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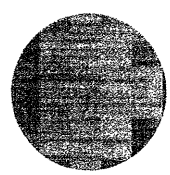

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THE TRIUMPH OF VHS OVER BETA

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ABSTRACT

This article deals with the diffusion and standardization rivalry between two similar but incompatible formats for home VCRs (video-cassette recorders): the Betamax, introduced in 1975 by the Sony Corporation, and the VHS (Video Home System), introduced in 1976 by the Victor Company of Japan (Japan Victor or JVC) and then supported by JVC's parent company, Matsushita Electric, as well as the majority of other distributors in Japan, the United States, and Europe. Despite being first to the home market with a viable product, accounting for the majority of VCR production during 1975-1977, and enjoying steadily increasing sales until 1985, the Beta format fell behind the VHS in market share during 1978 and declined thereafter. By the end of the 1980s, Sony and its partners had ceased producing Beta models. This study analyzes the key events and actions that make up the history of this rivalry while examining the context -- a mass consumer market with a dynamic standardization process subject to "bandwagon" effects that took years to unfold and were largely shaped by the strategic maneuvering of the VHS producers.

INTRODUCTION

The emergence of a new large-scale industry (or segment of one) poses daunting strategic challenges to innovators and potential entrants alike. Long-term competitive positions may be shaped by the initial moves made by rivals, especially in the development of markets subject to standardization contests and dynamic "bandwagon" effects among users or within channels of distribution. Later entrants are forced to contend with the advantages while they seek to exploit the disadvantages in positions established by "first movers" - companies who first commercialize a product or technology. While a market is developing or adapting to change, both first movers and followers maneuver to establish a sustainable winning position.

This article explores the effects of strategic maneuvering and mass-market dynamics among firms that pioneered the commercialization of the videocassette recorder (VCR) for household use. By the 1980s, the VCR had become the largest segment of the massive global consumer electronics business. The first VCRs were developed in the early 1970s. One design, the U-Matic, developed primarily by the Sony Corporation, soon emerged as a dominant design for professional and educational uses. By the mid-1970s, variations of this design, embodying more integrated electronics and narrower (1/2") tape, had resulted in similar but incompatible formats designed for home use: the Betamax, introduced in 1975 by Sony, and the VHS (Video Home System), introduced in 1976 by the Victor Company of Japan (Japan Victor or JVC) and then supported by JVC's parent company, Matsushita Electric, as well as the majority of other firms in Japan, the United States, and Europe.[1]

The Beta design, despite being the first compact, inexpensive, reliable, and easy to use VCR, as well as accounting for the majority of VCR production during 1975-1977 and enjoying steadily increasing sales until 1985, fell behind the VHS in

market share during 1978 and steadily lost share thereafter. By the end of the 1980s, Sony and its partners had ceased producing Beta models, with Sony promoting another standard using a smaller (8mm) tape, primarily for home movies (Tables 1 and 2). While the outlines of this competition have been discussed before, both in English (for example, [1] [2]) and in Japanese ([3] [4]), this study examines in detail how the VCR rivalry unfolded, why it developed as it did, and how company actions affected the outcome.

The literatures of management and economics contain varied discussions of how firms create and sustain profitable competitive positions in situations like this one. First-movers potentially benefit from technological leadership, which may be sustained through greater experience or success in patenting or R & D contests. They may be able to exploit opportunities for early acquisition of scarce critical resources, as exotic as specialized equipment or as mundane as retail shelf-space. First movers may benefit from the existence of buyer switching costs, from the accumulation of above-average profits reaped while enjoying a de facto monopoly position, or from their ability to shape product definitions, forcing followers to adapt to a standard or to invest in order to differentiate their offerings. Followers, on the other hand, may gain a "free ride" on investments made by the first-mover, such as educating buyers or solving certain critical design or manufacturing problems. Followers may also benefit from the resolution of uncertainties in the marketplace, may be able to utilize more recent developments in technology, or take advantage of "inertia" or inflexibility on the part of the first-mover. [5]

When an innovation is rooted in a novel and challenging technology, being a first-mover may not be as important as having been among the pioneers in developing that technology. [6] Firms that were technological pioneers may be able to follow the

leader rapidly enough to neutralize inherent first-mover advantages while also exploiting the benefits that accrue to followers. A pioneer coming second or third to market may have better information about buyer preferences, or more time to plan efficient manufacturing operations or organize alliances for production and distribution. Such a firm may also be able to copy valued features of the product first-offered, while adding others to differentiate itself. In particular, in a mass market without patent protection or standards legislation, the time required to create a dominant standard is so great that first mover advantages may be minimal.

In the case of the VCR, with the potential global market measuring hundreds of millions of units, the very scale of the market created a window of opportunity for firms with established technological capabilities to challenge the first-mover, Sony. As demand grew in the first years at rates outstripping producers' ability to supply it, the first "bandwagon" emerged in the formation of alliances for production and distribution. The development of demand for a complementary product - prerecorded tapes (usually movies) - set off the second bandwagon in the 1980s, as retail outlets for tape rental chose to focus on stocking tapes in the format adopted by a majority of users, though the alternative format still enjoyed substantial acceptance.

BACKGROUND

Inventors, Pioneers, Standard-Setters

Magnetic video recording technology was created in the United States, but numerous European and Japanese companies competed and collaborated in the 1960s and 1970s to adapt the technology to the requirements of a mass market. As discussed in earlier articles by Rosenbloom and Cusumano [6] and Rosenbloom and Freeze [7], Ampex Corporation, a small California company, invented a video recorder for

broadcasting applications in 1956. This came after several years of competition with RCA to use magnetic tape (as earlier used in audio tape recorders) to record television signals, and freed the broadcast industry from a reliance on live performances or a clumsy system of film recording. In the late 1950s, Sony, Japan Victor, and Matsushita, as well as several other Japanese firms, began studying and improving upon the $50,000-plus Ampex machine, employing novel recording-head mechanisms and solid-state electronic circuits, as well as other product and process innovations that allowed them to miniaturize the video recorder and dramatically reduce its price.

Design technology for video recording had been difficult for Ampex to master but proved more difficult to protect from a select handful of companies that had made audio tape recorders and then invested in the development of video recording. Although Ampex retained control over important patents, Japanese firms challenged these in Japanese courts as well as explored ways to invent around them. By the mid-1960s, several firms in Japan, along with Ampex in the United States and Philips in Europe, had accumulated considerable expertise in video-recording design and manufacture.

Despite a series of products through the 1960s that did not appeal to consumers because of still-high prices, poor picture quality, bulky housings, and inconvenient reel-to-reel formats, the Japanese pioneers continued to improve their machines until, in 1971, Sony succeeded in designing a cassette model with 3/4 inch-wide tape. This machine, called the U-Matic, was still too large and expensive for regular home use. Nonetheless, it found a market among schools and other institutions, and embodied the core design concepts that served as the basis for both the Beta and VHS formats.[2] In conjunction with an agreement to adopt Sony's U-Matic as a standard for institutional machines, three Japanese firms that later competed for the home-video standard -- Sony, Matsushita, and Japan Victor -- signed a cross-licensing agreement

for video-recording patents in 1970 [3][5][6]. Philips did not join this group and pursued its own distinctive VCR design.

While engineers and managers recognized that a standard format would be better for consumers and producers (who would benefit from expansion of the market), agreement on a single home video format proved impossible to reach. In fact, Sony's experience with the U-Matic had made its engineers particularly reluctant to cooperate in establishing or refining a new standard. As early as 1970, Sony had appeared ready to introduce a smaller machine that used a more sophisticated (azimuth) recording system and might have proved popular with consumers. Since Matsushita and Japan Victor were not yet ready to mass produce this type of machine, the U-Matic ended up as a compromise design, requiring a wide tape and large cassette. The compromise thus forced Sony, by agreeing to support what became the industry standard for institutional machines, to miss a potential opportunity to enter even earlier into the home market [3][8][9].

Utilizing nearly two decades of experience with video-recorder design, engineering, and manufacturing, Sony and Japan Victor both proceeded to develop 1/2 inch-wide tape VCRs for the home and introduced them in 1975 and 1976. Meanwhile, other companies, including Ampex, RCA, Matsushita, Toshiba, Sanyo, and Philips, introduced or experimented with alternative formats. Unlike the Sony and JVC designs, both of which resembled the effective U-Matic design, the other VCRs were based on distinctive design concepts which proved to be inferior to Beta and VHS.

