The fall of a Silicon Valley icon: Was Apple really Betamax redux?

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Contents

The term "Silicon Valley" has been used to refer to a geographic region, a group of industries, and an archetypal organizational culture. Practices and cognitive frameworks that exemplify "Silicon Valley" have diffused both throughout the region and also to high technology firms around the world. This diffusion has been both direct through employee mobility and indirectly through mass media coverage of the region, industries and culture.

These diffusion patterns have been defined by the Valley's exemplary companies. One of the region's earliest technology companies, Hewlett-Packard, provided a corporate culture for all to imitate. Meanwhile, in the 1950s and 1960s, semiconductor companies like Fairchild and Intel gave "Silicon Valley" its name and started the process of venture-funded spin-offs that continues to this day (Rogers and Larsen 1984; Morris & Ferguson 1993; Kenney 2000).

But the valley remained little more than a geographic region, invisible to the rest of the world, until the personal computer revolution of the 1970s. A local company, Apple Computer, became both the face of the PC revolution and Silicon Valley's first global icon. Apple was the earliest and most successful of the Valley's first-generation PC companies, and, in fact, the only one to survive the end of the 8-bit era. However, in the 1990s, Apple was eclipsed by Compaq, Dell and others, entering a long period of relative (and absolute) decline that many interpreted as a terminal slide.

The accepted explanation for Apple's decline is that its Macintosh was "another Betamax." To wit, the failure to license its technology consigned the Macintosh standard to a small share, and, through the lack of software, sealed its inevitable decline. Under this explanation, the fall of Apple is an exemplar for the positive feedback model of network externalities mediated by a supply of complementary assets (Shapiro & Varian 1999; Ferguson 1999).

But is it this simple? Or would a more nuanced examination of the company's fortunes suggest other explanations? In particular did Apple's pre-occupation with the Betamax allegorical tale keep it from finding a viable niche strategy until it had dissipated more than a billion R&D dollars and the majority of its market share?

The paper first reviews the Betamax-derived theories of network-based industry competition that, according to received wisdom, explain Apple's fate. It then examines the evidence for four possible explanations for Apple's fall: its failure to license its technology, its premium pricing strategy, errors in its product strategies/execution, and poor operational efficiency. It also presents Apple's contemporaneous fears that making the Macintosh standard ubiquitous (as IBM had done with the IBM PC) would not necessarily translate into company success.

The paper concludes by showing how a more skeptical reading of the accepted "Betamax" wisdom might affect the strategies of other firms engaged in I.T. standards competition.

Accepted Wisdom on Standards Competition

The accepted theoretical wisdom is that *de facto* information technology compatibility standards competition is a "winner take all" battle driven by two forces, positive network externalities and switching costs (e.g. Katz & Shapiro 1985; Morris & Ferguson 1993; Arthur 1996). While such Betamax-derived theories are widely accepted, there have been a few criticisms of the empirical evidence and the theories themselves (Liebowitz & Margolis 1999).

Positive-Feedback Models

The concept of positive consumption externalities for networks of users was originally developed for physical communication networks, in which "the utility that a subscriber derives from a communications service increases as others join the system" (Rohlfs 1974: 16). Examples of such networks include telephones, telexes, fax machines and e-mail systems. Katz & Shapiro (1985) extended this to the more abstract concept of a "network," in which only one of three categories corresponds to Rohlfs' (1974) physical networks.

Katz & Shapiro (1985) identified another category of goods, those that conform to a "hardware-software paradigm," in which buyers of a type of hardware (e.g. VCR) require specialized software (pre-recorded video tapes). When hardware makers rely on outside suppliers of software (rather than their own subsidiaries), then the larger the number of hardware users, the more attractive that market is to software makers to produce the specialized software. Then, the leading standard enjoys demand-side economies of scale, where every new adopter increases its advantage over rivals. Eventually producers shift to making products compatible with the dominant standard rather than sticking with an incompatible losing standard (Katz & Shapiro 1985, 1986, 1994; Farrell & Saloner 1985, 1986; Teece 1986; Besen and Farrell 1994).

A related stream of standards research examines the effect of asymmetric switching costs upon adopter decisions (David 1985; Beggs & Klemperer 1992). If intra-standard adoption of successive generations of products is less expensive than inter-standard adoptions, customers tend to "lock in" to one standard, as Greenstein (1993) demonstrated with U.S. mainframe computer purchases. New adopters are presumed to calculate the net present value of a prospective switching cost, decreasing the attractiveness of a flagging standard that might eventually disappear.

This is one reason researchers have concluded that the combination of network externalities and switching costs lead to the "tipping" of the standards contest (Farrell & Saloner 1986; Arthur 1996; Katz & Shapiro 1994; Shapiro and Varian 1999). Specifically, the theories make a strong and unambiguous prediction that, *ceteris paribus*, a virtuous cycle will inevitably "tip" a standard contest in favor of the leader, consigning the trailing standard(s) to market pressures that irrevocably force its share to zero (Arthur 1989; West 1999).

The most often cited example of such a tippy standards battle is that of VHS vs. Betamax (Cusumano et al 1992).[1] And whether directly through the VCR wars or indirectly through academic theories of positive network externalities, this winner-take-all, positive feedback model has driven standards-related decisions by adopters and producers (West 1999). For more than a decade, producers developed aggressive strategies to improve the actual supply of software, by courting software developers and using a penetration pricing strategy to quickly establish a market share lead that would attract developers. Producers have also sought to influence the perception of software availability and market share (truthfully or otherwise) to attract both users and producers of complementary assets. Adopters have sought to reduce their likelihood of adopting a losing standard (and paying the concomitant switching costs) by handicapping standards battles based on the availability of software and perceived market share.

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[1] Note that Liebowitz & Margolis (1994, 1999) question the premise of Betamax story — that a superior product was doomed due to lack of software — citing the format's inadequate recording capacity for time-shifting.

Limitations

Such research makes very strong predictions about the strength of network effects. Katz & Shapiro (1986: 824) assert that "the dynamics of industries subject to network externalities are fundamentally different from those of conventional industries." These models are based on strong assumptions that are questioned by other research:

- **software variety maximization:** The assumption is that more adopters leads to more software variety, and more software variety is valued by users. In their pioneering model of network externalities, Katz & Shapiro predicted positive feedback in the PC standards adoption decisions

> "…because the amount and variety of software that will be supplied for use with a given computer will be an increasing function of the number of hardware units that have been sold" (Katz & Shapiro 1985: 424).

This assumption of software variety maximization by buyers is either explicit (e.g., Besen & Farrell 1994) or implicit (Katz & Shapiro 1992) in all subsequent models predicting positive network effects and tipping for *de facto* standards contests.

But is software variety maximization important for all standards contests? Other durable goods require specialized complementary assets (Teece 1986), but differences in variety of add-on complements does not play a significant role in the selection of many other categories of durable goods. West (1999) argues the variety maximization assumption is an overgeneralization of the VCR case where unique software is regularly "consumed", but is not applicable to classes of goods where users will satisfice to a minimum level of available software.

- **adequate foresight** assumes that adopters can adequately anticipate future standards sales. For example, Katz & Shapiro (1985: 426) write

> "[A]n individual's consumption benefits will depend on the future size of the relevant networks. Consumers will base their purchase decision on *expected* network sizes."

Is this a realistic assumption for utility-maximizing consumers? Garud et al (1997) have shown that even industry professionals have limited foresight in situations of high ambiguity such as during radical technological change, so it seems a stretch to expect accurate prognostication by even the most enthusiastic early adopter.

Empirical research that directly tests such theories has been rare. As one proponent wrote:

> "Network effects, and demand-side economies of scale more generally, have been shown *in theory* to have implications for a variety of activities … There have not, however, been any attempts to test econometrically for the effects of networks on these phenomena" (Saloner & Shepard 1995: 479).

Liebowitz & Margolis (1990, 1994, 1999) have asserted that these limitations mean that the theories are unproved and, in fact, demonstrably false. Others have questioned whether there are unidentified moderators, which determine whether or not network effects will apply to a given standard or standards competition (Shapiro & Varian 1999; West 1999). For example, West & Dedrick (2000) show that the cost advantage of the late-arriving PC standard in Japan helped it displace an incumbent, despite the latter's established software libraries and market share.

