

Failures of Large Computer Companies

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Contents

Introduction	3
Apple Computer	4
1 History.....	4
1.1 Early Failures.....	5
1.2 Mid-late 90's failures.....	6
2 Analysis.....	11
2.1 Policy considerations.....	12
Digital Equipment Corporation (DEC)	14
1 Introduction.....	14
2 DEC Matures.....	15
3 DEC Fails.....	16
4 Conclusion.....	17
International Business Machines (IBM)	19
1 Empire Crumbles.....	19
2 Mainframe Myopia.....	19
3 Dominant Design.....	20
4 Company Culture.....	22
5 Independence: won and lost.....	23
6 Conclusion.....	24
7 Notes.....	25
NeXT Software	28
1 Early History.....	28
2 Failure in Hardware.....	29
3 Limited Success in Software.....	30
4 NeXT's Big Break.....	30
5 Final Analysis.....	31
6 Postscript.....	31
7 Notes.....	31
Silicon Graphics (SGI)	33
1 SGI History.....	33
2 Analysis of SGI's Failures.....	34
3 Conclusions from SGI.....	36
Comparison	38
1 Comparison.....	38
1.1 External Forces.....	38
1.2 Internal Forces.....	40
Bibliography	41

Introduction

By studying the history of computer companies that fell from industry-leading positions, we can identify the major reasons that caused these companies to fail and come up with a list of lessons to learn from their mistakes. We chose to analyze Apple Computer, Digital Equipment Corporation (DEC), International Business Machines Corporation (IBM), and Silicon Graphics (SGI), because they were all leaders that fell from glory in their respective markets. In addition we cover NeXT to also add perspective from a small company, trying to survive in markets dominated by large ones. By studying the business decisions, the leadership changes, how well each company reacted to technological changes, and the customer reaction to the company's products, we found similarities in the events that led to failure. People often accuse large companies of being too large and bureaucratic to be able to make quick business shifts, so we also examined how a company's size and culture impedes their ability to prosper in a rapidly evolving market. There are many internal and external factors that can contribute to a company's success or failure, so it is helpful to pinpoint the most important factors that can damage a computer company's business.

Apple Computer

– Archie Russell

1 History

Apple Computer took the world by storm in 1977 with the first successful personal computer, the Apple II. The II was not only the first successful personal computer, it was the first successful computer to have a keyboard and monitor, a form which has come to be synonymous with "computer" to many. The II sold millions of units, making Apple a billion dollar company. That alone would have been remarkable for a company founded by two men in their twenties on a shoestring budget, but in 1983 Apple had another hit with the Macintosh model. The "Mac" was the first successful personal computer with a graphical user interface complete with mouse, windows, menus. Along with the Apple LaserWriter, one of the earliest mass-market Laser Printers, the Mac redefined how a computer should be used, and all personal computers since have worked like the Mac. Unit sales were again, in the millions. At the turn of the decade Apple released a line of attractive, usable laptop computers and again made millions. Apple appeared to be a charmed company; Apple products were innovative in both design and engineering, high quality, and fun to use. Legions of Apple fans drooled over press releases and went to extremes such as tattooing the Apple logo on their bodies in their expression of Apple-philia.

But by the mid 90's Apple was a shadow of its former self. With few exceptions, Apple products had become overpriced and uninspired; the majority of the product line consisted of indistinct rehashes of the 1983 Macintosh, with relatively minor improvements. Competing products beat the Macintosh in performance in almost every dimension save style, typically at a significantly lower price. Apple was no longer a technological leader and struggled to stay afloat as the company lost money in all of 1994, 95, 96, and 97. The first quarter of 1997 marked a nadir, as Apple stock hit a 12-year low of \$4 and the company reported a \$708 million loss. Later that year, Apple's primary competitor, facing antitrust charges, infused Apple with \$150 million to prevent looming disaster[1]. Then, just as the end looked imminent, things turned around. Apple's stock price leveled off as the company began to earn meager profits again.

New, competitive products began to hit store shelves, slowly at first, but by the early 2000s

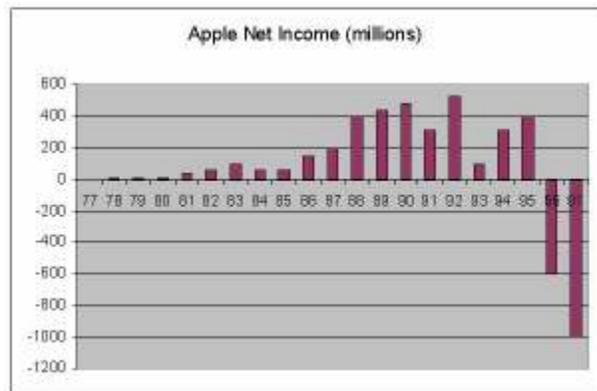


Figure 1 Apple Net Income

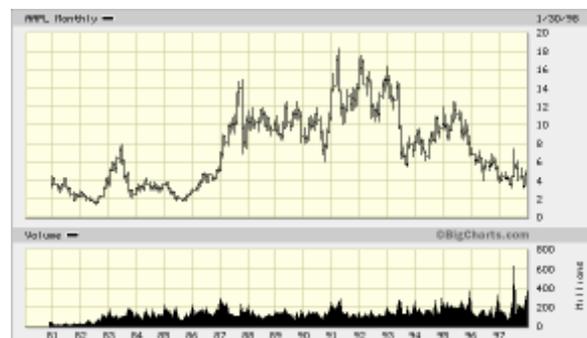


Figure 2 Apple Share Price

the company was out of trouble. As of 2006, the company has a \$72 billion valuation and is the envy of the high-tech world.

So what had happened? How did this company go from greatness to pariah, then back again? As with all our stories, there are a lot of angles.

1.1 Early Failures

Everyone who used a computer in the early 80's was familiar with the Apple II or its variants -- the II+, the IIc, the IIe, lesser known are the Apple I and the Apple III. The Apple I, little more than a circuit board, was prudently killed and replaced by the Apple II before it really got off the ground. The Apple III, however, is a different story.

1.1.1 Apple III

While the Apple II was successful in homes and schools, Apple created the III as a business computer. The III had more memory, better graphics, and a more advanced operating system. SOS -- the "sophisticated operating system" -- including a hierarchical file system, an Apple first. With Apple's established name, the Apple III seemed set to be a sure-fire hit. It was an unmitigated disaster.

Introduced in 1980, the III had major quality problems; probably the most chronicled of these were due to the lack of a cooling fan. Steve Jobs didn't want the noise of a fan and for most of the IIs this was acceptable, but the undercooled III would overheat, warping the motherboard. A recommended solution to re-seat displaced chips was to lift the III up off your desk to a height of three inches, and drop it. At \$3,500, the III was also more expensive than "business" computers based on the contemporaneous CP/M operating system.

Perhaps the biggest problem with the III was its poor compatibility with software written for the II. There was compatibility, but was intentionally crippled to prevent running programs needing more than 48K of memory; this included most programs written in the popular Pascal language. Instead of leveraging the II software as a strategic asset, the III had become a buggy new platform with little software competing with the II. The appearance of the IBM PC, a more powerful computer from a trusted business vendor, release a few months after the III's appearance was the last nail in the III's coffin, but Apple continued working on the III until 1984. Steve Wozniak remarked on the silliness of the situation: the II was an established platform generating massive revenue, but received little attention while the company committed resources for years into an obvious failure.

1.1.2 Lisa

Another early-80's failure of Apple was the "Lisa" model, named after Steve Job's daughter of sorts. The Lisa was Apple's first foray into a computer with a graphical user interface (GUI). Though some analyses cite the Lisa as a necessary step towards future successes, it was another product disaster. The general consensus is that the Lisa, at nearly \$10,000, was far too expensive for its market. Part of this cost was due to the Lisa's components; the Lisa had 1MB of memory

(enormous for its day). However, Apple was also trying to recoup Lisa's *development* costs in short order, which seems a poor strategy in retrospect. Development costs are "sunk costs"; a more rational approach might have been to try to make the Lisa successful, profitable product. As with the III, the Lisa also had a paucity of software and was competing against entrenched platforms, and it had a reputation for being slow. Though Lisa sales improved as Apple reduced its price and made the Lisa compatible with the Macintosh, Apple eventually ended the project and buried its inventory of Lisas in a landfill in Utah, under armed guard.

1.1.3 Macintosh 128k

One of Apple's most lauded successes is the Macintosh; less often mentioned is how close the Mac was to failing. Apple's second GUI-based computer, the Mac excelled where the Lisa stumbled: price and performance...or so it seemed. The original Mac came to market at \$2500 -- about a quarter the price of the Lisa. The Mac also had a 8MHz processor; 60% faster than the Lisa's. But, in order to reach this price-point the first Mac, over the objections of engineers, shipped with only 128k of RAM. The GUI alone required 64K, leaving a meager, Apple II-sized 64K for programs to use. Like the II and III before it, the Mac also had no fan, which left it subject to overheating (Steve Jobs would design *yet another* fan-less computer prone to overheating, the "Mac Cube", in 1999). It also came with no hard drive and, unlike the Lisa, came with only a single floppy drive -- requiring users to constantly insert and remove diskettes. In this initial configuration, the Mac was a very unattractive computer. Fortuitously, engineers had designed a back door that allowed for a follow-on with 512KB of RAM. It was this configuration, the "Fat Mac," that made the Mac usable. Without it, the Mac would likely have been remembered as merely an underpowered Lisa. Ironically, the Mac really only took off with the "Mac Plus", a configuration that had 1MB of memory, *exactly as much as the Lisa*.