In addition, just as Sony's Betamax was essentially a miniaturization of the U-Matic but with a more advanced recording technique, the VHS closely resembled the U-Matic (and thus the Betamax), even though the recording format and tape-handling mechanisms remained different. Accordingly, it proved difficult for Sony and Japan

Victor, and the firms that carried their machines, to differentiate their products through basic features. Hence, neither Beta nor VHS could gain a technological advantage in design or manufacturing that could be sustained long enough to gain a dominant market position. Sony did establish an advantage in reputation if not in actual design and manufacturing skills because of its unique history as an innovator in home video and primary inventor of the U-Matic. As discussed below, however, Sony's first-mover role did not create a sustainable advantage in such a large, dynamic market. Its chief competitors also had superb technical skills, while domination of the huge global market required cooperation with other firms in mass production, licensing, and distribution, of both hardware and software. Yet it was by no means certain when introduced that the VHS -- which came to market after Betamax and was backed by a small firm (JVC) with limited manufacturing and distribution capabilities -- would prove superior in the marketplace.

The Global Mass Market

Demand for a novel consumer-electronics product can rise rapidly as masses of new customers appear each year. In home video, for example, everyone with a television set was a potential customer. In contrast, professional video had been a very limited market. Machines for broadcast use were expensive and complex, and the number of buyers equalled the number of television stations -- hundreds in the United States, Japan, and Europe combined, not millions. As a result, one firm was able to supply most of the new and replacement demand for many years. Ampex Corporation had produced approximately 75% of all video recorders in use worldwide in 1962 and was able to dominate the broadcast market for two decades after its invention of the video recorder in 1956 [7].

The Beta and VHS models, however, opened up a true mass market, allowing

video recorders to parallel and then in the early 1980s pass color television sets to become Japan's (and the world's) top consumer electronics product in production value [10]. The vast size and worldwide structure of this new demand made it nearly impossible for any one firm to accommodate it alone. Annual production of home videocassette recorders in Japan exceeded one million as early as 1978, having commenced only in 1975, and continued to double each year until 1981. Japanese firms exported 53% of the video recorders they produced in 1977 and approximately 80% from 1979 onward. While the top export destination was the United States during 1976-1979, European exports consumed a larger share during 1980-1982, as VCR sales boomed with the increasing availability of prerecorded tapes (see Table 3 and [10]). Europe was probably a more favorable market to promote the use of software than the United States because of the smaller number of television stations and available broadcast programs.

Thus, the characteristics of home video -- the market's "mass" and global nature, as well as the product's technical complexity -- meant that emergence of efficient mass-production capacity, broad distribution channels, and clear market preferences would require years. An early mover into the market had no guarantee of a sustainable advantage from simply being first, but needed an effective strategy to capitalize on its position. The need for strategic action was especially strong since other pioneers, after observing customer reactions to the initial product offering, had the option of moving in with a comparable product, lower prices, better features, or superior distribution. In fact, Matsushita was known for competing in that manner: monitoring a broad range of technical developments and gradually building up in-house skills while waiting for Sony, Japan Victor, or other innovative consumer-electronics firms to introduce a new product first. Matsushita would then enter the market six months to a year later with a similar but lower-priced version, often

manufactured more efficiently due to Matsushita's mass-production skills and willingness to invest to achieve scale economies. The scale of Matsushita manufacturing reflected broad distribution guaranteed through an enormous domestic sales network, which marketed products under brand names that included Panasonic, Technics, National, and Quasar. Matsushita also could schedule large production runs because of its willingness to sell finished products to original equipment manufacturers (OEMs), in Japan and abroad, for sale under their labels ([3], pp. 151-154).

Theory of the Case

A VCR by itself is worthless. Users can employ it only in conjunction with a complementary product, the videotape cassette, that is designed to conform to the interface specification of the VCR. This is a common characteristic of contemporary information technologies, such as the personal computer and its software programs, compact-disc (CD) players and discs, or TV receivers and broadcast signals. Interface standards for innovative products of this sort can be established by various means: government regulation (FCC for television), formal agreement among a large number of producers of the primary product (CD players), or implicit acceptance by producers reflecting the market power of a sponsor (IBM PC).

In the case of the VCR, since no single producer or coalition was strong enough to impose a world-wide standard, and repeated efforts to bring producers to an agreement failed, the marketplace set the "standard." An interesting stream of economics literature has explored the dynamics of rivalry in just such situations [10][11][12]. The key factor is what economists call the "network externality," the fact that the value of a given product to a user is influenced not only by the product's inherent capabilities, but also by the extent to which others also use it.

This has two important dynamic consequences. Given rival products of substantially equal cost and capabilities, buyers will tend to choose the one that has been chosen, or appears likely to be chosen, by a greater number of other buyers. Furthermore, this creates a system with a positive feedback; the perceived benefit of choosing a given standard increases as more buyers choose it, thus increasing the probability of purchase by others not yet in the marketplace. An early lead in this sort of contest, however achieved, may become self-reinforcing.

The economics literature illuminates the role of the key protagonists in such battles, the sponsors who control the propriety technology. The incentives available to other producers of the primary product are important features of the process, and are bound up with their perceptions of the likely outcome. The literature also shows that there is no guarantee that the process will lead to a standard that is in some sense "best" for users as a whole.

In the drama of the VCR standardization battle, there were three sets of principal players: (1) the main protagonists, Sony, JVC, and Philips, sponsors of the three principal rival formats and major producers of the core product, the VCR; (2) the remaining consumer electronics producers, each of whom would adopt one of the standard formats for production and/or distribution; and (3) the producers and distributors of an important complementary product, pre-recorded software.

As it played out, the crucial battle was between Beta and VHS, Sony and JVC. (Although Philips held on to a different standard in Europe for a decade, it never posed a serious challenge to the other two.) The facts are simple: Beta reached the market first, took 58% of the market in 1975-77, and fell behind VHS in 1978. For the next six years, sales of Beta-format VCRs increased every year while its share of the worldwide market fell every year. Being outsold four to one by VHS in 1984, Beta sales began a rapid decline to extinction.

The figures present the picture of a classic "bandwagon," with the VHS format turning a slight early lead in sales into a dominant position. Chance events might have produced that early lead, and the theory tells us that might be enough to explain the outcome. The thesis of this article, however, is that the early lead and the eventual outcome reflect the deliberate actions of the main players. Strategic maneuvering by the principal protagonists in 1975-77 led to an alignment of producers of the core product and exploitation of distinctive dynamics of mass production and distribution sufficient to account for the early dominance of VHS sales. In a second phase of rivalry, in the 1980s, the strategic alignment of producers of complementary products reinforced the VHS advantage and hastened the demise of Beta, which might otherwise have survived as a second format.

EVIDENCE

A three-year period, from mid-1974 to 1977, proved decisive in shaping the emergent VCR industry and determining the outcome of the standardization battle that would rage on for another decade. At the start of that period, diversity characterized the positions of the world's largest consumer electronics companies with respect to home video, a market that remained wholly speculative in 1974. VCR designs based on six different incompatible formats were in late stages of development at rival companies, and three of the majors, Hitachi, Sharp, and Zenith, had no commitments at all to home-video development. By mid-1977, the pattern had changed sharply, as all ten of the biggest firms were marketing home-VCRs and the industry had divided into three "families," supporting either Sony's Beta, JVC's VHS, or the Philips format. The line-ups, and data about each firm's color TV sales and prior VCR

commitments, are identified in Table 4.

The decisive factors in the standards battle were few. First, of the six designs being developed around the world in 1974, four were significantly flawed and destined to fail. The Philips N-1500, Sanyo-Toshiba V-Code, and Matsushita VX designs were marketed vigorously yet fell short, despite the introduction of second-generation improved designs in each case. RCA's VCR design never got past the prototype stage and managers abandoned this after they saw the Betamax. Although a later Philips innovation, the V-2000, had many fine technical features, it was complex and costly to manufacture, and was introduced too late to capture a viable market share.

Because of their common technical heritage in the U-Matic, the Beta and VHS designs were closely comparable in cost and performance. Sony had a clear lead in time; it would take JVC roughly two more years to match the stage that Sony had achieved by late 1974. But moving first was not sufficient, in itself, to win the prize for Beta; how Sony moved and what its principal rivals did also mattered. In retrospect, as Akio Morita, then Sony's president, later acknowledged, he and Masaru Ibuka, then chairman, made a "mistake" and "should have worked harder to get more companies together in a "family" to support the Betamax format."[13] JVC, in the number two position, did "try harder" and was more effective at forming alliances in support of VHS.