"Cloning" and Related Explanations for Apple's Decline

Founded in 1977, Apple was the most successful manufacturer of the 8-bit PC era (1975-1981). Its Apple II became the standard in U.S. K-12 education and was also long popular with home users. But the 1981 introduction of the IBM PC effectively ended business demand for 8-bit computers, leading to the inevitable decline of Apple's original product line.

After several false starts, with its 1984 introduction of the Macintosh Apple designed a successful 16-bit PC to compete with IBM. The Mac was immediately recognized as incorporating breakthrough technology, most notably being the first with a graphical user interface for mass market PC buyers. Given the unique capabilities of the Macintosh in its first few years, Apple had the option of commanding a large price premium for its highly differentiated product — which it exploited. Despite the premium pricing strategy, the company's revenues and market share both grew in the late 1980s and early 1990s (Figure 1). However, from 1995-1998 Apple suffered from a plunge in revenues and market share that was widely expected to be fatal.

The conventional wisdom is that Apple's fall stemmed from its unwillingness to allow other firms to clone the Macintosh, which would have increased the popularity of the Macintosh platform and thus primed the pump of the positive-feedback model.[2] For example, a profile of the company by a leading financial newspaper recently wrote:

> If Apple had licensed Mac software to other computer makers in the late 1980s, it would have cut the generous gross margins the company enjoyed on Mac sales — but it also would have created a huge market for cheap Mac clones, driving Apple's market share sharply higher and letting what nearly everyone agrees was a superior machine duke it out with the PC.
>
> For whatever reason — arrogance, perfectionism, timidity, technical hurdles — Apple never did that. Instead, dozens of PC clone makers made cheap machines and delivered the keys to the computing world to Microsoft. Apple, meanwhile, continued to talk about how it was creating a computer for "the rest of us," even though that computer was much more expensive than the other choices the rest of us were offered (*WSJ.com,* 2001).

Such analysis — both contemporaneously and retrospectively — made causal predictions linking cloning to lower prices, lower prices to higher market share, higher market share to more software availability, which in turn would further increase market share; cloning was also expected to improve the variety of hardware (Figure 2).

According to this argument, Apple could be successful if and only if it aggressively

[2] The term "platform" is customarily used in the computer industry to refer to an architecture of related standards, on which complementary assets such as software can be built (Morris & Ferguson 1993; West & Dedrick 2000).

licensed its technology to competitors. Such licensing would "prime the pump" of adoption, which through the positive feedback model would assure Apple of an adequate supply of complementary assets and future survival.

The remainder of this section uses this causal chain as a framework to consider Apple's strategies from 1984 to 2000, the options available at the time, decisions made and their outcomes. As an alternative to the cloning hypothesis, it considers independently the effect of Apple's premium pricing strategy; the following section contrasts these explanations with more prosaic problems in the company's tactics and execution.

To Clone or Not to Clone

Both inside and outside Apple, the key question of facing Apple in the late 1980s and early 1990s was the whether it should license its technology to other PC makers. The question divided Apple from its developers and users, as well as groups within Apple. Some within and outside Apple felt that Apple needed to make the Macintosh platform ubiquitous to assure an adequate supply of software. Otherwise, they feared, the Mac would repeat the same death spiral of declining software and share that had doomed the Betamax.

The controversy focused on two issues: whether Apple should let other firms make Macintosh "clones," and, if so, whether in fact the company should exit the hardware business entirely and become a software-only company to compete with Microsoft. The presumption was that having more than one company make Mac-compatible computers — as on the IBM PC side — would expand the total sales of the Macintosh platform, its share of the overall PC market, and also its supply of complementary assets such as software. Against this, others argued that Apple could expand market share without licensing if it reduced prices and gross profit margins.

While the software-only option was very popular with external analysts, there is little evidence that it won serious consideration within Apple due the wrenching changes required. However, the internal debate among Apple executives (and with third party partners) over whether to license clone makers wracked Apple from 1985-1994 (Carlton 1997a; Linzmeyer 1999; Malone 1999).

Arguments for and Against Cloning

The cloning option was broached in a then-secret June 1985 memo to CEO John Sculley from Microsoft CEO Bill Gates. From the success of the Apple II and IBM PC, Gates anticipated the as yet unpublished theories of positive network externalities when he wrote:

> As the independent investment in a "standard" architectures grows, so does the momentum for that architecture. The industry has reached the point where it is now impossible for Apple to create a standard of their innovative technology without support from, and the resulting credibility of, other personal computer manufacturers (Carlton 1997a: 40-41).

Gates also contacted two PC makers, HP and AT&T, and relayed their interest in cloning to Apple.

While Apple did not follow through on Gates' proposal, it marked the beginning of the cloning debate both inside and outside Apple (Table 1). Co-founder Steve Jobs later described 1988-1992 as the "golden window of opportunity [for Apple] to license its Macintosh operating system software" (*MacWEEK.com,* 1997).

Many industry analysts and trade journal reporters had backed clones for many years (e.g., Davis 1988). Those with a direct financial interest, not surprisingly, strongly backed licensing. This included producers of co-specialized assets (such as software and

magazines) who would enjoy a larger potential market if, by licensing, Apple expanded the number of Macintosh computer buyers. Also supporting licensing were users, who anticipated greater variety or lower prices brought on by increased competition.

All of the arguments for cloning were premised on increasing the market share for the Macintosh platform. As late as 1994, the pro-licensing camp projected that the standard would need at least 20% of the global PC market to maintain the Macintosh as a viable platform. One of the most forceful advocates was then-CFO Joseph Graziano, who backed cloning:

> If you are asking, What does the Macintosh platform share have to be to be a sustainable business proposition? — which I think is the big strategic question — then I think that it has to be well over 20 percent. … That doesn't mean that it has to be all Apple. That's where this licensing thing comes in (Lach 1994).

However, there were real concerns about the economic feasibility of allowing clones. Those opposed to licensing contended that there was no guarantee that expanding the market for the platform would make up for Apple's smaller share of that market. In particular, they noted that the OS sales accounted for a small proportion of the PC revenues, and that without hardware sales it would not have the revenues and profits it needed to support its R&D (Carlton 1997a: 50-53). Through 1996, Apple's R&D intensity (R&D/sales ratio) was twice that of Compaq and roughly four times that Dell Computer, the two other major PC-only companies.

Some Apple execs worried that by splitting the Mac market with rivals, they would be unable to profit from a shared standard: from 1986 onward, they need only witness IBM's ever-smaller minority share of the "IBM compatible" market. There would also be questions whether other PC makers would be willing to depend on a PC rival for their essential technology, as IBM found trying to license OS/2 (Grove 1996: 48). Both factors proved major problems during Apple's brief 1994-7 cloning era.

Finally, others doubted that even with cloning Apple would made significant inroads into the market share of Microsoft's operating system — particularly after the 1990 introduction of Windows 3.0. To Graziano's 20% market share goal, analyst Jonathan Seybold replied "It is really, really difficult to find a scenario where Apple gets even 20 percent" (Lach 1994).

After the "golden window of opportunity" had closed, in late 1994 Apple started licensing new PC entrants to make clones, and the first clones were sold beginning in May 1995.[3] Although Apple refused to license strong competitors such as Gateway 2000, within two years the clones captured about 20% of the Mac market. In the summer of 1997, Apple unilaterally ended cloning, buying out the largest clone maker. Acting CEO Steve Jobs justified the decision by the failure of clones to attract new users and a net decline in overall Mac unit sales during the period clones were sold (*MacWEEK.com,* 1997).

The OS Focus Strategy

Some had proposed that Apple should spin-off its hardware business to become a software-only company analogous to Microsoft. To support this, they noted that Apple's differentiation (particularly since 1984) had come from its software, and that hardware itself was rapidly becoming a commodity. A second argument pointed to

[3] The most successful licensee was a startup clone-maker, Power Computing. Other licensees included small makers of computer peripherals, and larger companies (Motorola and Pioneer) that had not entered the PC market during its first two decades.

the potential conflicts of selling operating system to rival PC makers while Apple continued to make PCs.