1.2 Mid-late 90's failures

The late 80's and early 90's were a long period of profitability. The company continued to ship more units and make more money, but beneath the veneer, dry rot was spreading. Both the company's visionary founders departed. Technical failures and strategic blunders resulted in a lackluster product line, culminating in a tremendous financial collapse. In 1998 the stock reached a low near \$4, and the company posted losses of over \$1 billion. To put this in perspective, the initial public price of Apple stock 12 years earlier had also been \$4, and the company had never made more than \$600 million in any one year. In comparison, the early failures seemed like mere foibles -- though with important lessons. The late 90s failures almost did in the company.

1.2.1 Operating system failures

A factor in the failure of any technology company that must be considered is technical incompetence. Apple displayed a measure of this, perhaps most of all in its 90's operating system development work.

The initial incarnation of the Macintosh OS had been created for the minimal hardware platform that was available in 1983; tradeoffs had been made to meet time-to-market and cost constraints. The resulting product was legendary, but was tied so closely to the raw Mac circuitry that

platform evolution would be difficult. By 1989, affordable hardware had become much more powerful, and Apple management was meeting to discuss redesign of the OS to adapt to the changing needs of the market. Some features, such as a user interface with color, were added fairly quickly, but the less superficial features necessary to make the Mac competitive beyond the early 90's proved more challenging. Indeed, by 1997, this next generation of Mac OS, codenamed "Copland", was incomplete with no foreseeable ship date. On the advice of engineering manager Ellen Hancock, Apple CEO Gil Amelio killed Copland. What had happened?

Copland seemed to incorporate all the right ideas. For instance, a marquee Copland feature was "memory protection". Memory protection prevents poorly written software from causing system crashes -- this hadn't been a significant issue in the earlier Macs, which only ran one program at a time, but beefed-up early 90's Macs ran many more programs concurrently and accordingly, crashed much more often. Memory protection technology had been present in the industrial-strength Unix OS for decades; cheaper and more powerful hardware in the early 1990s made it both technologically feasible and a competitive must-have for personal computers, and appeared in 1992 versions of Microsoft Windows. Copland also included a "microkernel" and operating system "services", both respected means of organizing a modern OS. In order to remain backwards-compatible, Copland incorporated a "virtual machine" called the "blue box" which would run an older version of Mac OS, a technique called emulation. In contrast to the Apple III fiasco, the Copland approach would provide a comfortable upgrade path for existing customers. Apple's heart seems to have been in the right place; several of the Copland dreams materialized much later in Mac OS X.

But technically Copland proved difficult to execute. To illustrate one technical hurdle: Copland aimed to use no more than 4MB of memory, but the backward compatibility mode demanded a complete, memory-resident version of Mac OS 7, consuming two-thirds of the Copland memory budget before the first line of code was written. Interestingly, the 4MB limit may have seemed reasonable in 1992 when Copland was initially scoped out, but, as Copland fell behind it became quaint: 64MB of memory was standard by 1997. More fundamentally, the Copland emulation philosophy was flawed. While portions of the OS would be walled off from the emulator, application programs would all run together in the "blue box". A buggy or malevolent program would still be able to wreak havoc with any other program, *just like in all prior versions of Mac OS*.

1.2.2 Organizational failures

Insiders report that technical struggles were only part of the problem. Apple by the mid-90s had assumed the posture of a research organization. The regular releases, firm timelines and deliverables lists characteristic of successful software companies ceased to exist. Mac OS upgrades had become little more than bundles of cheap "shareware" programs. The widely touted feature of Mac OS 8 was a user interface tweak known as "springing folders". Perhaps revealing the depths of their devotion, Apple's loving users made OS 8 one of the top selling pieces of software of all time.

In, "Why Apple Failed", technology journalist Daniel Eran talks of Apple's "Snowball Projects" - projects which, like snowballs rolling down hills in cartoons, had grown larger and larger until they had only a snowball's chance in hell of completion. These projects became unkillable, because in their growth they had also grown to contain strategic technologies the company believed it couldn't do without.

An Apple messaging solution called PowerTalk illustrates this phenomenon. With roots as an email product, by the time it was killed PowerTalk had morphed into the all-encompassing "Apple Open Collaborative Environment" (AOCE). AOCE incorporated secure logins and passwords, encryption technology, universal directory services, an "information catalog" extension, support for numerous communications protocols, and a "peer-to-peer" architecture that was intended to save customers the expense of a computer dedicated to email management, which all sounds great, but AOCE ate up so much memory, network bandwidth, and disk space that it was difficult to run on computers of the day -- negating the benefits of both the peer-to-peer architecture and the product itself. Meanwhile, Microsoft released the much simpler, standards-based Exchange software. By any standard, Apple management should have recognized the AOCE was out of control, but many possibly valuable technologies in AOCE were deeply intertwined. Nevertheless, after \$100 million invested, Apple killed AOCE in '95.

1.2.3 Windows arrives

While Apple failed to execute on its OS strategy, the rest of the industry moved forward. Be and NeXT, two small companies founded by former executive, crafted software that was arguably far superior to the MacOS. But Be, NeXT and others ran into the harsh reality of computing platforms that had been the nemesis of many along the way; namely, introducing a new platform into an established market is (nearly) hopeless.

Though Apple had little to fear from *new* platforms, the Macintosh franchise was in serious danger due to an *improved* platform: the continued progression of Microsoft DOS/Windows on Intel x86-based hardware. Microsoft DOS had been around since the early 80s, but was initially little more than a program loader, scarcely worthy of comparisons to the MacOS and its GUI. Microsoft began efforts at a GUI based OS in 1985, but early efforts were unattractive and mostly useless shells on top of DOS. The two things Windows had going for it was perfect backwards compatibility with DOS and automatic "free" distribution with every PC sold. Microsoft did not try to convince users to switch to an entirely new hardware platform as did Be and NeXT, and didn't have to sell their software to retail consumers as IBM did with its Windows competitor, OS/2.

By 1990, Windows, version 3.0, had become very usable. Windows was still less refined than MacOS, lacking features like filenames longer than 8 characters, but it was no longer a mere facade above DOS. Microsoft had also begun to incorporate memory protection technology, unavailable on Apple machines for the next decade. To consumers, the difference between Windows and MacOS had become mostly cosmetic. The Windows PC population mushroomed. Millions of individuals and organizations became familiar with PCs and their software. Network effects amplified PC dominance; each time a program was released or a new user initiated into the PC world, the PC platform became more valuable. The Macintosh IIVX, a system target

towards home users, cost over \$3000 when released in 1992 *without a monitor*. Comparatively equipped PCs were available for less than half the price.

Though diehard Mac fans might disagree, the 1995 release of Windows was superior to MacOS. Featuring long filenames, further memory protection, a taskbar which tracked open programs, and a fair amount of flash, there was little left that Apple could point at that was superior in Macintosh. Computers running Windows '95 had a better operating system, could run more software, and were far cheaper than similarly performing Macs (though Apple typically produced computers with better *physical* design). In the following years, the situation became worse as the PC-Mac price/performance gap grew, while the MacOS buckled under user expectations of multitasking. Apple's decade-long inability to release a significantly new OS had finally come crashing down.

1.2.4 Attack of the clones

From inception, the Macintosh platform had a fundamental difference from the "IBM-PC compatibles". While anyone with technical know-how could assemble and sell PCs, only Apple could build the Macintosh. In some ways this was a blessing. Apple could control all aspects of their software and hardware, avoiding compatibility issues that plague computers made with a parts-bin approach. Additionally, as the only Macintosh producer, Apple had a monopoly of sorts, and could raise and lower prices at will. In contrast, price competition in the PC market can be brutal. But the lock Apple had on Macintosh was also a curse. Apple couldn't specialize in any single aspect of computer technology, needing to build complete systems.

A legendary unheeded letter from Microsoft CEO Bill Gates had all but begged Apple to license Macintosh technology to other vendors in 1985. Gates pointed out the benefits of a standard platform:

Any deficiencies in the IBM architecture are quickly eliminated by independent support. Hardware deficiencies are remedied in two ways:

- *expansion cards made possible because of access to the bus (e.g. the high resolution Hercules graphics card for monochrome monitors)*
- *manufacture of differentiated compatibles (e.g. the Compaq portable, or the faster DeskPro).*

The closed architecture prevents similar independent investment in the Macintosh. The IBM architecture, when compared to the Macintosh, probably has more than 100 times the engineering resources applied to it when investment of compatible manufacturers is included.

The consummate software baron, Gates likely had his own best interest at heart, but his argument had a lot of validity. Apple could never compete with the combined ecosystem of engineering resources behind the PC, and why would it want to slug it out if there were an alternate strategy? Gates also suggested that businesses were wary of buying Apples, for fear of being locked into a single vendor, and that Apple was perceived as being slow to bring new hardware (larger

displays, more RAM, faster processors, etc.) to the Mac. Apple, content to keep doing what it knew best -- *selling computers* -- didn't pursue Gates' recommendation till much later.

The threat to the Macintosh from PC compatibles wasn't immediate. When Gates wrote the memo, the capabilities of a typical PC were far behind that of the Mac. Additionally, early PC makers took years to accept the advantages of platform standardization Gates described and the business models it eventually demanded. Though many parts became commodities, PC manufacturers persisted in doing their own engineering work. As late as 2002, PC vendor Hewlett Packard was chiding its competitor Dell for doing little R&D. Dell laughed all the way to the bank.

Nevertheless, the powerful, inexpensive, PC built of commoditized parts eventually came to fruition, and, in conjunction with advances in Microsoft Windows and network effects, eventually surpassed the Mac in price and performance. Gates unheeded memo served as his business plan; as suppliers and parts vendors competed with to create better products at cheaper prices, Microsoft maneuvered itself into a monopoly position among PC Operating Systems vendors.