JVC's more effective campaign to form an alliance behind VHS produced a coalition that matched the Beta family in global market power. JVC and its principal ally (and parent), Matsushita, followed that with strategic commitments that gained a decisive edge in market share for VHS, beginning in 1978. Matsushita exploited its generic skills in mass production and substantial previous experience in VCR manufacture by establishing production capacity for the VHS that exceeded the combined capacities of all other Japanese VCR producers. JVC, meanwhile, moved

aggressively to bring leading European consumer electronics firms into the VHS family, almost preempting that market from Beta.

Strategic Alignment of Primary Producers

A set of assumptions that proved to be in conflict shaped Sony's strategy for commercializing the Betamax. Sony's leaders believed that the Beta design was good enough to be a winner, and they knew that they were ahead of their rivals in VCR development. But they also understood that no producer, on its own, could establish a VCR format, however good the design, as a recognized global standard. Thus, Sony set out to interest other VCR pioneers in adopting the Beta format, concentrating especially on winning the allegiance of Matsushita, its most formidable rival. But two premises hampered their ability to recruit allies.

As Japan's leading developer of video technology, Sony believed that it should not have to delay commercialization of the Betamax in order to cooperate, and probably compromise, on the development of an industry standard with other firms. As discussed earlier, Sony managers and engineers had felt their willingness to compromise on the U-Matic had been a competitive error. Consequently, Sony went ahead and began manufacturing preparations for the Betamax in the fall of 1974, before approaching other firms to discuss the prospect of their adopting the Sony machine as an industry standard (see Appendix A).

Furthermore, Sony was reluctant to build VCRs for its licensees. Sony had always been uniquely innovative with consumer products incorporating advanced electronics. Its management had never before agreed to ship Sony products to other companies for distribution under their labels, preferring to build up the Sony name and reputation and to avoid sharing the benefits of Sony innovations with too many levels of distributors. For example, Sony developed and marketed Japan's first

audio-tape recorder (1950), stereo audio system for broadcasting (1952), transistorized radio (1955), transistorized video-tape recorder (1958), and transistorized micro-television (1959), as well as unique products such as the Trinitron television, whose picture-tube technology did not follow the industry standard established by RCA [14]. Thus, while Sony managers realized they would have to license the Beta format to ensure its widest distribution, they were unwilling to compromise on their standard or help potential licensees with OEM shipments.

Sony first demonstrated the Betamax to representatives of RCA, an American video pioneer, in September 1974. At the same time, Sony began talking to JVC and Matsushita, its U-Matic partners, about "joint development" of a home-video format. But Sony did not manage these relationships well. When it approached the other firms, Sony had already begun tooling-up for the Betamax, signalling to prospective partners a commitment to proceed with mass production irrespective of their support. Sony thus acted as a true first mover, and may have believed that its lead in the market would convince other firms to follow. At the same time, having begun manufacturing preparations also made Sony less flexible, because altering the design of its machine would require expensive changes in manufacturing equipment.

The 1974 discussions with RCA accomplished one of Sony's objectives by persuading RCA to kill its own VCR development program, but they also brought to light the most vulnerable aspect of the initial Beta design, its limited playing time. RCA had given 200 of its own VCRs to U.S. customers in a market test during early 1974 and concluded that a minimum 2-hour playing time was necessary for commercial success ([1], p.84; [15], 4/21/75).[3] RCA executives knew from the Betamax demonstration that their efforts to develop VCR technology had been far surpassed by the innovative Japanese, and they terminated their own program. But they

decided to wait for further progress in the technology, especially for longer playing times, before committing to market a particular VCR.

When Sony demonstrated the Betamax to Matsushita and Japan Victor in December 1974, Matsushita also questioned the adequacy of a 1-hour playing time ([3], pp.13-17). These negative reactions to the Betamax then convinced managers at Japan Victor that a successful machine would have to offer at least two hours of playing time and strengthened their commitment to the VHS, whose development had proceeded on this assumption anyway. Japan Victor now joined RCA and Matsushita in declining to adopt the Beta format ([2], pp. 37-38).

Sony managers eventually realized they were not in a strong bargaining position and decided to modify the Betamax for 2-hour recordings. Sony postponed further licensing negotiations, losing valuable time and opportunities to continue attempts at enlisting licensees. In particular, when Hitachi, another major producer of consumer electronics products, showed an interest in July 1975 to license the Betamax, Sony managers refused, insisting that the Betamax was not yet perfected and thus not available for licensing ([3], pp.33-34; [1], p.156). It seems that Sony managers were still primarily interested in persuading Matsushita to adopt the Beta standard, rather than Hitachi, and knew by this time that Japan Victor was working on a competing format that, because of Japan Victor's position as Matsushita subsidiary, Matsushita was likely to support if Sony did not make a special effort to court its competitor.

Another problem with Hitachi was that Sony sought partners who could quickly manufacture VCRs on their own rather than requiring Sony to provide complete machines. Sony Chairman Akio Morita was unequivocal about this strategy, declaring early in 1976 that, "Sony is not an OEM manufacturer" ([13], 2/16/76). In this regard, Matsushita, which had a large manufacturing capability for VCRs based on previous unsuccessful products, was a better fit than Hitachi, which had only made

a few broadcast-use VCRs through a subsidiary and needed an OEM relationship before it could establish in-house production ([16], pp.79-80).

Sony resumed seeking partners as soon as it revised the Betamax to play for two hours. Top executives from Sony and Matsushita met again in March 1976 to discuss adopting Beta as the common standard. In July, Sony demonstrated the latest machine to Matsushita, Japan Victor, Hitachi, Sharp, Mitsubishi, Toshiba, and Sanyo, and also appealed to Japan's Ministry of International Trade and Industry (MITI) for support. MITI officials tried to negotiate a settlement and favored Sony in these discussions since it already had a machine in the market. Toshiba and Sanyo eventually agreed to back Beta, although the other firms decided to wait for the VHS, which Japan Victor announced publicly in September 1976 ([3], pp.59-72).

In contrast to Sony, Japan Victor followed a strategy aimed at forming as large a group as possible, aggressively pursuing both licensing and OEM agreements, including exports (see Appendix A and Tables 5, 6, and 3 above, as well as [2], p.42; [9][17]). Management first established a group of adherents in Japan who could boost JVC's manufacturing and marketing capabilities -- before completing the design and its own preparations for manufacture. Japan Victor initiated this process in the spring of 1975, shortly after Sony's demonstration of the Betamax, and by the end of 1976 had lined up Hitachi, Mitsubishi, and Sharp, in addition to Matsushita. Japan Victor also proposed an OEM relationship to Matsushita, even though the latter turned this down because Japan Victor did not have enough capacity to supply Matsushita's huge distribution network and Matsushita was capable of producing the VHS machine on its own within a few months ([3], p. 54). In addition, Japan Victor agreed to provide machines to Hitachi, whereas Sony would not, beginning shipments to Hitachi in December 1976 [9].[4] In January and February 1977, Japan Victor also began supplying VCRs to Sharp and Mitsubishi ([15], 12/13/76), which Hitachi had helped

to recruit.

As a second step, towards the end of 1976, Japan Victor moved to establish a footing in the U.S. market by negotiating with RCA. The U.S. company rejected this offer for an OEM relationship because of Japan Victor's small production capacity ([2] p.46). Yet, rather than giving up on OEM agreements outside Japan, JVC turned toward European firms, which would be satisfied with smaller quantities than RCA needed. Japan Victor pursued these European alliances far more actively and effectively than any other VHS or Beta producer, even after establishing a large production base and gaining world-wide recognition for its brand-name (see Table 5).

In addition, to entice other firms to support VHS, Japan Victor was willing to let other companies participate in refining the standard, such as in moving from two hours to longer recording times or adding new features. Japan Victor also provided considerable assistance in manufacturing and marketing [18]. Yet another important difference with Sony proved to be style: Japan Victor managers approached prospective partners in an exceedingly "polite and gentle" manner, and encouraged them to adopt as the common VCR standard "the best system we are all working on," rather than the VHS per se.[5] One outcome of Japan Victor's approach was that prospective manufacturing partners truly believed they would have some stake in the future evolution of VHS features ([2], pp. 32-33; [18]). Allowing partners to share in development also improved the VHS in ways that Japan Victor might not have pursued itself. For example, after Japan Victor exhibited the VHS prototype to Matsushita in the spring of 1975, Matsushita provided technical feedback that sped the completion of the new VCR ([1], pp.148-149). As discussed below, Matsushita also took the lead in increasing recording and playback time after consulting with RCA.