Related to such arguments were theories of industry transformation advanced beginning in the early 1990s. Successful firms in the computer industry in the period 1964-1981 had been vertically integrated makers of proprietary systems, typified by IBM, Digital Equipment and Apple. However, since the emergence of the IBM PC, the most successful computer companies had been those who adopted high-volume, low-cost standardized components that they shared with their rivals. Similarly, to achieve economies of scale and thus reduce unit costs, suppliers of components and operating systems needed to make their standards ubiquitous, including avoiding conflicts with potential customers (Morris & Ferguson 1993; Grove 1996; Moschella 1997).

To give Apple more options to become a software-only company, and to allow the combined Macintosh platform to enjoy the economies of scale already enjoyed by the vast majority of the PC industry, many had suggested that Apple must adapt its operating system to work on the same Intel-based hardware as used by the rival MS-DOS and Windows operating systems. In a videotaped 1992 speaking appearance, CEO John Sculley told a group of business executives:

> I wish we had started moving our technology to the Intel processor years ago so we had more options. Because most of the industry is taking advantage of the tremendous price drops that are going on the Intel world, and we can't because we're not on it, and it's very difficult to move our technology over to that processor very quickly. So I wish we had that option, which we don't. 'Cause we could have come out and done a Windows, and that would be very … you could build a whole company around that (Yoffie 1992).

Sculley and other Apple executives appear to have for many years overestimated the difficulty of moving the technology to Intel-based chips, as later that same month a small team of engineers began a project to get the Mac OS running on Intel-based technology. After three months they had a working prototype, but the project was abandoned when its internal sponsor left Apple (Carlton 1997a: 170-171).

But, technical issues aside, the shift from being an integrated computer company would have been traumatic due to sheer differences in scale. In 1988, at the beginning of the "golden window of opportunity," Apple had revenues more than 6x as large as Microsoft and net profits 3x as large. This allowed it to sustain a larger R&D budget than Microsoft until 1994; if it were a software-only company with the second most popular OS, it would have had a far smaller R&D budget than Microsoft during this period.

Also, by being vertically integrated, Apple had been able to make sure that products were available to showcase its technologies. The history of computer industry shows that those firms dropping hardware to concentrate on software — Novell, Daisy Systems, NeXT and Palm — must first produce an integrated product to establish their platform standard with a large market share. Such share both provides sufficient scale to support a software-only company and also enough demand by hardware firms to support the software. Despite highly visible technological differentiation, NeXT failed to grow after its 1993 decision to exit the hardware business.

Appropriating Success from the Standard

Another key question is if Apple were licensing to others, whether it would be able to profit from its technological innovation. In a general sense, such profit depends on

both the legal protectability of an innovation, as well as how much an innovator must share economically with suppliers, customers and developers of complementary assets (Teece 1986).

Apple was known for being aggressive in maximizing its share of the profits from its innovation. The 1983 Lisa (an unsuccessful high-priced predecessor to the Mac) had included a complete suite of business applications, forestalling the need for many third-party packages. With the Macintosh Apple aggressively courted third-party software developers, but waited three years before it openly embraced suppliers of complementary hardware peripherals such as printers and expansion cards.

Apple succeeded in appropriating the returns from its Macintosh standard, where IBM did not. IBM had used its mainframe computer-derived reputation to establish a PC standard, but by 1988 it was playing an ever-declining role in the "IBM PC" compatible market (Moschella 1997). In purchasing its processor and operating system from outside vendors IBM knew it was enabling rivals, but had expected to prevent 100% compatible computers by copyrighting the software ROM chips embedded in its systems. However, a series of court rulings allowed rivals to make "clones" if they followed specified procedures in designing the ROMs for competing systems, eliminating any legal barriers that might protect IBM and its innovation from direct competition.

Apple would not face the same risk, because as the operating system vendor, Apple enjoyed superior *de jure* and *de facto* protections against imitation. However, from a business standpoint Apple's hardware division (if still integrated) might have had difficulty competing with clone makers, and Apple would have faced practical limits on how much it could charge clone makers for its software to pay for the required R&D. Both turned into actual problems for Apple when clones were sold from 1995 to 1997: its hardware did have difficulty competing, and it was eventually unable to convince clone makers to pay the OS royalties it sought to support R&D.

Pricing and Market Share Strategies

With or without cloning, Apple's pricing strategy had a major impact on its market share. Its choices were a high-price strategy that maximized profitability, or a high-volume strategy that would produce higher revenues, economies of scale, and, it was hoped, higher gross profits. Licensing competitors to clone the Mac would have increased competition and thus reduced hardware profit margins, but Apple could have chosen to unilaterally initiate its own price reductions. So while a high priced strategy ultimately lowered market share, an absence of cloning was not inherently a low-share, cream-skimming strategy — even though this is the approach Apple adopted from 1984-1990.

In its initial 1979 plans, Apple had intended the Macintosh as a mass-market consumer appliance priced at $500. When the designers switched to a 16-bit processor and added a built-in display, the price shot up to $1,500. In 1983, the eventual design had a cost of goods of $500 per unit, which under standard Apple markups would be sold for $1,995. However, to support a $15 million product launch advertising campaign, new CEO John Sculley argued for a price of $2,495 (Linzmayer 1999: 67-76). Sculley's strategy won, in part, because it would not cost any sales — Apple knew it would be unable to manufacture enough computers to meet demand for the first six months (Sculley 1987: 170).

Upon its January 1984 introduction, the Mac won rave reviews for its innovative graphics and user interface, but with limited utility (no color, hard disk, few applications) few were willing to pay $2,500 for a product derided by many as a "toy." Thus Apple sold only 250,000 of the 450,000 units

originally forecast for 1984, and 45% of these were discounted sales to universities and software developers (Kawasaki 1990: 20-21). So instead of seeking to capture the mass market as originally conceived, Apple used its unique differentiation to support a premium price niche strategy that emphasized profits over market share.

Software developers, industry analysts, users and many Apple employees argued that a lower priced product line would increase Apple's market size and thus its total profits. But from 1987-1989, they were overridden by top executives, who often pointed to Apple's high R&D expenses compared to those of MS-DOS based PC makers like Compaq. At times, the resistance of key executives to cutting prices came across as arrogance, as when R&D head Jean-Louis Gasée said "We don't want to castrate our computers to make them inexpensive … We make Hondas, we don't make Yugos" (Levy 1994: 233; Carlton 1997a). With increasing memory prices and overhead costs and seeking to increase gross profit margins from 51% to 55%, in the fall of 1988 Apple raised prices up to 29% — unprecedented in an industry which had grown accustomed to annual price cuts for constant performance. Apple eventually reversed its price increase, but sales plummeted in the crucial Christmas quarter (Carlton 1997a: 79-81).

In 1989, severely chastened and with a new CFO, Apple abandoned profit margins to chase market share, privately seeking to raise its global PC share from 7.5% to 10.5%. A combination of administrative cost cutting and more aggressive product design allowed it in October 1990 to release a family of lower-cost products, including its first sub-$1,000 Macintosh — bringing it to rough price parity with top-tier MS-DOS rivals (Carlton 1997a: 135-142).

As for market share, after the Apple II faded away in the late 1980s, Apple's share of the global PC market (as driven by Macintosh sales alone) never reached 10% of the units sold according to IDC and Dataquest estimates. In the U.S., its unit share stayed above 10% from 1985 onward, peaking in 1993 at around 14%. In dollar volume, McKinsey credits Apple's higher priced PCs as claiming 9.9%-10.1% of the market in 1988-1991 (and 1994), and more than 11% of the market in 1992-1993 (e.g., see McKinsey 1994).

Apple's Positive-Feedback Downward Spiral

Arguments for both the cloning or low price strategies were framed in terms of increased market share that would assure a greater supply of complementary assets. As the editor of one Macintosh-specific computer magazine wrote:

> The most important potential benefit of Mac clones would be the proliferation of great software, which would increase to accommodate a larger installed base of computers. developers would have many more machines for which to sell their software, thus enjoying increased revenue and being able to reinvest more money into producing even better software. Better software is not only great for us computer users, but it is also what will keep the Macintosh ahead of the competition in the long run (Davis 1988).