1.2.5 Macintosh clones

Apple looked jealously upon the Microsoft situation -- an operating systems/software vendor company making immense profits while hardware companies battled each other for table scraps - - and kicked itself for not having done the same in the early 80s.

Steve Wozniak summed up his feelings about licensing in a 1996 Newsweek interview:

...Apple saw itself as a hardware company; in order to protect our hardware profits, we didn't license our operating system. We had the most beautiful operating system, but to get it you had to buy our hardware at twice the price. That was a mistake. What we should have done was calculate an appropriate price to license the operating system.

After backing out of an early licensing arrangement with Apollo in 1987, Apple decided to finally license the MacOS to other manufacturers in 1993 -- a full decade after the appearance of the first Mac. Apple CEO Michael Spindler initially expressed concern that clone sales could hurt Apple while not appreciably increasing Mac market share, but nevertheless pursued the strategy. Finding the first licensees was a struggle. Apple was fearful of licensing to established, successful PC manufacturers, and potential partners were (rightfully) suspicious of Apple's commitment to licensing. With Windows '95 on the horizon, Compaq executives expressed doubt that there was any value in producing Macintosh clones.

A handful of agreements were ultimately signed with lesser-known companies. As IBM had experienced with the PC platform, smaller, more nimble manufacturers began to predictably eat Apple's lunch. Unburdened by marketing costs, engineering boondoggles, highly paid executives, Apple's cloners were able to out-compete Apple. UMAX, a Taiwanese manufacturer, sold low-end Macs more cheaply than Apple. The largest Mac cloner, Power Computing, was able to buy small quantities of high-end components that would have been difficult to acquire in

volume and sold top-of-the-line Macs. Power was the fastest growing computer company in the 90s, and in 1996 had captured nearly 10% of the Macintosh market, with \$246 million in sales. While Apple received royalties of \$50 per machine, Steve Jobs claimed that each sale cost Apple "hundreds" of dollars, the cloners garnering sales but not increasing Mac market size.

Seeing an inevitable death-spiral if cloners continued to grow, Apple, by then with Steve Jobs again in charge, ended the cloning episode in 1997. Licensing agreements had promised cloners access to version 7.5 of the MacOS and "upgrades" to it. Apple branded the next version of MacOS "System 8", claiming it was not merely an upgrade to 7.5 and insisting the cloners had no license for it. Possibly to avoid lawsuits, Apple acquired Power computing for \$100 million.

The cloning experience probably wasn't Apple's mortal wound; Apple continued to sell the overwhelming majority of Macintoshes in the last year clones were on the market, but it was a humiliating strategic detour that cost, conservatively, over \$100 million at a time when Apple could least afford it. The failure of the cloning program was prophesied by many; the PC platform was deeply entrenched by 1994 and a large share of Apple's profit came through its control over Macintosh pricing. A somewhat bizarre element in the plan was that Apple sought to create a competitive area where it held a monopoly, and then tried to compete *in that very arena*. Most businesses seek to obtain and hold onto monopoly power. Apple was trying to imitate Microsoft, who made immense profit by avoiding hardware altogether, but Apple seemed reluctant to give up even a small portion of Macintosh hardware sales. Apple had its very own historical precedent to learn from; in the 1980s Franklin sold quality Apple II-compatibles for half Apple's price, biting painfully into Apple's bottom line until legal and technical maneuvers ended the practice.

The move seemed to make little business sense, but maybe business rationalities weren't the motivation for the cloning program. Steve Jobs described the thinking behind cloning as "institutional guilt".

2 Analysis

Apple's near-death-experience in the late 90s had several causes. Some were inevitable results of the structure of the computing industry, while others were due to avoidable mistakes in business strategy and execution.

Perhaps the most important factor in Apple's near-demise is the computing industry's tendency to gravitate towards a single, winning platform, losers be damned. Apple had an early technological lead with the Macintosh, but, for whatever the reason, was unable to capitalize on it. As the population of PCs and their users grew, there was little possibility for even the most competent competitors to threaten PC dominance, or even get a foothold in the market. Network effects had made the Apple II an early success, but eventually killed both the II and the Mac (almost).

A second, difficult-to-avoid phenomenon for Apple was its competition from its *own* installed base running unmaintainable software that Apple wanted to do away with. Apple knew that the Macintosh operating system needed to be replaced, but an all-out replacement would have meant creating an all new platform with no software, no users, and no network effect. Being the #2

platform is the pits, but it's a lot better than starting from zero. Apple had little choice but to keep the Mac OS together with duct-tape and band-aids, while new OS efforts struggled to be, first and foremost, backwards compatible. This awkward situation was, oddly enough, also the cause of the Mac's success; un-evolvable software was the shortest path towards the ambitious cost and schedule goals of the original Mac.

Though Apple was in a difficult spot with its OS, its complete failure to deliver a significant upgrade to the Mac OS in over a decade is a remarkable technical and managerial failure. That startups were able to do what Apple couldn't indicates that Apples downfall was not merely the result of pre-ordained market structures. Apple had other issues beyond the OS; the company seemed to operate in a research mode, not driven by profits, as had Xerox Parc in the 70s. In comparison, Microsoft took a much more boring approach, regularly shipping upgrades to its somewhat dull products.

Apple's failure to deliver a modern OS can be blamed on widespread organizational ineptitude; it can be hard to identify a single individual responsible for the failure of a years-long, complex project. But the refusal to license the Mac OS in the early 80's when it could have become dominant, followed by what most analysis consider a poorly-thought-out flip-flop ten years later rested solely with Apple's executive management.

Though things were bleak in '98, Apple recovered dramatically in the early 2000s. The company killed a number of "snowball" projects and replaced its OS with the flashy yet rock-solid OS X. Apple started packing fun, multimedia software with its computers, and began selling Macs based on the same, widespread Intel processors powering PCs. Apple branched out from computers with the iPod, a high-end portable music player coupled with an easy-to-use online music store. As of December, 2006, Apple stock was above \$80 per share – a gain of over 2000% from its 1998 low. A complete analysis of the Apple comeback is beyond the scope of this paper, but one worth mentioning is the return of Apple's founder Steve Jobs as CEO. Crediting Jobs is not mere hagiography; Jobs was, in large part, responsible for Apple's best products: the Apple II, the Macintosh, Desktop Publishing, Apple's portable Powerbook series, and was absent during Apple's long downward slide. His return ushered in Apple's innovative and financial resurgence; it's not unreasonable to give him a significant portion of the credit.

2.1 Policy considerations

One way of looking at Apple's almost-failure is that it was simply the result of the free market doing its job: bringing consumers maximum utility for the least possible price. If Mac failed in the market, maybe this wasn't such a bad thing; Apple did, after all, do a number of stupid things, and, for a period of time, charged a higher price for products that seemed to provide significantly less value than their substitutes.

But, one question that arises is whether the computer-platform monopoly that results from network effects is really advantageous to society. We often *like* network effects. They increase the value of the products we buy: if I can borrow CDs from my next door neighbor my CD player a lot more valuable than it would be if I couldn't. But monopolies typically charge higher-than-fair prices and have little incentive to innovate. There is no obvious reason to presume

monopolies with a metaphorical moat of network effects are likely to behave differently than other historical types of monopolies.

Had Apple gone under, Microsoft Windows' market-share in the personal computer OS market, currently at about 90%, could have quickly grown beyond 95%. There is some anecdotal evidence that Microsoft innovates only when challenged by a competitor with double-digit market share. Whizzy display features in the most recent version of Windows are very similar to recent features in the Mac OS, and Internet Explorer incorporated "tabbed browsing" only after the free Firefox browser garnered double-digit fraction of the browser market. Without challengers, would Microsoft have continued to enhance its products, or would it have been satisfied to sit on a lawn chair, directing the cavalcade of cash-filled dump-trucks rolling up the driveway?

Another consideration is that network externalities amplify winners (we hear about this regularly), but they also amplify *losers*. Without network effects, Apple may have faced similar troubles, but its fall would have likely been much longer and slower, preserving some of the value of the billions of dollars collectively invested in Apple gear, software, and training. Should we be concerned about this externality, or is the value of these wasted billions less than the gain we get in network effects as these users jump to PCs?

Policy solutions for these issues aren't trivial. Financial measures, such as tax breaks, for the company on the losing end of a platform battle would reward ineptitude, and it would be difficult to determine *when* they are appropriate. While keeping Apple alive might seem like a good idea to people that like the Mac, consumers are actually pretty happy when platform wars are decided. Would it have been reasonable for the government to bend over backwards to keep competition alive in the video-cassette format wars of the 80s?

After-the-fact remedies are also complex. Splitting up a platform monopolist is a difficult proposition; computer software is notoriously complicated to tease apart, and remedies risk damaging the unquestionably valuable network effects the monopolist brings us. Breaking Windows into two incompatible pieces of software might spur innovation, but would undoubtedly irritate consumers.

Digital Equipment Corporation (DEC)

– Bruce Sherwin

1 Introduction

Digital Equipment Corporation was founded in 1957 by two engineers, Ken Olsen and Harlan Anderson. Together, they started DEC with \$70,000 in venture capital funding from American Research and Development Corporation (AR&D). With their finances in order, they went to work in an 8,500 square-foot old rented woolen mill in Maynard, Massachusetts.

At the urging of their investors, DEC's first two products were not computers, at all. Rather, they were laboratory modules and system modules which were to be mounted at an engineer's workbench and used to construct logic systems. These modules could be connected together and used for testing memory systems, building computers, and performing other automated tasks.