JVC also strengthened the position of the VHS family by moving aggressively to line-up European distribution. Philips, the leader in the consumer electronics market

in Europe, still commanded less than 25% share of the market for color television in the region. With its German ally, Grundig, the number-two producer, Philips was producing home-VCRs based on its 1972 technology, now outmoded by the Beta and VHS innovations. Most of the other European consumer electronics firms had earlier marketed VCRs produced by Philips and Grundig, but by 1975 all of them had dropped the product. In contrast to RCA's reaction to the Japanese innovations, Philips determined to surpass the new designs with an innovative machine, for which they launched development in 1975. Meanwhile, Philips and Grundig persisted with the old design, upgraded in 1977 to provide two-hour recordings. The Philips V-2000 reached the market in 1980 but, despite impressive technical features, it was too expensive and too late.

JVC exploited this opportunity to recruit Telefunken, Thomson, Thorn, Nordmende, and other strong European brands into the VHS family. Moving quickly with its Japanese partners, JVC had defined the technical standards for a PAL (European color standard) VCR in 1977. JVC's readiness to supply machines on an OEM basis, plus the evident superiority of VHS over the current Philips offering, won commitments in rapid order from the remaining major European firms. [26]

The marketing clout wielded by the rival families is worth close analysis. All the participants understood that VCRs would be sold as adjuncts to television and audio equipment. A rough proxy for market power in that industry in the mid-1970s was a company's share of the color television receiver market. At one level, the rivals appear evenly balanced. Among the world's top ten consumer electronics companies, the VHS and Beta groups were evenly matched, each selling slightly more than one quarter of the color sets sold in 1976 (see Table 4 above), while Philips and Grundig together accounted for less than one-sixth. But the VHS family was more successful in gaining the allegiance of smaller brands. Hence, within each of the three major

geographic markets, VHS started out with a market share advantage. The VHS family -- Matsushita, JVC, Hitachi, Sharp, and Mitsubishi -- accounted for nearly 60% of color TV sales in Japan in 1976, compared to only 37% for Sony, Toshiba, and Sanyo. In the U.S. market, the VHS brands, led by RCA, had a 49% share of color TV sales in 1976, compared to only 41% for Zenith, Sony, Sears, and the rest of the Beta family. And by 1978, almost all the European brands not committed to the Philips format adopted VHS, leaving Beta in a minority position.

In 1975 and 1976, all of the world's leading consumer electronics producers climbed onto the home video bandwagon. Those that had bet wrong on video development, choosing an inferior design approach, or electing not to invest at all, reversed their positions and adopted one of the three contending formats. In the course of these two years, JVC, by adroit maneuvering (and with a major boost from Matsushita), transformed the structure of the rivalry to establish a standard format for home VCRs. In mid-1975, Sony had stood out in a field of diverse contenders. Its Beta design was the only format both ready for the market and capable of performing at the level required for the mass market. By mid-1977, VHS could challenge it from a position of parity, both in terms of product cost and functionality, and in terms of the market power of the VHS family.

Product Differentiation

Another issue is whether the market performance of VHS resulted from differentiating features, prices, or quality. A comparison of models introduced during 1975-1985 by Sony, Japan Victor, and Matsushita, the major home VCR producers, indicates some differences in all three dimensions. (Appendices B, C, D). In general, however, at no time did either format establish more than a transient advantage in features, prices, or picture quality.

For example, while Sony's initial models played for 1 hour and VHS machines 2 hours, Sony increased its machine's capacity to 2 hours merely 5 months after Japan Victor entered the market and several months before Matsushita appeared (Table 7). Sony offered more low-priced models until 1980, when Sanyo introduced inexpensive Beta models. Nevertheless, Matsushita quickly surpassed Sony in share once it entered the VHS market in 1977 and the VHS standard was dominant world-wide by the end of 1978. Beta and VHS offered basic models at similar prices, and the VHS group included more brand names, yet Sony led in the introduction of most new features at the same time it was losing market share to the VHS group. Between 1977 and 1983, Sony was the first company to offer wireless remote control, half-speed and one-third speed machines, multi-function machines (scan, slow, and still), high fidelity (hi-fi) sound, and a one-unit movie camera (cam-corder). But, as seen in Table 8, Matsushita or Japan Victor usually matched Sony's new features within a few months, and sometimes less. Japan Victor even introduced several innovations first, such as slow/still functions, a portable VCR, and stereo recording (which Matsushita also marketed at the same time).

While differences in picture quality are more difficult to assess, it seemed clear that VHS models were not superior to Beta, and the truth may indeed have been the opposite [27][28][29]. In addition, physical differences existed in the machine weights and cassette sizes, but it remains unclear how these affected the course of events, except that the smaller Beta cassette made it more difficult for Sony to increase recording or playing time simply by putting more tape into its cassettes [3][8][20][30][31].

The key issue here is that Beta machines still might have survived as an alternative format used for high-quality recording of broadcast programs off the air, or home movies. To achieve this, Sony would have had to distinguish Beta through

special effects or features that made it especially convenient or superior in performance. Yet, as with basic features and prices, Sony failed to differentiate Beta models for a significant length of time, due to the technical skills and initiatives of Japan Victor and Matsushita as well as their partners in the VHS group.

It also seems that Matsushita was able to counter Sony in the Japanese and U.S. markets by utilizing its huge engineering and manufacturing resources to offer a product line with more combinations of features and prices. Compared to Sony, Matsushita introduced both less and more expensive VCRs between 1978 and 1981, and manufactured about twice the number of model types Sony produced during the same time period (Appendixes B and D). Other marketing measures helped VHS firms overcome Sony's image for high-quality and reliability; for example, RCA and Matsushita (which marketed Panasonic and Quasar brands in the United States) both offered an extended labor warranty for their machines.

Mass Production and Distribution

By 1978, the VHS family had gained a significant edge in manufacturing capability, as well as in market power. Both the Beta and VHS machines were complex to manufacture, compared to other consumer-electronics products such as radios, televisions, or audio equipment, and in particular required high precision for machining the heads and sophisticated assembly skills for building the tape-handling mechanism and other components. The difficulty of designing and then mass-producing an inexpensive VCR kept Ampex and RCA from entering this segment of the market in the 1970s, even though both designed home-VCR prototypes in their laboratories [6][7][19]. Philips, in addition to difficulties with product reliability, also had to price its VCRs 20 to 30 percent higher than VHS and Beta machines ([9], p.4).

Both Sony and Japan Victor mastered the problems of engineering and mass production, benefitting from experiences gained through earlier video-recorder manufacturing. They also relied on integrated development teams for the Beta and VHS projects that brought together members with both design and operations backgrounds. Japan Victor, which had less experience making VCRs than Sony, paid special attention to making its VCR easy to manufacture and service by creating a relatively simple, low-cost design, with fewer components or assembly steps than the Betamax -- characteristics that appealed to companies wishing to license a VCR for in-house manufacturing. In contrast, while Sony had the manufacturing expertise to produce the Betamax relatively economically, potential licensees appeared concerned over their ability to mass produce the Beta design [6][18][20] [21].

Matsushita also made low-cost production a major priority as it modified the VHS design and prepared its own plants. The company spent at least 14 months studying manufacturing issues before formally adopting the VHS standard in January 1977. Matsushita engineers knew what problems to expect since they had accumulated invaluable experience in VCR mass-production from earlier machines, including a cartridge model once made in a plant with 1200 workers and a monthly capacity of 10,000 units, as well as the VX cassette model, which Matsushita had mass-produced in 1976 before switching to the VHS ([3], pp. 21-24, 54; [1], p. 159.) Matsushita emphasized not only a reduction in parts but also invested in manufacturing automation and scheduled large production runs, anticipating that its vast distribution system would enable it to sell a great number of VCRs ([16], pp.39-40). Matsushita's ability to deliver low-priced VCRs with an increasing variety of features also helped it to undercut Sony prices and win contracts to supply machines to overseas distributors ([15], 4/4/77) -- arrangements that further increased

Matsushita's scale of operations and ability to justify additional investments in product development and manufacturing automation.

Managers at Matsushita believed that the manufacturer to dominate the world market would be the company that captured the largest share of the U.S. market [4], where the major VCR distributors were likely to be RCA and Zenith, the leaders in color television sales. Sony had already moved first after developing a 2-hour model by establishing a relationship with Zenith, after having been rebuffed by RCA. RCA intended to lead in the market for home-video players, but wanted lower-priced machines as well as a longer recording time. Meanwhile, Matsushita took a strong interest in RCA's distribution resources. These mutual interests brought RCA and Matsushita together in negotiations for an OEM agreement after discussions broke down between RCA and Japan Victor, which did not have the manufacturing capacity to supply RCA with the volume of machines it wanted.