Instead, through fiscal year 1990, Apple forbade clones and kept profit margins high, limiting its market share. By the time it changed both strategies, it was already facing pressure from declining industry prices and the rise of Windows as a rival user interface.

The virtuous positive feedback cycle predicted by Arthur (1996) to accrue to a winning standard becomes a vicious self-reinforcing cycle for a standards loser. After the release of Windows 95 — which

eliminated Apple's perceived ease-of-use advantage — Apple faced a downward spiral of bad news:

- plummeting market share worldwide and in key markets 1996 and 1997, from a 1993 US high of 14% to less than 5%;
- losses in fiscal 1996 and 1997 totaling nearly $2 billion;
- delays and cancellations of development projects for its long-awaited next-generation operating system;
- the forced resignation of Apple CEOs in January 1996 and July 1997.

The bad news brought a demonstrable reduction in the available third-party software. While the Macintosh began the decade with far more menu-driven, GUI-based software packages than Windows, the advent of Windows 3.1 and Window 95 attracted a wide range of packages. Meanwhile, from 1997 onward, many third-party software developers either cut spending on future Macintosh versions or withdrew from the Mac market entirely to concentrate on developing Windows software.

Are Network Externalities the Explanation?

The collapse of Apple's sales from 1995 to 1997 fits the textbook example of a "bandwagon" effect. However, the software-mediated positive network externalities model is but one example of such effects (Farrell and Saloner 1985). In retrospect, it appears that the self-reinforcing nature of the bad news was as much psychological as economic; the decisions of computer buyers and third party software developers were driven more by the trend in Apple's market share and profits than the actual level. In particular, both groups (fueled by the press) reacted to the Apple's expected future market share and the increasing doubts about Apple's survival. When the market share leveled out from 1997-2000 at 1997 levels, a limited number of Mac users and developers who defected during the 1996-1997 collapse returned (e.g. Alsop 2001).

Also, despite the inexorable decline of Macintosh market share, it did not exactly emulate the Betamax pattern. The Beta format was actually introduced a year ahead of its VHS rival and held 100% of the market (Cusumano et al 1992); by comparison, the Mac was more than two years behind the IBM PC and never held more than 20% share, even in the U.S.. The U.S. share of Beta format fell continuously from 85% to 1% in 11 years (Redmond 1991). Meanwhile, 15 years after its introduction, from 1997-2000 the Macintosh maintained a stable level of about 4% in the U.S. and 3% worldwide. One possible explanation is that the VCR utility model is tied to novelty seeking and the consumption of new complementary assets — as compared to computer users, who generally require a small but stable supply of complementary assets (West 1999).

So while many of the mechanisms that eliminated the Betamax VCR also hurt the Macintosh, the VCR-derived theories seem inadequate to explain all the result. If falling behind in a standards war is not inevitably fatal, then perhaps it is relevant to examine some of the other strategic and operational decisions made by Apple during the relevant period.

Simpler Explanations for Apple's Fall

Strategic Errors

Over the past decade, criticisms of Apple's strategy have focused on the licensing debate or (to a lesser extent) its pricing policies. But, as one author observed, "the company's fundamental problem was its dearth of effective leadership almost from the outset" (Carlton 1997b). Apple had an opportunity to differentiate itself and establish a solid market position prior to the introduction of Windows 95, but was unable to do so

because of weak leadership in the Sculley era, and rapid turnover after his departure (Table 2).

Resources Squandered on Failed Diversification Efforts

The belief within Apple (and the industry) that Apple was doomed to follow the "Betamax" model created tremendous pressures on the company, pressures that at times created strategic paralysis within the company and other times sent it far afield in search of the "next big thing."

As co-founder Steve Jobs wrote employees in a memo justifying the buying out the license of Apple's largest cloner:

> It is widely believed that Apple missed a golden window of opportunity to license its Macintosh operating system software to clone manufacturers in the 1988 -1992 time frame, and that, had Apple done so, today the Mac OS might rival Windows as the personal computer operating system standard. We will never know. Unfortunately, the perception that Apple missed such a huge opportunity has haunted the company ever since, and finally drove Apple to make the poor business decisions resulting in the existing Mac OS licenses (*MacWEEK.com,* 1997).

Convinced that they had "lost" the PC standards battle, Apple executives pursued an aggressive and risky product development strategy — attempting both to leapfrog operating system software, and to diversify out of PCs. Both strategies were failures.

The company's technological advantage withered away as it focused on radical innovations (which were subsequently abandoned) rather than incremental improvements to its core technology. Apple incurred tremendous self-inflicted opportunity costs, as it squandered money and technological talent on colossal failures (Taligent, Kaleida, Newton, PowerTalk, QuickDraw GX, Copland, OpenDoc, CyberDog) which far overshadowed its modest successes (QuickTime, PowerPC, System 7). Carlton (1997a: 86) estimated engineering expenditures during 1987-1997 for canceled or failed technologies totaled $1.5 billion.

In its diversification efforts, Apple stumbled on one potential success when in 1991 Sculley began promoting the personal digital assistant (PDA). But the Newton, introduced in August 1993, failed in the market as Apple refused to compromise on its original vision. Instead, the smaller, simpler and cheaper Palm was released in April 1996 and captured the majority of the market, leading to the February 1998 termination of the Newton.

Shopping the Company, Not Solving its Problems

A major source of strategic indecision for Apple was its ongoing attempts at mergers and acquisitions. After turning down opportunities to buy Compaq (1984) and Sun (1985), the efforts by Sculley (and later Spindler) concentrated on selling Apple to a Fortune 500 parent. At the same time, long-term fixes were deferred for a decade as both men focused on selling the company, and Apple's board extended their respective tenures in the futile hope that they would soon conclude a deal. The effects became particularly acute from 1993-1996, when negotiations reached a fever pitch.

The attempts to sell Apple were potentially damaging with its existing customers, given that the future of the Macintosh and its users under a potential acquirer was far from certain. Apple succeeded in keeping the negotiations largely secret, before Spindler's desperate efforts to find a buyer became highly public shortly before being fired in January 1996.

With lifelong roots on the East Coast, Sculley had originally viewed his move to California as a temporary one lasting no more than five years. As that milestone came and went, and the threats to Apple became greater, he increasingly focused on selling the company. In his last two years, Sculley negotiated with both Kodak and AT&T. The Kodak negotiations foundered due to cultural differences, while AT&T pulled back to digest its purchase of NCR and planned purchase of McCaw Communications.

When Sculley was forced out, Spindler took over and won successive offers from IBM, Canon and Philips. The IBM offer marked the high point of nearly 15 years of merger efforts; in October 1994 IBM offered Apple $40 a share, a slight premium to the market price, but overconfident demands by Apple for $60/share and golden parachutes prompted IBM to break off negotiations.

Three subsequent purchases of Apple also failed. In April 1995, Apple rejected a $54/share buyout offer from Canon at a premium of 50% over the market price. In late 1995, Apple found acceptable a proposed $36/share buyout by Philips Electronics, but the deal was not approved by Philips' board of directors; soon after, Spindler was fired and Apple's days as an independent company appeared numbered. In January 1996, Sun Microsystems made a $23/share offer, at a 27% discount to the market price, which was rejected by Apple's board (Quinlan and Scannell 1996; Schlender 1996; Carlton 1997a: 51-57, 292-298, 355-358; Linzmayer 1999: 184-188; Malone 1999: 346-347).

Weak Products

As Liebowitz & Margolis (1994, 1999) have observed, results in the competition of standardized products are often more simply explained by differences in important product attributes. In its initial years, the Macintosh had major weaknesses when compared to the IBM PC, while in later years its relative ease of use advantage had declined. These two periods bracketed its one period of market share success, from 1991-1993 (Figure 1).

Delays in Supplying Key Features

Despite its many user interface innovations, the Macintosh trailed the IBM PC in the introduction of most other significant hardware innovations (Table 3). These were the innovations that were highly valued by computer users, particularly among business buyers who were more performance-oriented and less price-sensitive than buyers in Apple's two strongest markets, consumers and K-12 education.