It was not until 1959 that the engineers at DEC began "Phase II" of the plan they'd proposed to AR&D when they started their company. The goal of this phase was to build a general-purpose computer that would use the "same general circuits that would be used in the test equipment line." "The computer's capacity and speed would be in excess of computers available at the time, while the price would be significantly less." (Digital Equipment Corporation, 1992) Olsen wanted to build a computer that was small, affordable, and perhaps most importantly, interactive. With those goals in mind, DEC hired a young hardware engineer named Ben Gurley to design their very first computer. The machine Gurley designed was named the PDP-1 and it was one of the very first of a new class of computing machinery which would become known as the minicomputer class – relatively small computers which took advantage of transistor and core memory technologies. DEC did build the machine that Gurley designed and they were able to successfully demonstrate their first prototype's capabilities at the Joint Computer Conference in December of 1959.

DEC continued to develop new and innovative machines in the PDP line throughout the 1960s and into the 1980s. However, it was in 1965 that "Computing came out of the lab and into offices, factories, and new territories everywhere. The combined speed, size, and reasonable cost made Digital's PDP-8 the first successful minicomputer. Before long, 50,000 systems (PDP-8) – at one-sixth the price of a PDP-1, one-fiftieth the cost of a mainframe – were put to work in business, production, and research." (Digital Equipment Corporation, 1992) The commercial success of the PDP-8 solidified the minicomputer class of computing machinery and for the employees of DEC, it reinforced the beliefs and goals that DEC had been founded upon.

From the beginning, Ken Olsen and other leaders at DEC strove to instill a strong system of values in each of their employees. For example, Chapter 1 of a DEC engineering manual dated 1974, is entitled "WHY" and clearly dictates the company's philosophy and beliefs on a number of topics, including: honesty, profit, quality, responsibility, line management, civic responsibilities, environment, customers, competitors, simplicity and clarity, OEMs, end users, personnel development, promotion, hiring from customers, and the "first rule" – "When dealing

with a customer, a vendor, or an employee, do what is “right” in each situation.” (Digital Equipment Corporation, 1974)

These values, the principle building blocks of DEC culture which were repeated time and again, dictated that an engineer should be rewarded based on technical ability, as well as for the ability to get the job done and for accepting responsibility. It was widely understood that “the accepted plan is the responsibility of those who proposed it.” (Digital Equipment Corporation, 1974) This was empowering in that it gave people a strong sense that they could make a difference in the success or failure of their company. Many former DEC employees report that the clarity provided through these strong statements about values from company leaders like Ken Olsen and Gordon Bell was critical to developing and shaping a culture of innovation where strong engineers could thrive. It was this culture that made DEC a desirable place to work and the employer of choice for at least a decade’s worth of engineers. (Schein, 2003)

2 DEC Matures

As DEC began to age, the company grew in size and profits increased. DEC was a leader throughout the minicomputer era of the 1960s and 1970s. Their PDP machines were favorites at many research institutions and universities, across the US. Olsen’s vision of interactive computing was realized through the success of his company and the widespread adoption of the minicomputer. However, this growth was not without cost or effort.

There were internal problems to deal with, like the lack of experienced managers. To battle this problem, Olsen began to hire experienced managers from other large companies. He also began to divide his company into logical groups in order to more efficiently manage his employees, based on their roles within the company. For example, Peter Kaufmann was hired from Beckman Instruments to manage manufacturing, Ed Kramer was hired from Sylvania for his technical and marketing skills, Jean-Claude Peterschmitt was hired to manage European operations, etc. (Schein, 2003)

Other internal problems were prevalent, as well. One problem was the growth of sub-cultures. Sub-cultures at DEC were groups of people who generally worked in the same logical group with one another and held onto additional beliefs beyond the scope of the more widely held company values. Many times the existence of these sub-cultures was benign. However, in some instances, two groups would develop opposing beliefs that prevented them from working well with one another. Many former DEC employees have reported that in the later-1980s and 1990s, this became a very serious issue. Based on their own histories of success, powerful managers started to second-guess, ignore, or go around Olsen when making important business decisions. (Schein, 2003) Another closely related issue was the spread of the primary culture to a very large population of employees. While this might seem desirable at first, it made making adjustments to the company’s values very difficult. These and other similar growing pains proved challenging for DEC and drastically increased the overhead of running the company for Olsen and other leaders.

A number of external factors also influenced DEC as it matured. There were the social forces and influences of the 1960s which were promoting ideas like liberation, and decentralization.

Adaptation to these new social concepts was less disruptive for DEC whose minicomputers seemed to embrace individualism and allowed users to disconnect from the mainframe style environment that they were used to working in. This also fit well within the company values which respected each engineer for his abilities and promoted people based upon their competencies.

However, there were also technological forces throughout the 1960s and onward which had both positive and negative effects on DEC. Various demands from customers caused DEC to build a large array of hardware to satisfy the needs of its clientele. As a result, DEC struggled to provide a unifying vision across their product line and to identify which pieces of their product line were not profitable. In addition, Bell's Law of Computer Classes can be used to explain how new technology made new computer classes possible and changed market demands for computing machinery. In an effort to adapt to new technology, DEC continually improved on their existing products, building the VAX (Virtual Address eXtension) systems on top of the solid PDP architecture in the mid-1970s and then releasing Alpha-based machines in the early 1990s. DEC also took risks and made a bets on things like emitter coupled logic (ECL), during the 1970s and 1980s. Some of those bets turned out better than others. In the case of ECL, DEC was not so lucky. After some number of years, complementary metal-oxide-semiconductor (CMOS) technology caught up with and eventually surpassed the performance and easily beat the price of ECL-based chips.

Throughout the history of the company, the confluence of these social and technological forces kept DEC scrambling to innovate and keep themselves on top of the market. For the most-part, DEC was a very successful engineering company. So much so, that in the late 1980s and early 1990s, DEC employed more than 120,000 people, was a Fortune 100 company, and was the second-largest computer company in the world with revenues over \$14 billion. (Digital Equipment Corporation, 2006)

3 DEC Fails

Gordon Bell's Law of Computer Classes can be used to explain the advent of the personal computer in the 1980s and 1990s. Interestingly, this law also explains why DEC was so successful in the minicomputer business for such a long period of time. Perhaps even more intriguing is that both the early successes of the company and the rise of this new class of computer devices contributed to the eventual dissolution of DEC.

The early successes of DEC served to reinforce the values of the company leadership and this helped to create a unified corporate culture with a very rigid and clear set of beliefs. These successes also set very clear directions for the engineering teams at DEC. DEC was in the business of building minicomputers and minicomputer software and services. Employees at DEC believed in what they were doing and they believed that their company would be successful because the products that they were building were technologically superior to those offered by their competitors. Although there were visible problems with these beliefs, changing the culture at DEC proved difficult and little was done to correct these issues.

The market infiltration of inexpensive IBM – and eventually IBM-compatible personal computers – based on Intel’s processors and standards-based software in the very early 1980s and 1990s was a serious threat to DEC’s proprietary system designs. However, the culture of innovation was alive and well within DEC and many company-insiders believed that their pure and elegant minicomputer designs would continue to prevail in the marketplace. Engineers and executives alike almost refused to acknowledge this new class of personal computers that had begun to commoditize the small-computer industry. It wasn’t until 1982 that DEC released any type of personal computer to compete with IBM. Unfortunately for DEC, they further fragmented the fledgling PC market by releasing three different and mostly incompatible platforms, none of which were compatible with the IBM PCs. As a result, none of the 3 original DEC PC products were commercially successful. In fact, it wasn’t until 1989 that DEC finally admitted defeat in the PC market and began to produce IBM-compatible systems called DECstation PCs. Prior to that time, they continued to spend money developing products like the almost-IBM-compatible VAXmate and the MIPS processor based DECstation workstations - which were not to be confused with the DECstation PCs shipping with Intel x86 processors. Unfortunately for DEC, none of their proprietary PC products ever sold in a volume comparable to the other major IBM-compatible PC manufacturers and when they did eventually release a compatible PC, potential customers were confused by their unconventional product naming scheme.

Also reinforced by the culture of the company was DEC’s propensity to branch into new areas of technology and to build new and proprietary hardware and software to meet niche market demands. For example, in addition to their computer systems, DEC offered networking products, file and print sharing products, a database product, and software for transaction processing, etc. Generally, these products were not financially successful for DEC and were a source of confusion for many customers who saw an unaligned set of disparate offerings in the company’s catalog.

Hamstrung by these recent failures and with profits sliding downward, DEC felt that new leadership might be able to save the company. In June of 1992, the board replaced CEO Ken Olsen with Robert Palmer, a man who had been a successful leader working on DEC’s Alpha product. Palmer made immediate changes at DEC in an effort to recover a sound footing for the company. Unfortunately, many felt that it was too late and even after a layoff of 60,000 people, closing plants, and selling many pieces of the business, Palmer was unable to salvage DEC. A slowly creeping tide of red ink washed over the company; eventually dissolving it on January 26, 1998 when what remained of the DEC was sold to Compaq.

4 Conclusion

After analyzing DEC’s history, lessons can be learned from the company’s mistakes. There were undoubtedly dozens of contributing factors to the failure of the company. However, the cause for many of those issues can be traced back to the culture which developed at DEC, as the company matured.

When Ken Olsen founded DEC, he wanted to build a great company where engineers were valued for their technical abilities and where “doing the right thing” was the only way things

were done. It turns out that doing the right thing is not necessarily the same thing as doing the profitable thing.

Olsen's culture of innovation, when left unchecked, also promoted product diversification to an excessive extent. Building a disjointed product catalog did little to provide a unifying vision for DEC's customers and employees.