As RCA managers pondered which Japanese producer to link up with, they reconsidered the issue of tape length. In February 1977, apparently to the astonishment of Matsushita executives, RCA requested a VCR that "could record a football game". This meant a recording time of at least three hours. Rather than ending the negotiations, Matsushita launched an intensive effort to double playing time from two to four hours by using the approach Sony had taken to double the playing time of its one-hour machine: halving the width of each recording track (called the track pitch) as well as slowing the recording speed. Matsushita put 70 engineers on this project alone and achieved the increase in playing time in merely two months, as well as setting up production capacity for 10,000 units per month within six months. By the end of March 1977, Matsushita had an agreement to supply RCA with approximately 50,000 4-hour VCRs by year's end ([1], p. 161-163; [2], p. 47).

A large part of the VHS advantage came from the sheer ability to deliver more machines than Beta producers could make early on in the competition. As early as 1978, because of Matsushita's massive capacity, the VHS group accounted for approximately 66% of Japanese VCR production capacity totalling 191,000 units per month (Table 9). Matsushita -- not Japan Victor -- thus proved instrumental in winning over RCA and pushing the VCR competition toward the areas where Sony was weakest: low prices and mass distribution, as well as longer playing and recording times. Japan Victor personnel opposed a doubling of the playing time, arguing that this constituted a 'bastardization' of the VHS (i.e., a compromise in picture quality), and they refrained from collaborating with Matsushita in pursuing the feature. Japan Victor eventually built a two-speed (2- and 4-hour) machine in August 1977 (primarily to satisfy its OEM partners) but not until July 1979 did it introduce such a machine commercially under the JVC brand name ([15], 7/11/79). Japan Victor, which had about one-tenth the sales volume of Matsushita, also took six months to build a machine with 4-hour play and 12 months to achieve a monthly capacity of 10,000 units ([15], 8/29/77).

Most important, the nature of competition changed as a result of Matsushita's alliance with RCA. First, a bandwagon effect clearly seemed to take place in the U.S. market as GE, Sylvania, Magnavox, and Curtis Mathes scrambled to join the VHS group in 1977, under the rationale that the format RCA supported would probably become the dominant machine in the American market ([15], 5/30/77, 6/27/77, 11/7/77). U.S. distributors initially had been indifferent to the choice of standards and appeared to be waiting for clearer market signals before selecting a format. Second, because of the longer playing time, Matsushita and its distributors, and later other firms in the VHS group, were able to establish an image of the Beta machine as deficient with respect to this basic feature. Sony increased the Betamax's playing

time to 3 hours in October 1978 but not until March 1979, a year and a half after Matsushita introduced the 4-hour VHS did Sony introduce a 4.5-hour machine (see Table 7).

Thus, by the spring of 1977, Matsushita was able to plan a large-scale entry into the worldwide VCR market and begin exploiting its skills in low-cost manufacturing and mass marketing. These skills, in turn, helped RCA, which had brand recognition as well as extensive distribution channels, offer reliable products at low prices. The effective Matsushita-RCA combination then damaged Sony's competitive position in both the U.S. and Japanese markets, not only because Sony's market share and distinctiveness declined. Shortly after RCA's announcement of a reduction in prices to undercut Sony in August 1977, Zenith demanded a renegotiation of its OEM agreement with Sony, to whom it was paying $100 more for Beta machines than RCA paid Matsushita for VHS machines ([15], 4/4/77). With a lag of more than two months, Sony and Zenith responded by matching RCA's prices ([15], 8/29/77, 10/3/77, 10/31/77, 11/7/77). Yet these moves portended a difficult future: Sony would now play the game on terms Matsushita and RCA set, and play it poorly; in fact, Sony had trouble matching the prices of both Matsushita and Japan Victor in the low end of the VCR market between 1979 and 1981 (see Figure 1). While Sanyo took over as the primary supplier of the lowest-priced Beta machines, it did not have the range of alliances or the distribution channels to which Matsushita had access.

Strategic Alignment for Complementary Products

Of the three principal functions of the VCR, namely, "time-shifting" (recording broadcast programs for later viewing), home movies, and playing pre-recorded cassette programs, it was only in the last one that the differential availability of the

VHS format proved to be a significant factor in consumer choice of players. The blank cassettes used for time-shifting and movies were readily available in either format. The format did represent a potential constraint on the sharing of these tapes among households, once recorded, but such use remained small. On the other hand, users quickly perceived that pre-recorded tapes were more available in VHS than Beta, and that difference appeared very salient to users intending to rent or buy programs.

Until the early 1980s, that difference did not matter much in the marketplace. The VCR was broadly perceived to be a "niche" product, appealing primarily to certain demographic segments. In 1980 and 1981, with VCR ownership in only 5 to 10% of television households in most advanced countries, forecasts typically projected a leveling of demand at penetration levels of 15 to 30% in the late 1980s. [22] Users gave little evidence of interest in pre-recorded tapes. In the United States, in the late 1970s, three-quarters of all VCR owners bought no pre-recorded tapes. [15] 9/9/78, 10/16/78, 4/12/79. In 1983, several years after the beginning of the tape-rental business, 40% of VCR owners never used such tapes and only 8% identified them as "important."[22] p.141. With a small installed base of players, and low consumer interest, producers and distributors of programs had slight incentive to offer much.

All that changed in the mid-1980s. Confounding the forecasts, the VCR turned into a mass-market product, reaching 30% of American homes by 1985, five years ahead of most forecasts, and still climbing. Sales and rentals of pre-recorded cassettes began to grow exponentially, doubling each year from 1982 to 1986. Although at least one leading U.S. firm concluded in 1982 that tape rentals would not be accepted by US consumers, and that the economics of the rental business would not support a large industry [23], entrepreneurs flocked to open rental stores in every neighborhood.

Europe stood at the leading edge of this change. VCRs began to achieve mass-market penetration in Europe earlier than elsewhere, apparently due to the

availability of fewer broadcast channels there. In 1983, when penetration had reached 10% in the United States and 12% in Japan, it was 29% in the United Kingdom and still growing. Because TV-set rental was a common practice in Britain, extended readily to VCRs, the practice of renting programs on tape was a natural adjunct. The linkages formed by JVC and Hitachi with Thorn and Granada, the leading U.K. TV-rental operations, led those distributors to emphasize the VHS format in tape rental as well. Program producers and distributors, observing the preponderance of European brands adopting VHS, tended to emphasize it over Beta and Philips formats. One pioneer in tape production, Magnetic Video, in 1980 had three times as much capacity in Europe for VHS production as for either Beta or V-2000. [15, 10/6/80].

In the United States, aggressive steps by RCA in the 1970s provided the first impetus for the VHS bandwagon, when it finally started rolling in the mid-1980s. Because of its ambitious videodisc venture, RCA had well-developed ideas about the consumer market for recorded video programming. To promote its VCR in 1978, RCA developed an important alliance with Magnetic Video Corporation of America [MV]. MV was a leader in pre-recorded video (primarily used then for education and training) and was the first to offer feature films on cassette. RCA supplied two MV program cassettes free with each VCR in 1978, along with a membership in the MV "club." MV, which soon found most of its growth coming in the VHS format, expanded capacity to enable it to duplicate 2.4 VHS tapes for every Beta product. Matsushita facilitated this by developing equipment for high-speed duplication, and rapidly making low-cost decks available to MV and others. When the British firm, Granada, began opening rental shops in the United States in 1980, it offered only VHS machines and cassettes.

Sony matched most of these moves, but with a lag and less effect. In 1979, Sony linked up with Video Corporation of America, but VCA continued to promote VHS as well. Sony also proved less effective than Matsushita in supplying equipment for

duplication of tapes on the Beta format. As a consequence of these and other moves, by 1980, the VHS format clearly dominated Beta in the channels for pre-recorded tapes. According to one estimate, VHS then accounted for 70% to 90% of the revenues of cassette dealers in the United States. [15] 12/8/80.

As the mass market began to grow in subsequent years, VHS sustained and multiplied this initial advantage. The greater abundance of VHS program material gave buyers greater incentive to choose VHS players, which then led tape distributors to stock more VHS tapes, and so on. By 1984, contrary to most forecasts made as recently as 1980 or 1981, the sale and rental of pre-recorded tapes was a billion-dollar business in the United States, dominated by the VHS format. [24] In 1984, Zenith, the leading U.S. color-TV brand, switched from Beta to VHS, and the end was in sight for the Beta format.

CONCLUSIONS

The triumph of the VHS format is an oft-cited, classic example of the dynamics of standardization. The evidence cited here shows, however, that it is also an important illustration of how strategic maneuvering can harness the dynamic power of a special marketplace -- the mass consumer market -- to make a winner out of a late entrant with a weak starting position.