As one magazine wrote upon the Mac's initial roll-out: "The engineering is compact and elegant, and the machine is perhaps the first moderately priced computer that is easy to use. But Mac has some drawbacks. It is difficult to expand, has a small memory and does not have a color monitor" (*Time* 1984). Such deficiencies were cited at the time as the major reasons why many firms found the Macintosh not to be a "serious" business computer, despite its ease of use and strength in preparing advertising and technical manuals. Two years later, Apple added hard disk support, but it was not until 1987 that it provided expansions slots and color monitors.

The failure of Apple to address deficiencies relative to the IBM PC were attributed to the strong opinions of the lead product design executives for the Macintosh — first Jobs, then later Jean-Louis Gasée, VP of research & development. Both were unwilling to compromise their vision of an "insanely great" design, no matter how much such perfectionism ignored the utility lost by omitting important features.

Such uncompromising, strong-willed leadership meant Apple was late to portable computing, with its first portable Macintosh coming in 1989, seven years after the first Compaq transportable computer.

Unfortunately, the Macintosh Portable was a huge flop due to its size (too big to use on an airplane) and weight (16 pounds). The delays and failures of Apple's portable computing design efforts were widely attributed to bad decisions made by Gasée, who was fired after the Portable debacle (Carlton 1997a: 104-105; Levy 1994: 256-257).

This illustrates a key point: were Apple's failures (such as in laptops) due to management error, or due to inherent limitations of its go-it-alone strategy? A case could be made for both. On the one hand, under new R&D management Apple eventually developed a successful notebook product line, its 1991 PowerBook series. On the other hand, it should be noted that three early breakthrough MS-DOS portable computers came from three separate companies — which did not include IBM, the inventor of the architecture. In this case, the comparatively open architecture of the IBM PC allowed multiple design centers, which encouraged innovation.

The fact that IBM did not share in the success of this new product category (at least until its 1992 ThinkPad product line) also showed that, in the case of the IBM PC architecture, the success of the architecture did not accrue to the architecture's creator. So while cloning could have improved product offerings for the Macintosh platform, it would not have helped Apple's corporate future.

Declining Product Advantage

Belatedly, Apple recognized that the core of falling sales in the late 1990s was its failure to maintain a perceived advantage over its competition, particularly in the area of ease of use. For the first time, in 1997 its 10-K acknowledged this reality:

> The Company believes that the Mac OS, with its perceived advantages over Windows, and the general reluctance of the Macintosh installed base to incur the costs of switching platforms, have been driving forces behind sales of the Company's personal computer hardware for the past several years. Recent innovations in the Windows platform … have added features to the Windows platform that make the differences between the Mac OS and Microsoft's Windows operating systems less significant. The Company's future consolidated operating results and financial condition is substantially dependent on its ability to maintain continuing improvements on the Macintosh platform in order to maintain perceived functional advantages over competing platforms.

Apple certainly had adequate time to prepare for this challenge. While Windows had been announced in 1983, the first usable implementation was 1990's Windows 3.0, which was widely adopted after the bugs were fixed in the 3.1 release (1991). The Windows 3.1 solution still lacked the technical elegance of the Macintosh, as most users found that the MS-DOS text-only interface was never very far away.

But the long-awaited, and long-delayed Windows 95 was something else. Early technical evaluations correctly predicted that the easier-to-use Windows 95 would give PC compatibles rough parity with the Macintosh. As important as the technical triumph of Windows 95 was the marketing triumph, a testament to Microsoft's new role as the industry leader. Backed by a $200 million marketing campaign, the August 24, 1995 introduction of Windows 95 became the computer industry's largest media event ever (e.g., see Goldberg 1995).

Apple fanatics claimed that the Mac retained an advantage, but it was too minuscule for most new users to notice as the trade press proclaimed the ease-of-use

war now a draw. As one newspaper columnist later noted:

> When Microsoft Corp. introduced Windows 95, Apple enthusiasts gloated, "Windows 95 equals Apple 89." But it was a little like whistling as they passed the graveyard. What they didn't say is that "Apple 95 equals Apple 89, and Apple 96 equals Apple 89," says Dan Kusnetzky, a director with consulting firm International Data Corp. (Browser 1997).

That Apple's 1997 technology was nearly equivalent to its 1991 version could be traced back to the investment of engineering resources in Pink/Taligent, Copland and other new software technologies that were later abandoned. Apple had started several next-generation operating systems that never shipped. In 1988, it split its OS development group into two groups, with the "pink" team attracting the most talented engineers (at least by their own estimation). In 1991, the "pink" team became the core of the Taligent joint venture with IBM, which was killed in 1995 without ever shipping an operating system (Carlton 1997a; Hagedoorn et al 2001).

Around 1994, Apple began development of its "Copland" next-generation operating system that was intended to address the Windows 95 challenge. Two years behind schedule, it was canceled in the summer of 1996, earning it the #2 spot on a list of the century's "10 biggest software flops" (*PC World* 1999). Even if Taligent or Copland had succeeded, both would have required programmers to totally rewrite their applications for new Macs, highly risky because it would render obsolete Apple's existing library of third-party software.[4]

The 1996 purchase of NeXT led to announcement of a "Rhapsody" operating system, but those plans were delayed and scaled back. Finally, Apple announced OS X, which after, several delays, finally shipped in March 2001 — more than a decade after the challenge of Windows 3 and Apple's formation of its "pink" next-generation OS team.

Other Factors

Errors in Execution and Operations

From the beginning, Apple had suffered from a dysfunctional organizational culture that hindered its execution (Moritz 1984; Malone 1999). Within the company, it was expressed by a joke: "What's the difference between Apple and a Boy Scout troop? The Boy Scouts have adult supervision."

Its numerous failures to deliver major OS revisions killed its credibility and support from third-party software developers; as one executive said, "In the last few years it was impossible for any developer to work with them. We couldn't rely on anything they said. … We were absolutely convinced they were going to die" (Kirkpatrick, 1998). In hardware, it was late to enter the laptop segment. While its PowerBook models were eventually successful, they lost momentum after a 1995 fire in one model was caused by a faulty battery.

The company also faced a chronic mismatch of supply and demand, with too few of popular products and bloated inventories of unpopular ones. One reason was that in 1991, the head of Apple's sales laid off five of seven demand forecasters, raising the margin of error from ±5% to ±50% (Carlton 1997a: 329). More generally, until 1997-1999 reorganizations, Apple lagged leading PC makers such as Dell and

[4] The importance of PC application software compatibility is illustrated by the fate of NEC's PC-98. In 1991, the PC-98 platform held nearly 60% of the Japanese PC market but six years later NEC abandoned the standard after Windows rendered obsolete the vast PC-98 software library (West and Dedrick 2000).

Gateway in the management of its inventory and other finances. "The company lost $1 billion in 1997 mainly as a result of asset problems, such as being too long on inventory," said Apple's subsequent senior VP of operations, Tim Cook. "We had five weeks of inventory in the plants, and we were turning inventory 10 times a year" — as contrasted with 40 turns a year for Dell (Bartholomew 1999).

Clearly the Macintosh as a platform was less robust to tactical errors at a single company than was the larger "Wintel" alliance. When top 10 U.S. PC makers such as IBM, Compaq, Packard Bell and AST faltered in their product design efforts during the late 1980s and early 1990s, other companies like Dell and Gateway rushed in to pick up the slack. In these case, sales (or market share) of the individual PC makers fell, but the Windows/Intel standard continued to grow as existing suppliers and customers easily switched their loyalties to rival hardware makers.

Unilateral Strategic Hostage-Taking`

In its role as both a PC maker and an operating system vendor, Apple had an Achilles' heel: its dependence on Microsoft for key technologies. Its Apple II was built around the Basic programming language licensed from Microsoft, while the most popular business software for the Macintosh was sold by Microsoft, and in both cases Apple lacked leverage to prevent unilateral actions by Microsoft.