The cultural ideals promoted at DEC also dictated that the technologically superior design will prevail in the open market. DEC was proven wrong at least twice, with this assumption. Once, this belief was crushed by the proliferation of the IBM-compatible PC devices. A second time, it was shattered by open-standard software which handily defeated DEC's proprietary interface specifications – especially for technologies like networking.

And finally, the self-reinforcing culture which developed at DEC served to slow adaptation to rapidly changing market demands, as the company grew. As the company's headcount increased, the cultural beliefs of the whole became more firmly rooted in the minds and behaviors of the independently operating pieces of DEC. This made adjustments to the company's direction a significant challenge and was a major reason for DEC's failure to successfully react to the emerging IBM-compatible PC market.

International Business Machines (IBM)

– Avichal Singh

1 Empire Crumbles

IBM had led the computer industry for decades and in 1990 its revenues peaked at \$68.9 billion and income at \$5.9 billion. However it soon went into a free-fall, hitting a low-point in 1993 posting a loss of \$8.1 billion¹. Staggering as these financial losses were, they exposed only the tip of the proverbial iceberg; the problems at IBM were more insidious and had been gathering strength for a long time.

Robert Heller compared the fall of IBM to that of the Roman Empire: its huge profits concealing enormous waste, attacked on all fronts by rivals and led by incompetent leaders. Then noting the loss of the indispensable position of IBM, his damning statement was - 'If it didn't exist, it wouldn't be necessary to invent it'². And indeed, IBM seemed to be on a path to extinction. Under John Akers, the company had been divided into 13 separate units, dubbed 'Baby Blues', in an apparent maneuver to sell-off the company.

The following sections analyze what went wrong to cause the fall of this goliath.

2 Mainframe Myopia

System/360 was certainly the crowning success of IBM. In early 1970s IBM embarked on yet another ambitious project – Future System (FS), which unfortunately ended in failure and was scrapped in 1975. The possible causes of the failure are many – including an overly complex architecture and overambitious goals - but the repercussions of this 'most expensive development failure in the company's history'³ were even more widespread and lasting. The failure of FS combined with the amazing run of success of S/360 lulled the company out of their previous fear of obsolescence of S/360 architecture and replaced it with the overriding objective to maintain the S/360 lineage which had become an industry standard and the source of IBM's immense profits⁴.

2.1 \$100 Billion Blunder

In 1980, riding their wave of success, IBM projected their past record of growth and surmised that they could achieve \$100B in sales by 1990 with mainframes continuing to be their central pillars of success. Driven by that goal, the buildup of personnel and manufacturing capacity, proved as costly to accumulate as it was to dismantle later⁵. The maxim that IBM ignored was that the "only way to predict the future is to invent it"⁶. However IBM's lofty goals were not to be achieved by new innovative products, but by increased production. They bet too heavily on the continued success of mainframes and lost when the market changed.

2.2 Focus on Mainframe

In their self-inflicted mainframe tunnel vision, IBM kept ignoring other fast-emerging markets. IBM's myopic view would not see beyond the large profit margins and million dollar sales that accompanied the larger systems. This is exemplified in the step-child treatment of the low-margin Office Products Division⁷ – known for its electric typewriters - which ironically could have gained an entry into the personal computer market for IBM well before anyone else. Although a 1970 memo recognized the unique position of this division and the opportunity to

offer unique small-office systems, the lack of management interest precluded a new product initiative⁸. The rise of word processors by Wang (an early form of PCs) – a perfect match for this division - was similarly ignored⁹.

Even when IBM belatedly recognized the potential of new markets, it deluded itself into believing they would all fit into a fantastical world with mainframes at the centers of an interconnected-web of preferably AS/400 minis and IBM-PCs. As late as the 90s IBM poured resources into efforts such as Systems Applications Architecture and OfficeVision, bent on making this dream a reality, resulting in categorical failure¹⁰.

Unlike IBM, succeeding leaders – Intel and Microsoft – have well learned and utilized the principle that ‘surges in new product introductions are accompanied by leaps in profit’¹¹. Unfortunately for IBM, their resistance towards introducing new product lines at the risk of cannibalizing existing higher-profit products, could have been stemmed if ‘Future System’ project had succeeded and set a precedent for this.

3 Dominant Design

IBM had spent the better part of early computer revolution thoroughly dominating the industry. Much of its success was based on the monopoly powers, and therefore most of its design was to protect that monopoly. This design, exposed in the proceedings of the antitrust lawsuit and even partially confessed in the memoirs of its leader (Watson Jr.), shows a methodical single-minded approach to annihilate competition and leave the customer only two choices – IBM or IBM.

IBM’s market, by its own definition, can be compared to a pyramid with three layers¹²–

- Top layer – high-end scientific/defense/academic users
- Middle layer – primarily the large corporate market
- Bottom layer – small commercial and personal users

The monopoly of IBM was by virtue of control over the middle market, this is where IBM earned the bulk of its profits. During the punch-card era, Watson Sr. had built this monopoly in the information-processing business upon its heritage from Herman Hollerith. Watson Jr. was successfully able to retain this monopoly and transition the business from punch-cards to computers. Finally the domination was entrenched with the success of S/360 which made it an overbearing industry standard. The top and bottom layers however were usually areas of contest, possibly allowing new entrants, therefore were always to be kept in check.

The following illustrates the monopolistic tools IBM used to ensure the continuation of their regime and avoid a threat emerging to its bread-and-butter middle market from the top/bottom tiers:-

Market Segmentation & Price Discrimination: IBM segmented its markets using their separate product lines (for commercial, scientific uses etc.) and by further categorization in those lines (usually by memory) into entry-level to advanced systems. Each segment was given individual treatment. Segments with an IBM stronghold would be milked for profits (as high as 40%). These profits could then afford IBM to frequently operate at low-profits or outright loss¹³ in contested market segments, eventually grinding out competitors and discouraging others from jumping in¹⁴.

Lock-In: Since earlier systems were mutually incompatible, once investments were made in training personnel, writing and implementing software etc., the customer would effectively be locked-in with their choice of supplier. Being the dominant player, this played right into IBM’s hands.

Tie-In (Bundling): IBM bundled the hardware, support and services (software, training etc.) in one pricing model. Thus competitors were forced to try to match it on all three counts which proved a tall order for all of them¹⁵.

Fear, Uncertainty and Doubt (F.U.D.): The classic example was the pre-announcement of System 360/90 supercomputer with boastful credentials, while it was still on paper. This virtually stalled the sales of previously successful CDC-6600¹⁶.

3.1 Problems Emerge

The old pyramid was replaced by a kaleidoscope of end-century markets which had fractured along many technological lines in hardware and software. At the same time the pillars on which IBM's monopoly was built were shaken. The antitrust actions which had plagued IBM throughout its successful history first led to the 1956 consent decree which forced IBM to license its patents to other companies. Then in 1969, under the pressure of the renewed antitrust actions, IBM was forced to abandon the practice of bundling software and support with its hardware¹⁷.

The market was shifting from low-volume, high-priced to high-volume, low-priced products; from directly dealing with a select group of large customers to selling via dealers or other retail channels. The economies of scale were being rendered meaningless by surfeit of global suppliers. The seemingly specious argument that IBM had persisted with in defense of the antitrust lawsuit – that they faced a constant and formidable competition – became frighteningly true with the onrush of competitors in all arenas.

Innovative thinkers and pioneers like Steve Jobs, Ken Olsen and countless others had ushered in a sea of change to challenge IBM's monopoly. It is ironic that the company whose founder coined the 'Think' mantra never realized that 'monopoly of thought can never be achieved'¹⁸.

3.2 Wrong Cures

Great success often enslaves the management to the same processes that wrought the success, even though they may become antiquated. IBM's recidivism is largely to blame for inability of IBM to cope with the new markets. As the markets changed around it, IBM kept trying to re-establish its monopolistic regime using its old bag of tricks:-

F.U.D.: In 1989, IBM prematurely announced OfficeVision – which would link IBM mainframes to its AS/400 minis and PS/2 computers. But the blue boy had cried wolf one too many times. In the eventual delays, customers did not wait for IBM, and instead chose the networking options brought to the market by its competitors¹⁹.

Proprietary control: After it's own product – the IBM-PC - had effectively established an open standard, IBM tried to regain proprietary control of the market by introducing it's PS/2 line of computers running the OS/2 operating system. But customers rejected being led by IBM and stayed with the open PC standard. IBM's actions again had the opposite effect than desired as IBM ended up falling between two stools.

Segmentation to avoid cannibalization: Compatibility across the S/360 line was the bedrock of its success. However throughout its later history IBM could not overcome its fears of cannibalizing its main product lines, and used incompatible product lines in order to segment and protect its markets.

Results were half-hearted measures like System/Three, PC Jr. or PS/1 which failed on the market. These were either deliberately incompatible or unnecessarily deficient in features to

avoid eating into their higher-profit counterpart product lines. Where IBM failed to cannibalize its existing products its competitors didn't. It was a hard way to learn the lesson that "Either you eat your own children, or somebody else does"²⁰.

Unfortunately one tactic which – marred by its mainframe focus – IBM did abandon, could have benefited it. This was to not leave any market segment uncontested. If it had displayed the same historic focus to deal with the encroachment of Mini's and Micro computers quickly and emphatically, perhaps its history would have been written differently. It almost seems that IBM, governed by some perverse logic, tried to stem the tide of the technology by refusing to enter these new markets. Perhaps concerned that its entry would grant legitimacy to the market; thus fueling its uncontrolled growth, which would then threaten the old order.