In April 1975, Sony enjoyed what looked like an insurmountable lead. Its Betamax, already on the market in Japan, was clearly superior to VCRs being offered by major rivals, Matsushita, Sanyo, Toshiba, and Philips. It had a lustrous reputation globally as an innovator and leader in consumer electronics. JVC, in

contrast, a minor factor in the industry, was still struggling to perfect VHS prototypes that seemed to offer few evident technological advantages. Two years later, while Beta still enjoyed a lead, JVC had set in motion the fundamental forces that would continually erode, and then extinguish, Beta's share of a massive global market.

In retrospect, it is possible to identify the key events and to "explain" the outcome in terms of a few factors. But as it happened, the implications of each strategic move must have been more difficult to discern. Each of the key protagonists acted in a way that made sense in context. Sony's behavior followed patterns that had brought it great success over two decades. JVC, the underdog, could not reasonably have been less humble or flexible in its relationships. Had the market grown more slowly, as nearly all observers expected, Sony might have been able to respond more effectively to its early mistakes.

A few important moves made the difference. JVC created a winning alignment of VCR producers in Japan by the way its managers conducted the formation of alliances, showing versatility and humility, where Sony pressed commitment and reputation. The alliance with Matsushita brought huge added benefits, as the giant firm invested massively in capacity in advance of demand and pushed the technology to meet RCA's requirements. JVC completed the sweep by moving ahead of Sony to enlist European partners behind VHS.

JVC's early success in aligning itself with Japanese producers made it possible to gain an edge in the bandwagon for distribution rights. Sony's reluctance to be an OEM supplier, and its underestimation of the threat of the VHS, left Beta in a minority position for potential market power in the major markets of North America and Western Europe. As the theory suggests, once VHS took the lead, it continued to gain share year after year. The final "bandwagon," among producers and distributors of video

software, accelerated that process. Even without the later bandwagon, the outcome probably would have been the same in the long run. Nonetheless, the dominance of VHS formats in tape rental channels hastened the demise of Beta and made certain that it would not even survive as a second format.

Pasteur said "chance favors the prepared mind." Chance no doubt played a role in the dynamic growth of the VCR industry and the eventual success of VHS. But the alliances JVC formed for production and distribution, and the timely strategic commitments of its ally, Matsushita, proved to be the decisive factors in the triumph of VHS over Beta.

ACKNOWLEDGEMENTS

This research would not have been possible without the cooperation of many individuals at the Victor Company of Japan, Sony Corporation, and Matsushita Electric. We particularly thank Mr. Yuma Shiraishi and Ms. Junko Yoshida of JVC for their assistance. James Utterback offered suggestions on issues and references. The Division of Research at the Harvard Business School as well as the Leaders for Manufacturing Program at M.I.T. both provided funding that contributed to this project.

Table 1: Beta-VHS Annual Production and Cumulative Shares, 1975-1988

Units: (A) = annual production in 1,000 units; (B) = cumulative production in 1,000 units; (C) = share of total VHS and Beta production/share of total VHS and Beta cumulative production

	BETA FORMAT			VHS FORMAT		
Year	(A)	(B)	(C)	(A)	(B)	(C)
1975	20	20	100/100	--	--	--
1976	175	195	61/64	110	110	39/36
1977	424	619	56/58	339	449	44/42
1978	594	1,213	40/48	878	1,327	60/52
1979	851	2,064	39/44	1,336	2,663	61/56
1980	1,489	3,552	34/39	2,922	5,585	66/61
1981	3,020	6,572	32/35	6,478	12,063	68/65
1982	3,717	10,289	28/32	9,417	21,480	72/68
1983	4,572	14,861	25/30	13,645	35,125	75/70
1984	6,042	20,903	20/26	23,464	58,589	80/74
1985	3,387	24,290	8/20	40,977	99,566	92/80
1986	1,106	25,396	4/16	29,553	129,119	96/84
1987	669	26,065	2/13	39,767	168,886	98/87
1988	148	26,213	0.3/11	44,761	213,647	99.7/89

	8mm FORMAT	
1984	10	10
1985	566	576
1986	1,051	1,627
1987	1,351	2,978
1988	1,531	4,509

Sources: For 1976-1983, [32]; for 1981-1983, [33]; for 1975 and 1985-1988, and 8mm format, Victor Company of Japan, Public Relations Dept.

Table 2: VCR Production and Format Shares, 1975-1984

Unit: %.

	1975	1976	1977	1978	1979	1980
BETA Group						
Sony	100	56	51	28	24	22
Others	-	5	5	12	15	11
Subtotal	**100**	**61**	**56**	**40**	**39**	**34**
VHS Group						
Matsushita	-	29	27	36	28	29
JVC	-	9	15	19	22	18
Others	-	1	2	5	11	19
Subtotal	-	**39**	**44**	**60**	**61**	**66**

	1981	1982	1983	1984	...	1989
BETA Group						
Sony	18	14	12	9		
Sanyo	9	10	8	6		
Toshiba	4	4	4	3		
Others	1	1	2	2		
Subtotal	**32**	**28**	**25**	**20**		**0**
VHS Group						
Matsushita	28	27	29	25		
JVC	19	20	16	17		
Hitachi	10	10	11	15		
Sharp	7	7	9	9		
Mitsubishi	3	3	3	4		
Sanyo	-	3	4	5		
Others	2	2	2	5		
Subtotal	**68**	**72**	**75**	**80**		**100**

Sources: [32] [33] [16].

Table 3: Japanese VCR Exports, 1975-1983

Units: value in 1 billion yen, production in 1,000 units, %

	Value	Units	Export %	Exports by Region/Total Exports(%) N. America	Europe	Other
1976	31	139	48	75	17	8
1977	66	402	53	85	8	7
1978	126	973	73	60	28	12
1979	222	1,671	78	46	33	21
1980	444	3,444	78	32	42	26
1981	854	7,355	84	34	44	22
1982	1,080	10,661	82	27	52	21
1983	1,261	15,237	80	41	38	21

Source: [9], p. 43.

Table 4: Home-Video Families and World Color-TV Shares, 1976-1977

Company	Format	1974 VCR Commitments	1976 World Color TV Sales Rank	1976 World Color TV Sales Share %
Sony	Beta	Betamax prototype	3	7.4
Sanyo	"	V-Code in Japan	5	6.2
Toshiba	"	V-Code In Japan	6	5.8
Zenith	"	none	4	6.4
Total	Beta			25.8
Matsushita	VHS	VX-100 prototype	1	12.7
Hitachi	"	none	7	5.6
RCA	"	Selectavision prototype	8	5.2
Sharp	"	none	10	3.1
Total	VHS			26.6
Philips	Philips	N-1500 in Europe	2	11.5
Grundig	"	N-1500 in Europe	9	3.8
Total	Philips			15.3

Source: [34].

Table 5: Group Alignments (1983-1984)

Note: Suppliers indicated by initials (J = Japan Victor, Ma = Matsushita, H = Hitachi, Mi = Mitsubishi, T = Tokyo Sanyo, S = Sony, To = Toshiba, Sa = Sanyo, P = Philips, G = Grundig)

Japan	U.S.	Europe
VHS GROUP (40)		
Japan Victor	Magnavox (Ma)	Blaupunkt (Ma)
Matsushita	Sylvania (Ma)	Zaba (J)
Hitachi	Curtis Mathes (Ma)	Nordmende (J)
Mitsubishi	J.C.Penny (Ma)	Telefunken (J)
Sharp	GE (Ma)	SEL (J)
Tokyo Sanyo	RCA (H)	Thorn-EMI (J)
Brother (Mi)	Sears (H)	Thomson-Brandt (J)
Ricoh (H)	Zenith (J)*	Granada (H)
Tokyo Juki (H)		Hangard (H)
Canon (Ma)		Sarolla (H)
Asahi Optical (H)		Fisher (T)
Olympus (Ma)		Luxer (Mi)
Nikon (Ma)		
Akai		
Trio (J)		
Sansui (J)		
Clarion (J)		
Teac (J)		
Japan Columbia (H)		
Funai		
BETA GROUP (12)		
Sony	Zenith (S)*	Kneckerman (Sa)
Sanyo	Sears (Sa)	Fisher (Sa)
Toshiba		Rank (To)
NEC		
General (To)		
Aiwa		
Pioneer (S)		
V-2000 (7)		
		Philips
		Grundig
		Siemens (G)
		ITT (G)
		Loewe Opta (G)
		Korting (P)
		B&O (P)

* In spring 1984, Zenith switch from the Beta group to VHS.