In the late 1980s, Apple had vested its differentiation hopes versus Windows with intellectual property law, in particular a 1988 lawsuit accusing Microsoft of copying the Macintosh user interface with Windows 2.0. While direction of copyright protection for user interfaces was uncertain (as exemplified by cases such as *Lotus v. Paperback Software*), Apple in the end lost its lawsuit — not on the legal precedents, but on a loophole it left in a 1985 GUI license granted to Microsoft. Microsoft had, in turn, won the license in 1985 as one of the conditions for renewing the Basic license for the Apple II (Carlton 1997a; Linzmayer 1999).

A decade later, in January 1997, Microsoft released its Office 97 for Windows but not for the Macintosh. While Mac users had wrestled with the problem of collaborating with Office 95 co-workers, the problem was exacerbated with the Office 97 file formats, which were not readable on the Macintosh. Individual Mac owners who worked in an increasingly Windows work force also faced this problem, as it became even more difficult to use their home Macintosh to bring work home. In fact, contemporaneous field interviews and press accounts suggested that Macintosh incompatibility with Office 97 was a crucial factor for organizations dropping Mac support throughout 1997. Doubts about the future availability of Office upgrades for the Macintosh plagued Apple until August 1997, when Apple and Microsoft's CEOs jointly announced Microsoft's commitment to develop versions of Office for the Mac (Kawamoto et al 1997). The file format compatibility problems were finally resolved with the March 1998 release of Microsoft Office 98.

Just how crucial Microsoft Office was to Apple's survival was revealed later during the *US v. Microsoft* trial. In November 1998, an Apple executive testified that before the August 1997 agreement, Microsoft threatened to withhold future Macintosh development of Office to gain Apple's cooperation on unrelated standards issues. Barring such cooperation, "Microsoft would take any necessary action to drive Apple out of business," testified Avadis Tevanian, Apple's senior vice president for software engineering. Without this software, Apple's CFO said "we were dead," so Apple felt it had no choice but to agree to Microsoft's terms (Grimaldi 1998; Brinkley 1998).

So two path dependent decisions — the timing of the Apple II Basic license renewal and the emergence of Microsoft as the leading supplier of Macintosh business software — at crucial times left Apple without free rein to pursue its platform competition with Microsoft.

Conclusions

What Explains Apple's Fall?

Based on theories of network externalities, the conventional wisdom is that after refusing to allowing Macintosh clones, Apple's fall was inescapable as gravity itself.

Any *post hoc* analysis is limited by the lack of a true counterfactual, and thus it is impossible to prove what might have happened at Apple given a different strategy. However, the evidence in the preceding sections suggests that Apple's downward path was less inevitable than accepted theory would predict. Even if the theory was partially right but other factors contributed to its decline, then Apple's strategic myopia — obsessed with the cloning debate and with "leapfrog" radical innovation — may have prevented it from improving the execution of its existing standards strategy. When in 1997 Apple accepted that strategy and focused on improving pricing, product development and operations, it quickly stabilized its market share and improved financial performance.

Does the Evidence Support Licensing Theories?

The simple argument — that Apple's decision to forbid clones sealed its fate — subsumes seven causal predictions (Figure 2). Based on Apple's actions from 1984-2000, as well as other industry trends, one can retrospectively judge the accuracy of these linkages:

- *multiple vendors->increased competition* is supported both by the Wintel-based industry experience and also the brief period when Mac clones were available (1995-1997);
- *increased competition->greater hardware variety* is also supported; this greater variety would have improved the Mac's market share for laptop buyers (particularly from 1995-2000) when greater variation was evident in Wintel designs; but significant impact on desktop buyers seems doubtful, given the standardization of the PC dominant design around a few basic features;
- *increased competition->lower prices* is supported, but not the converse: Apple possessed the option to independently lower prices without clones, as its 1990 price cuts and 1998 iMac introduction demonstrated;
- *lower prices->increased market share* is consistently supported by the patterns of the PC industry and related industries such as PC software and handheld computers;
- *increased share->more software->increased share,* the core prediction of network externality theory, is supported during some periods but not others.

The difficulty of such network externality theories explaining Apple's fate is that their strong predictions don't allow for the effect of product differentiation. Against the Macintosh, the IBM PC platform enjoyed a two year head start, larger installed base, and a larger variety of software applications: all should have provided a self-perpetuating positive-feedback loop that (according to theory) would have caused the Mac's share to fall towards zero. Instead, Apple succeeded in improving the worldwide and U.S. market share for the Macintosh through 1993 — through 1995 in Japan against an even larger head start. During this period of increasing market share, the results show that Apple

maintained enough differentiation to be competing in a different market segment from the IBM PC, albeit one that drew from an overlapping pool of potential buyers.

As its differentiation disappeared with Windows 3.1 and Windows 95, then from 1995-1997 Apple faced the self-fueling market share collapse exactly as predicted. But from 1997 onward, Apple has enjoyed an essentially stable share despite a dramatic disadvantage in software variety. This supports the view of West (1999) that PC buyers differ from VCR buyers in the utility they derive from software libraries: in making a standards decision, PC buyers may satisfice to a minimum level of co-specialized complementary assets (web browser, e-mail, word processor, MP3 player) while the VCR buyers of Cusumano et al (1992) consumed complementary assets and thus chose based on maximizing the variety of complementary assets.

Assessing Apple's Strategic Alternatives

Implicit in the cloning argument is the suggestion that Apple Computer would have done better if it had licensed competitors. But this was only one of several options available to Apple during the late 1980s and early 1990s. As noted earlier, the four major options were:

- *licensing Macintosh clones*, and even spinning off PC hardware sales, in hopes of making the Macintosh standard ubiquitous. This would have helped platform sales but, as IBM's experience showed, platform success would not necessarily accrue to the originating company.
- *penetration pricing,* lowering product prices and gross margins towards the same goal, with less market power to promote platform success but more likelihood that any success would accrue to Apple.
- *focus on new product development* rather than long-shot efforts to achieve "next big thing" that could have maintained competitive advantage (or reduced disadvantage) in laptop sales and OS updates, particularly in reducing the impact of Windows 95.
- *improved operational execution,* particularly in product forecasting and supply chain management, would have reduced or eliminated the severe losses of 1996-1997 that shook confidence in the company and fueled the largest round of platform defections.

It should be noted that some of these options might have resulted in a more competitive industry structure and greater consumer welfare — but not necessarily better corporate performance for Apple. With doubts about the survival of Apple and its PC standard, Apple's global market share declined 62% from 1990-2000 (Table 4). With the success of the IBM PC standard guaranteed and IBM's corporate future more assured, IBM's share still dropped 43%.

However, consideration of these four strategic options raises questions about the accepted wisdom that, after losing a PC standards war, Apple's only choice was to do what Sony did and abandon its standard. As Apple's fortunes began to ebb in early 1996, no less an analyst than Bill Gates weighed in on the side of execution rather than network effects:[5]

> Business professors love to talk about strategy, and as Apple has

[5] In 1999, the whole question of whether network effects provide Microsoft an insurmountable lead became the central issue in *U.S. v. Microsoft* (e.g., see Liebowitz and Margolis, 1999). Gates and Microsoft were accused during that trial of exaggerating the strength of the competition provided by Apple and others. But the despite this, there is little reason to suspect Gates was being disingenuous three years earlier in the *Fortune* article, as his response is consistent with the confidence and bluntness of other interviews.

> declined, the basic criticism seems to be that Apple's strategy of doing a unique hardware/software combination was doomed to fail. I disagree. Like all strategies, this one fails if you execute poorly. But the strategy can work if Apple picks its markets and renews the innovation in the Macintosh (Schlender 1996).

