselling Sony units or components. Despite intense competition, which eventually forced many players out of the market, Sony has remained both the variety and the market share leader.

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