Source: [9], p. 42; and Victor Company of Japan, Public Relations Dept.

Table 6: VCR Sales by Country and Format (1983)

Units: million units, %

	Unit Sales	VHS	Beta	V-2000
U.S.A.	4.1	75	25	0
Japan	3.4	70	30	0
Britain	2.3	74	24	2
W. Germany	1.5	60	20	20
France	0.4	70	20	10
Italy	0.2	60	20	20
Above Totals	11.9	72	25	3

Source: [9], p. 5.

Table 7: Recording-Playing Time Comparison

Year/Month	BETA	VHS
1975/5	1 hr. (Sony)	
1976/10		2 hr. (JVC)
1977/3	2 hr. (Sony)	
1977/10		4 hr. (Matsushita)
1978/10	3 hr. (Sony)	
1979/3	4.5 hr. (Sony)	
1979/8		6 hr. (Matsushita)
1979/8		4 hr. (JVC)
1979/12		6 hr. (JVC)
1982/3	8 hr. (Sony)	
1982/9	5 hr. (Sony)	

Source: [4], p. 208; Victor Company of Japan, Public Relations Dept. (Appendix C).

Note: Some of the longer playing times for Beta were achieved with thinner tape, not new machine models.

Table 8: Special Effects Comparison (Sony and Matsushita)

	Introduction Date (Year/Month)		
	Sony	**Matsushita**	**JVC**
Wireless Remote	1977/3*	1977/6	1979/6
1/2-Speed Machine	1977/3*	1977/6	1979/8
Slow/Still	1979/3	1978/7	1977/12*
Portable VCR	1978/9	1980/2	1978/2*
1/3-Speed Machine	1979/3*	1979/8	1979/12
Scan/Slow/Still	1979/3*	1980/6	1979/8
Stereo Recording	1980/7	1979/8*	1979/8*
Hi-Fi	1983/4*	1983/5	1983/11
One-Unit Camera-Recorder	1983/7*	1985/1	1984/3

Source: [16], p. 82; Appendices B, C, D

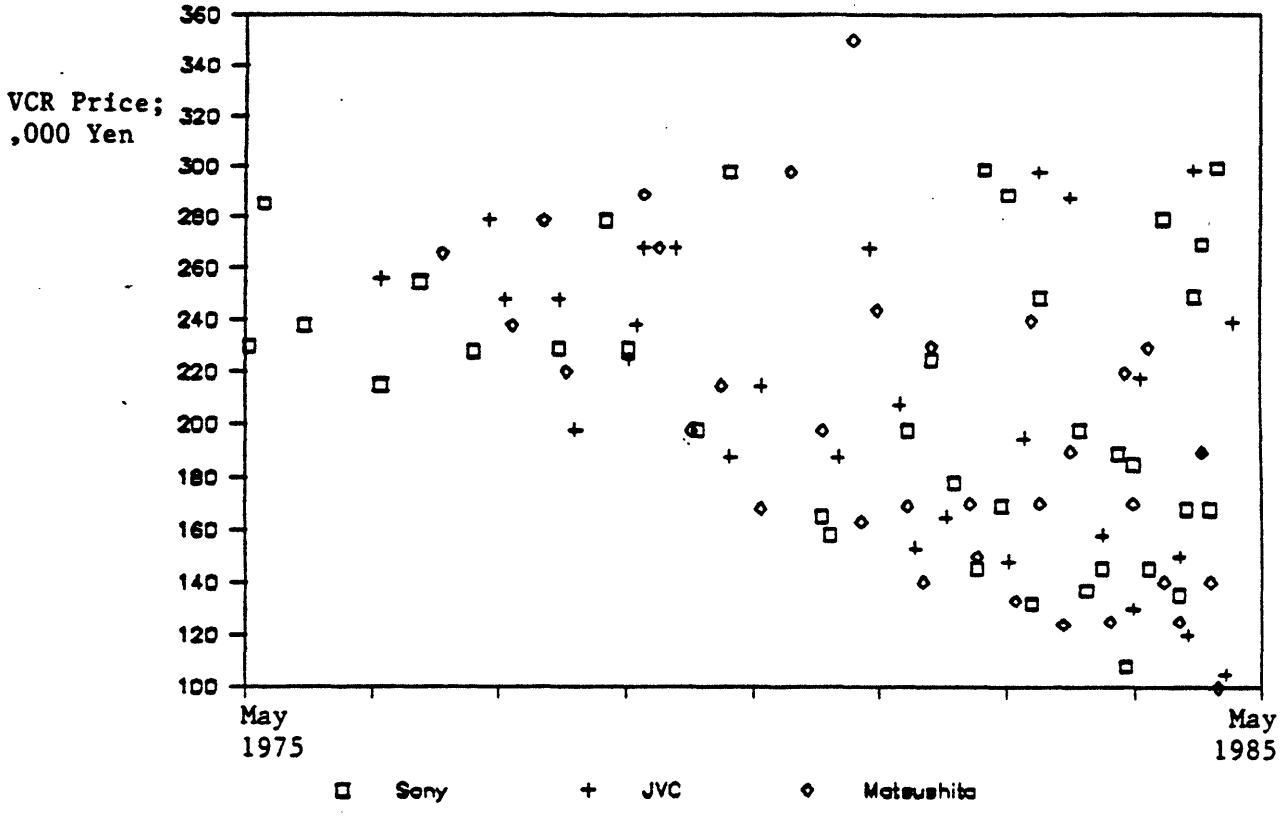
Table 9: VCR Monthly Production Capacity (1978)

Unit: 1000 machines, average monthly capacity

VHS Group		Beta Group	
100	Matsushita	45	Sony
20	Japan Victor	10	Toshiba
6	Hitachi	10	Sanyo
126	VHS Total	65	Beta Total

Source: [4], p. 220.

Figure 1 VCR Price Summary Comparison



Source: Appendices B, C, D.

Appendix A: VCR Industry Chronology, 1974-1978

Year/Month	
1974/9	Sony proposes to Matsushita and Japan Victor that they jointly adopt the Sony VCR under development, although development was largely completed and Sony already had begun setting its manufacturing dies and making other production preparations.
	Sony also shows the Betamax prototype to RCA, in the hope of persuading the U.S. firm to adopt it. (RCA subsequently abandons an attempt to develop its own VCR but rejects the Betamax because of its short 1-hour recording and playing time.)
	Toshiba and Sanyo introduce their own VCR, the V-Code I, with 30 minute and 1-hour tapes.
/12	Sony shows the Betamax prototype to Matsushita and Japan Victor, but still receives no commitment from them.
1975/4	Sony introduces the Betamax SL-6300 in Japan, priced at 229,800 yen (ca. $800). 1-hour recording time.
	Japan Victor announces to Matsushita that it had a competing VCR under development, the VHS.
/7	Hitachi approaches Sony as a potential licensee of the Betamax, but is rebuffed as Sony prefers to wait for Matsushita and modify the Betamax for 2 hours.
/9	Matsushita introduces its own VCR model, the VX-100, with 1-hour tape. Japan Victor also completes a VHS prototype and demonstrates this to Matsushita and later to other firms.
/12	Hitachi adopts the VHS format.
1976/1	Japan Victor asks Sharp and Mitsubishi Electric to adopt the VHS format; they agree by fall 1976.
/2	Sony introduces the Betamax (SL-7200) in the U.S.
/3	Hitachi, acting on behalf of Japan Victor, asks Toshiba and Sanyo to join the VHS group.
	Sony again approaches Matsushita and asks that it adopt the Betamax and Matsushita shows the VHS prototype to Sony for the first time.
/4	Toshiba and Sanyo introduce the V-Code II with a 2-hour tape.
/5	Matsushita introduces the VX-2000, with a 100-minute tape.
	Japan Victor begins manufacturing preparations for the VHS.

/6
/7
/8 Sony and Japan Victor each ask the Ministry of International Trade and Industry (MITI) to back their standards. MITI proposes Japan Victor adopt the Betamax, or that the two firms negotiate on a standard, adopt one or the other or a combination, but these suggestions fail to be accepted.

/10 Japan Victor introduces the VHS for commercial sale in Japan with a 2-hour tape.

/12 Hitachi begins marketing VHS machines supplied by Japan Victor.

1977/1 Sharp begins marketing VHS machines supplied by Japan Victor.

Matsushita publicly adopts the VHS format.

/2 Sanyo, Toshiba, and Zenith adopt the Betamax format.

/3 Sony introduces a 2-hour color version of the Betamax (SL-8100), although it is not compatible with the 1-hour Betamax.

Matsushita introduces a 4-hour version of the VHS for export to RCA, Magnavox, Sylvania, GE, and Curtis.