Evidence from the Jobs II Era

Apple's improved financial performance success since 1998 suggests that with a clearer strategy and operational focus, Apple's 1990s performance could have been considerably better. Among the changes made by Steve Jobs after he took over in July 1997:

- ended cloning to no longer divide the small Macintosh market with rivals;
- designed and released innovative new product designs, including the iMac and a series of improved laptop computers;
- increased the product run rate to provide economies of scale for internal R&D and independent software developers;
- reduced inventory from more than a month to less than a week;
- developed a new OS X fully upward compatible with its existing OS 9, linked to open software and the installed base of Unix and Linux systems;
- stabilized global market share at around 3% from 1997-2000; and
- achieved three consistently profitable years after the two years of massive losses.[6]

Apple's performance in the Jobs II era suggests that it is not following network externality path to extinction, but instead to a small and stable niche. Is a Macintosh more like a Betamax or a BMW? A *Forbes* reporter was among the first to draw the contrast: "Can Apple continue to survive as a high-end player? In automobiles, BMW does, even though its revenues are only 11% those of General Motors" (Morgenson 1990).

Could the company's fortunes have been turned around before 1997? At this point, it would be difficult to determine whether Apple's 3% share is the size of a niche insensitive to software variety, or whether correcting Apple's operational errors earlier would have stabilized Apple's share at a higher level. Apple's attempts starting in May 2001 to grow share through direct retail distribution were an attempt to prove the latter. Either way, Apple's share stabilized at a fraction of the 20% figure top Apple executives in 1994 predicted would be necessary to support a viable business model.

At the opposite extreme, there is clearly a minimum efficient scale for an R&D intensive company such as operating system developer. As Arthur (1996) predicts, software companies face high fixed R&D costs and low marginal product costs. Thus far Apple has remained above the minimum efficient scale, and its recent use of open source technologies undoubtedly lowers the cost and thus the required scale (West 2003). However, at some point a declining Mac share would bring to an end Apple's attempts to use software innovation to provide differentiation.

Implications for High-Tech Companies

Should Firms Worry About Becoming "Another Betamax"?

The failure of Apple's Macintosh to follow the trajectory of Sony's Betamax into oblivion raises important questions about so-called "old truths" on competitive strategy in network industries.

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[6] In the face of slowing global PC demand and product development delays, Apple reported unprofitable quarters during its 2001 and 2002 fiscal years, but unlike in 1996-1997 its full fiscal years were profitable.

In particular, the predictions of the Betamax-derived theories assume that buyers derive additional utility from each marginal increase in software variety. This is consistent with entertainment that is "consumed", such as movies (rented to watch only once), or video games (which are generally used for a few weeks or months before being abandoned). A slightly weaker form of this prediction is that there are decreasing returns to additional software variety — as for example with general purpose computers, where the most popular software is attractive to a wide audience, but additional packages reach an increasingly smaller niche.

But for other types of goods, a minimum set of software could be adequate — as when a PC is used for Internet access or a handheld computer is used for time and contact management. This pattern would be consistent with the increasing number of special-purpose computer technologies. It would also be consistent with an industry environment driven by cross-platform electronics standards, in which users derive equivalent utility from all products that support a small number of open standards, as with Apple's support for the Internet, MP3 and DVDs.

Finally, the predictions of tipping derived from the supply of co-specialized complementary assets assume that there is a significant cost of supporting multiple standards. This has traditionally been applicable to video games (which maximize performance by closely designing for system characteristics) or for GUI-based business applications (due to a lack of cross-platform programming interfaces). Tipping would not be expected if different platforms can be easily supported with co-specialization that is minor compared to the overall effort — as has been true for Unix workstations since the mid-1980s. Another example is the provision of streaming audio and video content on the Internet, where the cost of producing the master recording is comparatively high, but the cost of converting to multiple formats is very low.[7]

In cases where tipping is not expected, then market share is no longer the *sina qua non* for standardized products, and firms can concentrate on traditional product differentiation, marketing and price leadership strategies. As with non-network industries, such strategies can include niche strategies if such niches are large or munificent enough to be profitable.

More Recent Standards Competitions

Like Apple, the experience of other technology pioneers suggests that market share without innovation is hardly enough. And, as Apple found out, any advantage of share and innovation must be weighed against differences in market power:

Web Browsers. Netscape held a virtual monopoly on graphical web browsers until the 1995 release of Windows 95 and Internet Explorer. Some have attributed the rise of Microsoft's browser to its market power, as when the U.S. government alleged that Microsoft illegally used its OS quasi-monopoly to promote its web browser. Others have contended that Netscape's decline stemmed from its failure to innovate its products, in part due to limitations in its software architecture (Liebowitz & Margolis 1999; Ferguson 1999).

Handheld computers. Palm Computing established an early lead and managed from 1996-2000 to retain the majority of the market despite aggressive licensing by Microsoft. Usage patterns thus far suggest that software complementary assets are relatively unimportant, while most hardware needs would be met by a dozen add-on modules — thus obviating network adoption pressures. While market share for the Palm

[7] The Internet example is different from the traditional retailing of prerecorded music and videos, where considerations and geographically convenient distribution have explain tipping to the more popular standard (Grindley 1995).

OS has since declined, this decline has been attributed more to limitations in OS capabilities and the failure of Palm and licensees to innovate rather than either differences in complementary assets or Microsoft's market power from its desktop Windows OS (LeToq 2001).

Streaming Multimedia. Another innovative startup, Real Networks, established an early lead but was later challenged by Microsoft's Windows Media format. On the one hand, the provision of streaming multimedia from Internet servers to individual clients conforms to the physical networks models of Rohlfs (1974), for which tipping would be expected. On the other hand, the relatively small cost for both content suppliers and consumers to support both standards obviates any strong impetus to tip in favor of either standard. Hence, in 2001 Microsoft developed new strategies to leverage its operating system and web portal position market power to encourage both consumers and producers to favor its format.

Such example of contemporary standards battles suggest that innovation is as important in information technologies as with any technology-driven industry. If there is any benefit to reconsidering the "Betamax" metaphor, it comes from a renewed focus by I.T. firms on establishing and maintaining innovation strategies.

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Tables and Figures

Date	Firm	Status	Reason Apple Killed It
1985	Microsoft	Proposal by Bill Gates	Unknown
1987	Apollo	Contract signed by Apollo	CEO (Sculley) changed his mind
1987	Sony, Tandy	Requested license to GUI	Unknown
1990	Sun	Merger approved by management	Dropped when Apple adopted IBM PowerPC
1992	Intel, Novell	Working prototype of Mac OS on Intel hardware	Product champion left company
1994-1997	Power Computing, Pioneer, Motorola, others	Nearly 500,000 computers sold based on PowerPC chips	Canceled by new CEO (Jobs)
1995	Gateway 2000	Contracts ready for signature	Opposition from Apple sales executives

Sources: Grindley (1995), Carlton (1997a); Linzmeyer (1999); Malone (1999)

Table 1: Proposals for licensing Macintosh technology for other platforms

Who	Joins	Leaves	Title	Period
Mike Markkula	1/77	8/97†	Chairman	1/77-3/81
Steve Jobs	1/77	9/85	Chairman	3/81-4/83
John Sculley	4/83	9/93	President/CEO	4/83-11/87
			Chairman/CEO	11/87-6/93
Michael Spindler	9/80	1/96	CEO	6/93-1/96
Gil Amelio	1/96	7/97	Chairman/CEO	1/96-7/97
Steve Jobs	12/96		Interim CEO	7/97-1/00
			CEO	1/00-

† Removed from board of directors
Sources: Rose (1989), Apple (1995), Carlton (1997a), news reports