4 Company Culture

In hindsight it is clear that IBM's cultural problems were long time in the making. Understandably in the heady days of S/360 and later IBM was recognized and lauded for its managerial excellence²¹. But the cracks began to show as soon as the ship ran into rough waters.

4.1 Self-Denial and Mounting Hubris

By the 1980s, IBM internal view of being the epitome of excellence in technology, customer service and respect for individual had strayed far from the reality.

In spite of their heavy R&D spending, they had little to show for it, especially in breakthrough innovations²². As exhibited by rivals CDC in Supercomputers and Compaq in PCs, when IBM could not control the market, it found it difficult to compete on the 3 Ps – price, performance and product features. IBM's shift in from rentals to sales had triggered a decline in customer relations and those relationships were never salvaged. IBM was also increasingly blamed for leading the customer – by force-feeding high-margin expensive products - instead of trying to learn their needs. Their much-touted full employment policy had been distorted to breed mediocrity²³ and its failure was only underscored by its eventual abandonment in the face of mounting challenges.

The false egotistical view was fueled by IBM's past successes and via management's repeated statements affirming their superiority in annual reports and to the media, even in the face of mounting challenges²⁴. IBM's mounting hubris was perhaps responsible for such actions as the \$100B goal set in 1980 and the 1984 purchase of Rolm with an ambitious goal to extend IBM's power to telecom. The eventual sale of Rolm was remarked as a close to 'one of the most embarrassing chapters in Big Blue's history'²⁵.

4.2 Bureaucracy

In 1982, IBM chairman John Opel noted that it took 31 approvals for an employee to get a needed piece of equipment²⁶. Bureaucracy, as with any large organization, had been a constant battle that IBM fought. Unfortunately the weapon that Opel and later his successors used to tackle it: "Reorganization", always failed to produce desired results.

IBM's policy of being their own producer and supplier resulted in groups protecting their own vested interests and a web of internecine deals. The separate divisions were often given ill-defined or conflicting missions²⁷, and things worsened as their markets overlapped with the progress of technology. The barriers between separate divisions also hindered any collaboration/cross-fertilization of ideas or effort.

Bureaucracy quagmire was heavily to blame for IBM's late entry in almost each new market that emerged, be it minicomputers, engineering workstations, personal computers or laptops²⁸. Even after the prodigious success of the independent IBM-PC team, the machinery quickly moved in instituting layers of procedures, reviews and management²⁹.

These layers of management were always tied in a strict chain of command all the way to Armonk (IBM's headquarters). The citadel of power was the Corporate Management Committee (CMC), lorded over with a heavy hand by the chief executive. All proposals passed through the CMC before development commenced, which involved persistent lobbying and incessant visits to Armonk³⁰. In 1975, Rex Malik observed that at IBM 'power is as widely distributed as in Kremlin'. The balance of power never really improved, as Don Estridge – the iconoclast leader of IBM-PC team – himself noted 'all roads lead to Armonk'³¹.

4.3 Risk Aversion

After the near failure of System/360, Watson Jr had asked Vice-president Frank Cary to institute a system which would avoid the repeat of similar failures³². These beliefs were further compounded with the Future System failure. The culture would become increasingly risk-averse eschewing any technological gamble. Entrenched in their support for the legacy of System/360 mainframes, IBMers would become staunch supporters of the status-quo.

The IBM culture was marked by precautionary but dilatory practices such as 'non-concur', which would allow anyone disagreeing with a product plan to raise their objections all the way to the top management. This known culture was partially responsible for deterring any 'high-flyers' to the company; out-of-the-box thinkers who could possibly have transformed its culture. It is conspicuous that none of the notable ex Xerox PARC employees - responsible for seeding so many innovative companies – joined IBM³³.

The inaction, perpetuated in IBM by its fear, proved to be the worst action in the competitive technology industry. As a consequence IBM suffered on many occasions, for instance following the FS failure, IBM shied away from the RISC technology which it had itself pioneered, only to later play catch-up to SUN, HP and others that had established a successful market presence based on RISC workstations³⁴. The overly-cautious system which had been set in motion by Watson Jr. only succeeded in ensuring that not the failures but the success of System/360 project was never repeated.

5 Independence: won and lost

The story of IBM-PC is legendary and has been told many times. Several 'Independent Business Units' (IBU) were setup under the aegis of Frank Cary and then endorsed by John Opel³⁵. They were created as a prescription to resolve the maladies of the rampant bureaucracy and stagnancy. One such IBU led by Don Estridge in Boca Raton, Florida was setup to deliver an IBM-PC. Freed of the conventional shackles the team certainly delivered a stupendous success. The product was delivered in unprecedented span of only 13 months³⁶ (compared to typical IBM gestation period of 2-3 years³⁷) and was a smash-hit success in the market.

However due to its strict deadlines and the freedom given to it, it took some unprecedented decisions. The PC comprised mainly of 3rd party components, primarily microprocessor supplied by Intel and the Operating System by Microsoft. Controversially the contracts with Intel and Microsoft did not restrict them from selling their wares to IBM's competitors. The proprietary core of the PC, the BIOS was quickly and brilliantly reverse-engineered by Compaq³⁸ and soon

by others; this opened the flood-gates to IBM clones. Even as the PC-standard proliferated, IBM saw its leadership in PC deteriorate and later all but vanish as the PC fell to a commodity status.

5.1 What if?

The immediate question that arises is why were IBM's fortunes essentially signed away in those contracts with its suppliers – namely Intel and Microsoft. The answer is provided by IBM's initial estimate of the lifetime sales of the PC – a paltry 250,000³⁹. With so little at stake the IBM-PC group was allowed to write its own rules. Had the management had any premonition of the true market-demand, the independent effort and therefore perhaps even the resulting success would not have occurred, much less the contracts in question.

It is arguable though whether IBM would have been wholly saved, simply if the contracts were signed differently or had the parts been delivered internally, thus providing proprietary control. It is possible with the lack of an Open standard the market absorption would have been slower. Possibly Apple and other new platforms would have fragmented the market. Even if IBM had dominated a proprietary IBM-PC market, competitors could have forced it to cross-license its technology as per its 1956 consent decree (an old loss to the antitrust). And in microprocessors, cloners could have plagued IBM as always. IBM possibly would not have been able to set the blistering pace that Intel did to shake them off.

Of course even the unqualified success of IBM-PC would not have resolved any of the inherent problems at IBM which necessitated the setup of an independent unit for its development – implying that the regular IBM was incapable of delivering products to meet the demands of the new market.

5.2 What was really lost

Failures are always hard, and it is even tougher to show the maturity to learn from them. But it was a tragedy for IBM that it didn't even learn from its success. A decade before all its problems came to a head; the small team at Boca Raton had showed what was possible if the energy within IBM was let loose. The model demonstrated the possibilities if the bureaucracy and insularity rampant in IBM could be cut in a swath.

The rigid culture of IBM was clearly at odds with the free-spirit espoused by the IBUs. They could not co-exist for long; unfortunately it was the IBU model that was dissolved. The true lack of independence of IBUs was apparent by the reeling in of the IBM-PC unit upon its success. Don Estridge was 'kicked upstairs' to Armonk, a regular IBMer was put in-charge of the rechristened 'Entry Systems Division' which was eventually moved to New Jersey – a location much closer to the Armonk headquarters⁴⁰.

What IBM needed was to assimilate the learnings and the culture of the IBUs. Instead it found itself trying various alliances with companies such as Apple, NeXT and Intel, hoping to 'beg or borrow'⁴¹ or have rubbed-off some of their ingenuity and innovation, when it had already lost an opportunity that had presented itself a decade ago.

6 Conclusion

In 1993, Louis Gerstner took over the reins of IBM from John Akers. The turnaround he engineered is certainly creditable. His first decision was to keep the company whole and not sell off its separate divisions. Watson Sr. had stated that IBM was in one business 'of meeting its customers needs for information processing'. That still rang true in the mid 1990s. Thus by not

breaking up the interdependent parts of the company that served the customer, Gerstner took a step in the right direction.

Gerstner steered the development of a niche but successful market for the dying mainframes. He also rightly put his trust in the IBM employees by not making any radical changes, but adopting a gradual reform to overturn bureaucracy and bring back the focus on customer needs. IBM found its success in the consulting and services realm. Although shifting the focus away from its base of hardware and technology, still serving the needs of the customer by helping them leverage technology to serve their business needs.

The old IBM however, had died in 1993. The dominant, indispensable position that IBM occupied was no more. The new IBM that has emerged, although highly successful, is still only a shadow of its former self.