/4 Pioneer and Aiwa adopt the Betamax format.

/8 Sanyo reaches an agreement with Sears-Roebuck to supply it with Betamax machines.

/10 The VHS group settles on a European standard, followed by export agreements to several European distributors.

/11 NEC adopts the Betamax format.

1978/1 Hitachi begins in-house production of the VHS

/5 Mitsubishi begins in-house production of the VHS for export

Sources: Primarily [3] and Sony Corporation, "Table of Sony VTR History," Unpublished Memorandum, 16 August 1977.

Appendix B: Sony Product Schedule, 1975-1985

Name	Date	Yen Price	Comments
SL-6300	May-75	229800	First Betamax
SL-7300	Jul-75	285000	
SL-6301	Feb-76	238000	
SL-7100	Oct-76	215000	Price-Down/Simple Operation
SL-8100	Mar-77	255000	2-hr Recording (Both Beta I&II)
SL-8300	Mar-77	258000	2-hr Recording Only (Beta II)
SL-8500	Oct-77	228000	
SL-3100	Sep-78	229000	Portable
SL-J7	Mar-79	279000	Multi-Function/Beta-Scan/Beta III
SL-J5	Jun-79	229000	
SL-J1	Mar-80	198000	Portable
SL-J9	Jul-80	298000	Stereo
SL-F1	Jul-81	165000	Portable
SL-F11	Jul-81	278000	Wireless Remote Control/Stereo
SL-J10	Aug-81	158000	Price-Down
SL-J30	Jun-82	198000	Priced-Down with Stereo
SL-J20	Jun-82	137000	
SL-F7	Sep-82	225000	Swing Search
SL-J25	Dec-82	178000	
SL-F3	Mar-83	145000	
SL-B5	Mar-83	199000	Portable
SL-HF77	Apr-83	299000	Hi-Fi
SL-F5	Jun-83	169000	Micon Voice
BMC-100	Jul-83	289000	Beta-Movie
BL-F17	Oct-83	132000	
SL-HF66	Nov-83	249800	Hi-Fi
SL-HF55	Apr-84	198000	Hi-Fi
SL-HFR30	May-84	137000	BetaPlus (Expandability for Hi-Fi)
BMC-200	May-84	289000	Beta-Movie Auto Focus
SL-HFR60	Jul-84	145000	BetaPlus
SL-HF300	Sep-84	189000	Hi-Fi
FL-F33	Oct-84	108000	
SL-HF500	Nov-84	185000	Hi-Fi
SL-HF355	Nov-84	198000	Hi-Fi
EV-A300	Jan-85	145000	8mm
BMC-500	Jan-85	268000	Beta-Movie Auto Focus
SL-HF900	Feb-85	239800	Pro/Hi-Band
CCD-V8	Mar-85	280000	8mm Movie
SL-HFR70	May-85	135000	Hi-Band
SL-HF505	Jun-85	168000	Hi-Band
EV-A300	Jun-85	145000	8mm
EV-S700	Jun-85	249800	8mm Digital
BMC-600	Jul-85	270000	Hi-Band/Beta-Movie/Auto-Focus
SL-HF505	Sep-85	168000	Hi-Band
CCD-M8	Sep-85	198000	8mm Movie
EV-C8	Sep-85	148000	8mm Portable
CCD-V8AF	Oct-85	299800	8mm Movie/Auto Focus

Source: Sony Corporation, cited in [16], p. 83.

Appendix C: Japan Victor's Product Schedule, 1976-1985

Name	Date	Yen Price	Comments
HR-3300	Oct-76	256000	First VHS; 2-hr, 2-head
HR-3600	Dec-77	279000	Slow/Still; Wired Remote
HR-4100	Feb-78	248000	Portable
HR-3310	Sep-78	248000	Microphone Mixing
HR-4000	Nov-78	198000	VHS Player
HR-4110	Jun-79	225000	Portable, Slow, Wireless Remote
HR-3500	Jul-79	238000	Slow Function
HR-3750	Aug-79	268000	Multi-Function/Speed, 4-head Stereo
HR-6700	Dec-79	268000	Multi-Speed, 6-hrs., 2-head
HR-2200	Jul-80	188000	Portable, 2-head
HR-6500	Nov-80	215000	4-head, Timer & Counter*
HR-7300	Sep-81	188000	"
HR-7650	Jan-82	268000	Front-Loading, Wireless Remote
HR-2650	May-82	208000	
HR-C3	Jul-82	153000	Compact (VHS-C)
HR-7500	Nov-82	165000	Random Search Function
HR-7100	Nov-82	139800	
HR-D120	Jul-83	148000	
HR-D225	Sep-83	195000	
HR-D725	Nov-83	298000	Hi-Fi
HR-D220	Nov-83	158000	One-Touch Timer
GR-C1	Mar-84	288000	Compact Camcorder
HR-S10	Jul-84	158000	
HR-D130	Jul-84	138000	Simplified Timer
HR-D150	Nov-84	129800	
HR-D555	Dec-84	218000	Hi-Fi/Stereo
HR-D250	May-85	149800	
HR-D140	Jun-85	119800	
GR-C2	Jul-85	299000	Compact Camcorder
HR-D565	Aug-85	189800	Hi-Fi
HR-D160	Nov-85	104800	
HR-D755	Dec-85	239800	Hi-Fi, Programming Remote Control

*Note: All subsequent models are 4-head

Source: Victor Company of Japan, Public Relations Dept.

Appendix D: Matsushita Product Schedule, 1977-1985

Name	Date	Yen Price	Comments
NV-8800	Jun-77	266000	2-hr/4-hr Recording
NV-5500	Mar-78	238000	
NV-6600	Jul-78	279000	Slow/Still
NV-5000	ct-78	220000	Portable
NV-6000	Aug-79	289000	6-hr Rec/Slow/Still/Stereo
NV-6200	Oct-79	268000	Stereo
NV-3000	Feb-80	198000	Portable
NV-3500	Jun-80	215000	Multifunction (Scan/Slow/Still)
NV-3300	Nov-80	168000	
NV-3700	Mar-81	298000	Wireless Remote Control/Stereo
NV-3200	Jul-81	198000	Portable
NV-1000	Nov-81	350000	4-head/Clean Still/Reverse/Stereo
NV-700	Nov-81	229000	4-head/Clean Still
NV-310	Dec-81	163000	
NV-710	Feb-82	244000	4-head
NV-100	Feb-82	178000	Portable
NV-350	Jun-82	169000	
NV-300	Aug-82	139800	
NV-200	Aug-82	163000	Portable
NV-750	Sep-82	229800	4-head
NV-600	Feb-83	169800	3-head
NV-150	Feb-83	189800	Portable
NV-330	Mar-83	149800	3-head
NV-800	May-83	289800	Hi-Fi/4-head
NV-370	Aug-83	132800	3-head
NV-850HD	Oct-83	239800	Hi-Fi/4-head
NV-630	Nov-83	169800	
NV-360	Feb-84	123800	
NV-180	Mar-84	189800	Portable/4-head
NV-7700	Mar-84	189800	4-head
NV-270	Aug-84	125000	3-head
NV-870HD	Oct-84	219800	Hi-Fi/4-head
NV-650	Nov-84	169800	4-head
NV-900HD	Jan-85	229800	Hi-Fi/4-head
NV-M1	Jan-85	298000	VHS-Movie
NV-550	Mar-85	139800	
NV-260	May-85	125000	
NV-880HD	Jul-85	189800	Hi-Fi/4-head
NV-660	Sep-85	139800	
NV-U1	Oct-85	100000	
NV-M3	Oct-85	298000	VHS-Movie

Source: Matsushita Electric, cited in [16], p. 84.

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NOTES

1. Betamax is a trademark of the Sony Corporation. VHS is a trademark of the Victor Company of Japan (JVC).

2. A useful discussion of the concept of a dominant design as well as "architectural" variations, which seem to describe VHS and Beta as refinements of the U-Matic, can be found in Henderson and Clark [25].

3. The dates following reference [15] refer to the weekly issue of TV Digest, the leading industry trade journal.

4. JVC committed to supplying Hitachi on an OEM basis although this entailed that a large portion of its production capacity of about 2,000-3,000 units per month would be diverted to that end. This portion would have been significantly smaller for Sony, which, at the time, had a production capacity of more than 7,000 units per month (see [15] 4/21/75).

5. Kokichi Matsuno, message to employees in taking over as JVC President in 1975, and Shizuo Takano, JVC's Video Department manager, both quoted in [2], p.41. Another source giving a similar account of JVC's approach is [18].