Table 2: Chief executives of Apple Computer, Inc. 1977-2000

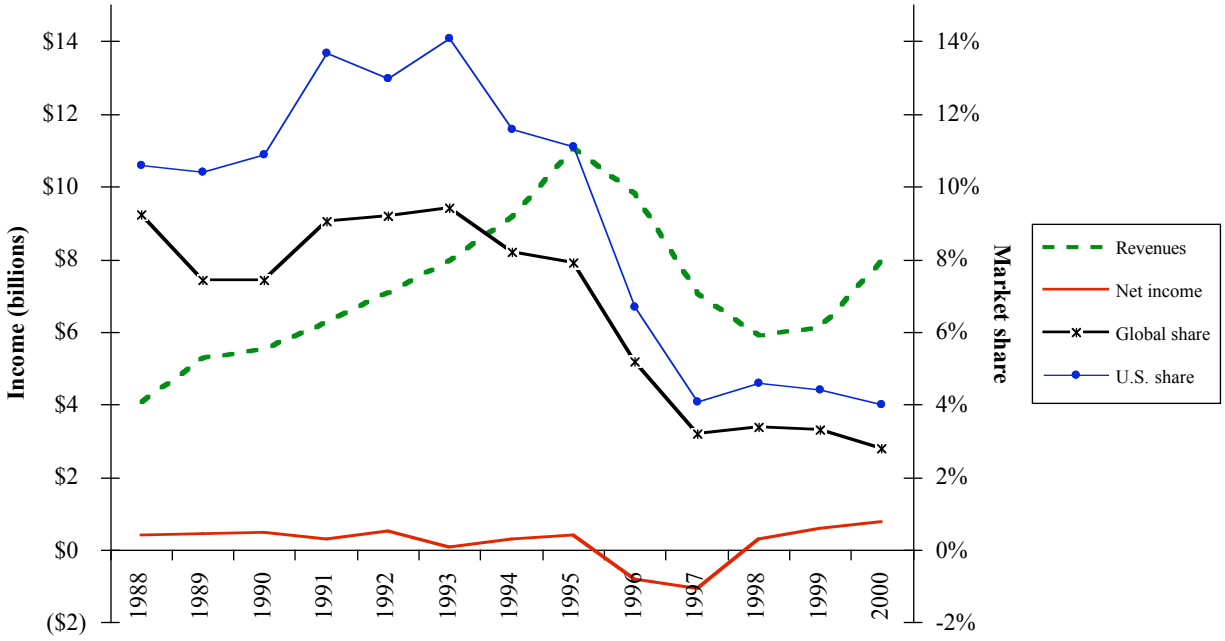
Innovation	IBM PC Compatible	Macintosh	Mac lead/lag
16-bit computer	1981 (IBM PC)	1984 (Macintosh 128)	-3 years
Color computer	1981 (IBM PC)	1987 (Macintosh II)	-6 years
Expansion slots	1981 (IBM PC)	1987 (Macintosh II)	-6 years
Portable PC	1982 (Compaq)	1989 (Macintosh Portable)	-7 years
Hard disk	1983 (IBM XT)	1986 (Macintosh Plus)	-3 years
Laptop PC	1984 (HP-110)	1991 (PowerBook)	-7 years
Graphical user interface	1990-1995 (Windows 3.0,95)	1984 (Macintosh 128)	+6 to +11 years
Mouse	1985 (Microsoft Mouse)	1984 (Macintosh 128)	+1 years
RISC-based CPU	(none)	1994 (Power Macintosh)	n/a
First server OS	1993 (Windows NT)	1999 (OS X Server)	-6 years

Table 3: Introduction of key innovations by competing PC standards

	1990		2000
Company	Share	Company	Share
IBM	11.9%	**Compaq**	12.8%
Apple	7.4%	Dell	10.8%
Commodore	7.1%	HP	7.6%
NEC	5.6%	**IBM**	6.8%
Compaq	3.9%	**NEC**	4.3%
Toshiba	3.7%	Gateway	3.8%
Atari	3.1%		
Epson	2.5%	**Apple**	2.8%
Packard Bell	2.2%		
Olivetti	1.9%		

Source: Dataquest

Table 4: Market share leaders in PC industry, 1990 and 2000



Source: Company annual reports; Dataquest
Note: Revenues and net income for fiscal year ending September 30; market share is calendar year

Figure1: Apple financial performance, 1988-2000

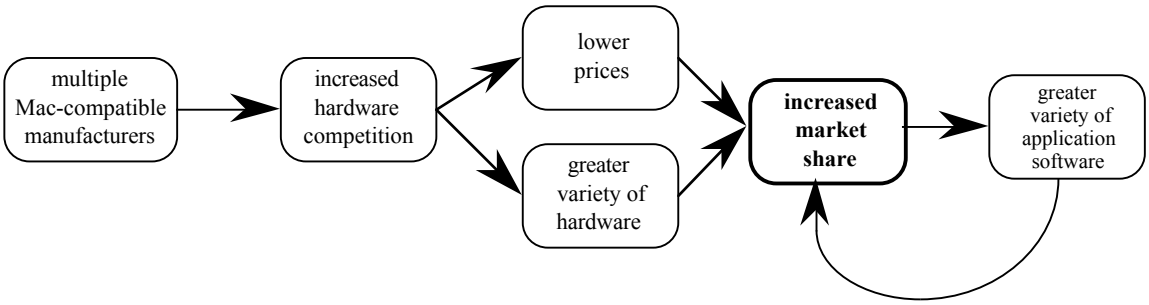
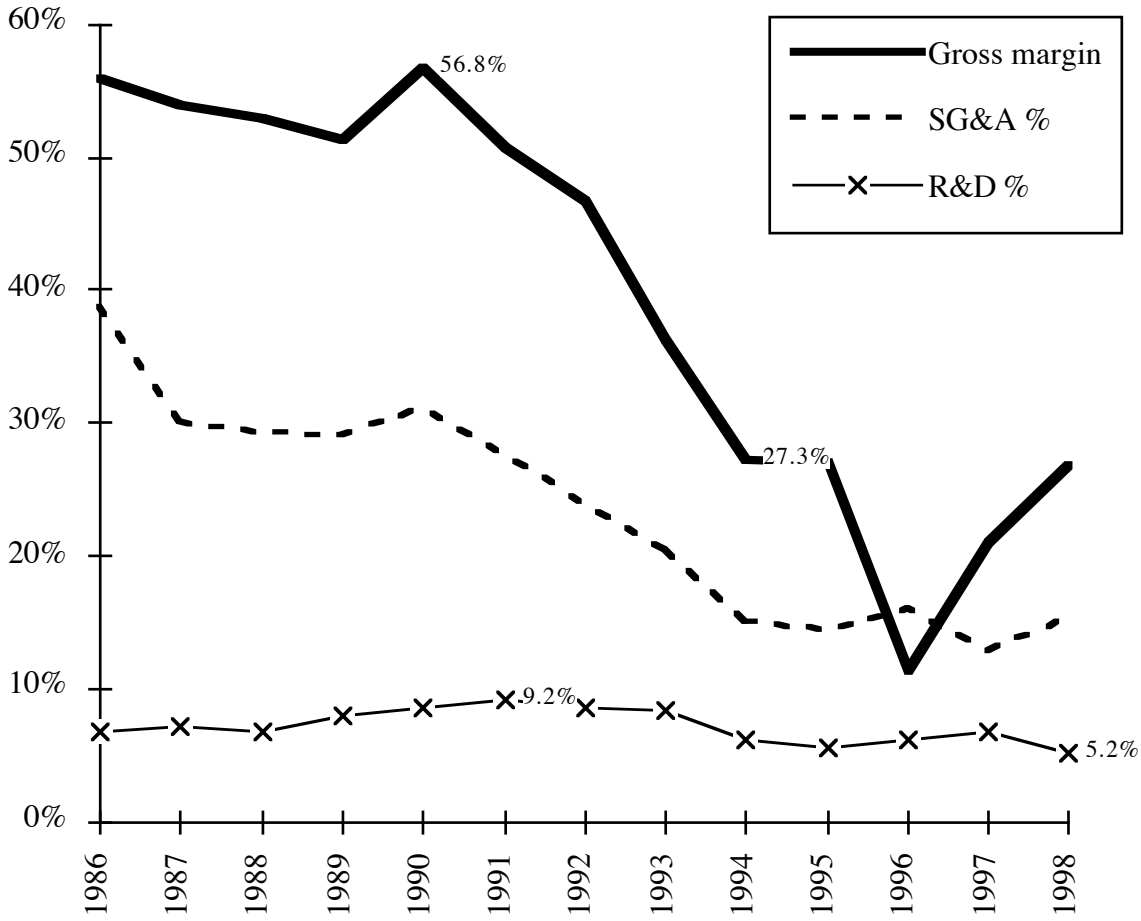


Figure 2: Causal chain of arguments by cloning advocates



Source: CompuStat
Note: In fiscal year 1996, excludes $375 million write-off for discontinued R&D

Figure 3: Changes in key operating ratios, Apple Computer, 1986-1998