7 Notes

¹ Pugh, E.W. (1995). pp. 324

² Heller, R. (1994). pp. 345

³ Pugh, E.W. (1995). pp. 309

⁴ IBM's mainframe profits were reported to be 50% of its total sales & 70% of its total profits in 1980; and 44% of its total sales and 50% of its total profits (Source: Heller, R. (1994). pp. 260)

⁵ IBM reduced its employee from the peak of peak 405,535 in 1985 to 256,207 in 1993. (Source Pugh, E.W. (1995). pp. 324)

IBM incurred 24 billion dollars in restructuring charges (largely for severance pay for dismissing people and closing factories) between 1991-1993 (Source Mills, D.Q. & Friesen, G.B. (1996). pp. 86)

⁶ Statement by Alan Kay – Xerox Parc & Apple employee (Source Heller, R. (1994). pp. 115)

⁷ In spring 1991, IBM's typewriter and printer divisions were spun-off to form Lexmark. The company prospered after its divestiture by IBM. (Source Heller, R. (1994). pp. 281-283)

⁸ Pugh, E.W. (1995). pp. 313

⁹ Heller, R. (1994). pp. 282

¹⁰ Ibid. pp. 260-261

¹¹ Ibid. pp. 271

¹² DeLamarter, R.T. (1988). pp. 87-88

¹³ For IBM 1401 line, profit rate varied from close to 40% on mid-scale commercial systems where IBM had a stronghold, to as low as 15% in higher-end entry level market where IBM needed to fend off competitors. Indeed prices for many subcategories in various lines were marked for a loss and no profit at all. (Source: DeLamarter, R.T. (1988). pp. 18,49,77, 80)

¹⁴ Tom Watson Jr. – “It was our job to make sure that for the well-placed rivals like GE and RCA, the computer marketplace seemed too risky a bet”. (Source Heller, R. (1994). pp. 92)

¹⁵ During its early history, none of IBM’s competitors has been claimed to have matched IBM’s support and service levels and certainly not their sales team. However Remington-Rand and Burroughs are particularly blamed for their failure in this. (Source: Sobel, R. (1986). pp. 41-64)

¹⁶ After the announcement, CDC was unable to book a single order for 18 months. (Source: Slater, R. (1999). pp. 95)

Eventually CDC filed a private antitrust lawsuit against IBM for such practices, and IBM ended up settling this suit at a high cost. As terms of settlement, CDC was sold the IBM’s Service Bureau Corporation for much lower than it’s actual value, and awarded with cash and contracts worth \$101 million. (Source: Pugh, E.W. (1995). pp. 298)

¹⁷ Heller, R. (1994). pp. 22,71

¹⁸ Statement by Alan Kay – former Intel CEO (Source Heller, R. (1994).. pp. 118)

¹⁹ Heller, R. (1994). pp. 261-262

In an ironical sequence of events Microsoft is contended to have the same tactics by pre-announcing its Windows NT operating system to spread F.U.D. against IBM’s OS/2 operating system. (Source Heller, R. (1994). pp. 198)

²⁰ Heller, R. (1994). pp. 129,254,319

²¹ IBM was selected for many years as the Most Admired Corporation of America and noted by its peers as leader of quality and excellence (Source Heller, R. (1994). pp. 2)

²² Efreem Mallach (lecturer and consultant) noted six big-bang innovations of that era, none of which came from IBM – word processing, networking, Unix, virtual memory, database management, and multiprocessor mainframes. (Source Heller, R. (1994). pp. 101-102)

²³ Mills, D.Q. & Friesen, G.B. (1996). pp. 157

²⁴ Perhaps the most famous is Frank Cary’s remark on being asked what were the chances of IBM’s success; his response was “100 %” (Source Heller, R. (1994). pp. 9)

²⁵ Heller, R. (1994). pp. 160

²⁶ Ibid. pp. 47

²⁷ Pugh, E.W. (1995). pp. 313

²⁸ IBM is noted to have a four year lag in PCs, eleven-year lag in minis, five-year lag in both laptops and engineering workstation. (Source Heller, R. (1994). pp. 338)

²⁹ Heller, R. (1994). pp. 175

³⁰ Ibid. pp. 83.

Following the success of the IBM-PC Don Estridge reportedly spent upto 80% of the time in Armonk (Source Heller, R. (1994). pp. 175)

³¹ Heller, R. (1994). pp. 47, 175

³² Ibid. pp. 270

³³ Ibid. pp. 115

³⁴ Pugh, E.W. (1995). pp. 316

³⁵ Heller, R. (1994). pp. 54,80

³⁶ Ibid. pp. 33

³⁷ Ibid. pp. 106

³⁸ Ceruzzi, P.E. (2003). pp. 278

³⁹ Heller, R. (1994). pp. 33

⁴⁰ Ibid. pp. 176

⁴¹ Ibid. pp. 142

NeXT Software

– Bernt Wahl

1 Early History

In September 1985, Steve Jobs left Apple Computer, the company he had co-founded with his friend Steve Wozniak 9-years earlier that had ushered in the Personal Computer Age. At Apple Jobs was no longer viewed as the wunderkind, he had been exiled from decision-making and relegated to minor roles.

Soon after Jobs' leaving, Apple sued, claiming his access to privileged inside information compromised trade secrets. Steve Jobs' rebuttal, "It is hard to think that a \$2 billion company with 4,300-plus people couldn't compete with six people in blue jeans."¹ The suit was ultimately dropped, leaving Job's team free to create the 'NeXT' Computer.

From the beginning, Jobs' envisioned a NeXT Computer intended for the soul. Forged out of Magnesium, the twelve-inch 'Black Cube' was as much icon as machine. A machine designed to epitomize style, with the utility of a true workstation. Form carried over into functional art. Unencumbered by legacy code, the NeXT Machine provided utility for developers and engineers as the Macintosh had done for graphic artists and publishers.

Built on a Mach Kernel, Berkeley Unix and WYSIWYG Display Postscript, the workstation soon became a favorite within the academic engineering community. Priced at \$10,000, the machine sold for roughly half as much as competing models. It came equipped with a 25 MHz Motorola 68030 CPU, a Motorola 56001 DSP Chip, 8 MB of random access memory (RAM), a 256 MB MO drive, Ethernet, NuBus and a 17" 'MegaPixel' grayscale display. Hardware aside, what set the NeXT Workstation apart was its comprehensive suite of software. The NeXT Cube shipped with high-resolution Postscript-enabled graphics programs, a word processor integrated with a digital version of the Oxford English Dictionary, emails that incorporated voice messages and images, Mathematica (an industrial grade analytic engine), sound synthesis modules and other innovative software programs.

By 1987, NeXT's manufacturing facility was completed in Fremont, California. It was capable of producing 150,000 machines per year. Inventory, manufacturing and testing was controlled by dozens of NeXT Cubes and seven humans.

In October 1988, at Davis Symphony Hall in San Francisco, Steve Jobs showed the 'NeXT Cube' to a packed auditorium of dignitaries, the press and invited guests². Ironically, the event was held a stone's throw from Brookes Hall, where Jobs launched the Apple I in 1976, and where Douglas Engelbart had in 1968 transformed computing by demonstrating the mouse, hypertext, multiple windows, and network collaboration in what has come to be known as "The Mother of All Demos"³ -- features Jobs was now championing in his new machines.

For a brief time, Steve Jobs was on top again. Jobs' picture adorned Newsweek along with a myriad of other business and computer magazines. The press gives accolades to the 'NeXT

Machine'. Soon a faithful following ensued; young academics were scrambling to get their hands on NeXT Computers. Around the world, NeXT user groups, such as BNUG, sprung up. At research centers, scientists used the machine to track physics experiments and share files online. One fellow -- Tim Berners-Lee -- used his machine to create an online publishing protocol which he dubbed the World Wide Web (WWW). At the NeXTWorld Expo 5000 attendees packed the Moscone Center to hear Steve's vision⁴. NeXT became the machine to have. How did this NeXT Machine fail?

NeXT Computer's initial strategy was to manufacture affordable workstations, targeted toward sophisticated, performance-driven individuals in academia and publishing, sectors long ignored by other manufactures. To assure adequate software availability the company actively recruited software development. It then bundled some of the software with its machines.

Soon NeXT's innovation and media popularity made it an industry target. The young firm simply had taken on too many fronts to be effective as both a hardware and software company. Established companies like SUN and Microsoft saw the firm as a threat. Competing companies publicly discredited NeXT's value proposition -- pointing out the machine's weaknesses in performance, while internally adopting many of its innovative features. As NeXT found areas to exploit, larger, entrenched companies patched up their own weaknesses as they spread FUD (fear, uncertainty and doubt) about NeXT's future. SUN's co-founder Scott McNealy stated, "It's the wrong operating system, the wrong processor, and the wrong price."⁵ Microsoft's Bill Gates said, "We look at it [NeXT Computer] and there was nothing there that we found of interest"⁶.

Over time, Steve Jobs realized that if his firm was going to be competitive, he would need to in list strategic allies. Besides Motorola - NeXT's source for processors -- the firm developed a strategic partnership with Canon. A market leader in laser printing as well as the OD Drives, Canon brought expertise in manufacturing, supplied key components and invested \$300 million in NeXT. Jobs also partnered with Lotus for spreadsheets, Intel to broaden platform adoption⁷, Adobe for publishing and other 'best of breed' firms who wanted to share in the NeXT vision.

2 Failure in Hardware

The fast 88000 RISC processors from Motorola --critical to NeXT's performance sustainability -- never materialized in quantities or price points needed for its 'next' generation machine. The delay of the 88000 put NeXT in a compromising hardware position without an alternate plan to fall-back on. With the advent of the MIPS RISC chip and SUN's SPARC chip competitors surpassed NeXT in performance.

IBM-compatible PC's performance weakness was their reliance on Intel's CISC architecture, a rich instruction set with poor performance. What kept the market viable was that these processors ran legacy software and had lower prices due to economies of scale. RISC architectures on the other-hand -- found in high-end workstations -- were optimized for performance. NeXT found itself in a position with slower processors than other workstations that cost more than standard PC processors.

NeXT's misfortunes were not just limited to processors. In its effort to push its new technology, the firm ignored customer concerns. When the NeXT machine initially shipped, it only came with a 256 MB magneto-optical drive for storage. While this was an unprecedented amount of storage at the time, the disks were slow, had a limited lifespan, and cost \$50. It took NeXT a considerable time to acknowledge the machine's storage shortcomings and offer additional storage peripherals: hard drives, CD ROMs and floppy drives. This lack of attentiveness created frustration and ill-will in the NeXT community. Furthermore, an initial lack of color display capabilities limited opportunities in certain markets.

NeXT's inability to gain market share in the saturated workstation hardware market proved to put the company in a distinct financial disadvantage. In the end roughly 40,000 NeXT machines were produced, with a peak production rate equivalent to one-third of SUN's market.

3 Limited Success in Software

NeXT came to the conclusion that it could not compete effectively on two fronts, so it chose to focus on software. The NeXTStep OS (operating system) -- often seen by outsiders as the best option for a united front against Microsoft -- gained limited traction. Deals followed, IBM planned to bundle the NeXTStep OS and SUN⁸ finally decided to license the NeXT OS. With NeXTStep fashioned to be programmer-centric, coders found development on the new OS ideal. Developers programming with NeXT's built-in object oriented libraries and tool builder, found that projects could often be coded in a fraction of the usual time. Niche markets developed for NeXT software; finance firms used it for forecasting, auto firms for modeling, musicians for sound synthesis, engineers for computations, Pixar (Steve Jobs' animation studio) provided software for rendering purposes and WebObjects (NeXT's merchant server software) became a profitable enterprise software. Steve Jobs continued to nurture the company, convinced that someday the merits of the NeXT's OS and its revolutionary software would be realized. A belief he also held in his other money-losing company, Pixar.

4 NeXT's Big Break

Meanwhile, across the bay, Apple was experiencing bleak times. Apple, once the dominant player in the PC industry, had lost substantial market share since Jobs' departure. It now found itself without a next-generation operating system. Apple's ill-fated attempt to build its new OS (Copland) based on an outdated system structure, was failing. The firm was hemorrhaging money and with no successor to its Apple OS 9, Apple started looking for alternative solutions to its internal development efforts. Apple was seriously considering the purchase the Be OS, produced by a small firm founded by Jean-Louis Gassie, Apple's former CTO. The Be OS proved to be a reliable fast running OS with extensive multimedia capabilities.

On December 20, 1996, Apple Computer made a surprise announcement. For \$400 million in cash, Apple had acquired the firm with the sophisticated OS that could carry its Macintosh Computer line into the future. The firm was NeXT, the OS was NeXTStep and as an added bonus the firm came with a hardheaded visionary with ideas on how to create "an insanely great" computer. His name was Steve Jobs.

5 Final Analysis

In the final analysis both NeXT and Apple survived because of complementary needs. NeXT Computers had tried to enter the fiercely competitive workstation market using innovation. Its inability to gain market share in a saturated market without a distinct advantage put the firm in a vulnerable financial position. Though the NeXTStep OS could potentially have had broad appeal, NeXT's drive to lead in innovation pushed hardware costs too high for a mass-market machine. This is similar to what happened to another pioneering machine, the Xerox Alto more than a decade earlier. Issues like NeXT's incompatibility with Window's software; user unfamiliarity with the new brand and the product's unknown capabilities also complicated its adoption by a large customer base.

Apple once dominated in the PC industry by providing low-cost solutions to a waiting computer market, but in the mid 90's found itself fighting a war against low-priced commodity hardware. Without an updated operating system to differentiate its machines, Apple customers refused to pay the premium prices associated with its Macintosh Computer. Apple failed to deliver on a new OS, and was in jeopardy of losing its remaining market. Both companies failed to deliver products that customers needed at prices they were willing to pay.

6 Postscript

In the end, Apple and NeXT got lucky. With their combined resources the two computer brought out a product with a world class OS (NeXTStep and Unix), under one of the world's most recognized brands (Apple), at prices consumers were willing to pay, with abundant software that was easy to use, in really cool looking packages. Adoption under the Apple brand saved the NeXTStep idea from extinction. Maybe the lesson learned here is that success is based on functionality, looking cool and giving customers what they want at a price they could afford. When the value proposition is no longer there customers will seek alternative propositions.

7 Notes

¹ Stross, Randall (1993). *Steve Jobs and the NeXT Big Thing*. Athenium, 56

² At the NeXT Introduction, a PR person did not let Time Magazine photographer in, a mistake that may have had cost Jobs a cover shot. Source Bernt Wahl, personal observation.

³ *The Story of Computer Pioneer Douglas Engelbart's use of Power and Influence to Boost Humanity's Collective IQ*, Bernt Wahl (1998)

"If the computer is the machine that changed the world, then Douglas C. Engelbart's Augmentation Research Center at SRI (Stanford Research Institute) in Palo Alto, California transformed it into something the world could use. Using a combination of charisma, vision, organizational skills and sheer determination, at a time when punch cards, vacuum tubes and teletype machines were synonymous with computing, he led his research group to pioneer computing devices that would help people collaborate. These mechanisms of computing would later be known as the mouse, multiple windows, email, hypertext and teleconferencing. Today it

is hard to imagine the digital world without his creative influence, but when he first proposed them he was dissuaded from pursuing this research, both in his Ph.D. theses and later academic work. It was by felt colleagues in the 1950's and 1960's that these 'wild ideas' were unlikely to produce worthwhile applications, especially ones worthy of tenure at a major university like U.C. Berkeley where he was teaching. "

⁴ Steve Jobs sheds tear at NeXTWorld in front of 5000 attendees after Andy Grove is given a lecture on how to follow 'Steve's Passion' by devotees.

⁵ Scott McNealy's standard reply to NeXT comparisons

⁶ Bill Gates discussions with Bernt Wahl (1993)

⁷ Bernt Wahl shows Intel CEO Andy Grove how to operate a NeXT Computer (1993)

⁸ Years earlier, Steve Jobs is reported to have kicked in a SUN Microsystems sign because of a refusal to license the NeXTStep OS

Silicon Graphics (SGI)

– Chris Scoville

1 SGI History

SGI was founded in 1981 by Jim Clark, Abbey Silverstone, and Kurt Akeley (among other Stanford graduate students), with funding from venture capitalists to produce graphics display terminals, and the company later became an industry leader for creating workstation computers used mainly for producing and displaying detailed and complex 3D graphics. In SGI's successful years, they had two important products that set them apart from competitors: fast computers and well-written and efficient graphics libraries. The graphics libraries became the base for the widely used OpenGL standard. In the 1990's, SGI workstations were widely being used by many of the major Hollywood film studios to create special effects for films (a market that gave SGI lots of publicity but not the majority of their profits). The ground-breaking special effects in the films Terminator 2 and Jurassic Park were created on SGI workstations. SGI reached the pinnacle of their success in 1993-1994. SGI's earnings grew from \$167 million in 1988 to just over \$1 billion for the fiscal year ending June 30, 1993 because SGI's workstations were being used for mechanical engineering, computational chemistry, molecular modeling, movie special-effects work, and scientific research and simulations. At this time, SGI's architecture was on the cutting-edge for graphics workstations, which contained "a MIPS chip (SGI purchased MIPS in 1992), SGI proprietary application specific integrated circuits (ASICs), which is referred to as the "Geometry Engine", and SGI's Graphics Library, some of which was built into the hardware" (Goldberg, 1994).

SGI's founder Jim Clark knew that SGI could not rely on selling graphics workstations forever, and wanted to take the company in new directions, but he could not convince the CEO, Ed McCracken and the other executives at SGI to follow his ideas. "SGI's founder began telling his executives that the future lay in things like cable-TV boxes and digital game players" (Goldberg, 1994). In 1993 Clark negotiated a deal to have SGI produce the graphics processing chips for the 64-bit Nintendo game system, and shortly after, SGI decided to drop the deal with Nintendo because upper management thought it was too distracting to the core workstation business. Clark could not convince the company's executives to follow his ideas nor could he convince them that the graphics workstation market was coming to an end, and in 1994 he left the company over these differences.

In 1994 a new competitor emerged for the SGI workstation: multiple PCs networked together (called a render farm) running Linux or another Unix-based operating system and using graphics accelerator cards in each PC. This was often a cheaper option than the expensive SGI workstations, and the recent advancements in 3D graphics performance by the NVidia and ATI graphics accelerator cards made this a viable option for many users. SGI's competition came from personal computers, yet SGI decided not to devote the majority of the company's focus on the PC market. In 1996, SGI entered the supercomputer market by purchasing Cray Research, and in 1998 SGI continued to invest heavily in the workstation market when they announced they were switching architecture designs to use the Intel Itanium chips. The Itanium chip was delayed and did not have the fast performance that was expected, and "the attempt by SGI to

introduce its own family of Intel-based workstations running Windows NT proved to be a financial disaster, and shook customer confidence in SGI's commitment to its own RISC-based MIPS line" ("Silicon Graphics", 2006).

In 2000 as SGI began to lose more business to PCs and other companies producing graphics workstations, the company sold their Cray supercomputer business to Tera Computer Company, and in 2001 the company had to cut more jobs. In order to maintain focus on the workstation market and make up for lost income, SGI sold a number of patents to Microsoft in 2002, and sold Alias in 2004 (most popular for the Maya software used to create 3D graphics and animations), which it had acquired in 1995. The company succumbed to its competition, and on May 8 2006, SGI filed for Chapter 11 bankruptcy protection. "SGI's market capitalization had dwindled from a peak of over seven billion dollars in 1995 to just \$120 million at the time of their delisting" ("Silicon Graphics", 2006).

2 Analysis of SGI's Failures

Jim Clark's departure from SGI is not the single event that caused the downfall of the company, nor can one confidently say that had SGI followed Clark's ideas, it would still be in business today, but Clark's history and involvement in the company offers insight into how the company was run and the mistakes made by the upper management of the company. The venture capitalists that originally supported SGI appointed a CEO and an executive team to run the company and the founding engineers. "By the time SGI made its first sale, Clark and his engineers owned little of the company they started" ("Jim Clark 1944-",2006). In the early 1990's, the executives wanted to continually invest in the core technologies that brought the company revenue (graphics workstations) and a few other technologies that were closely related (SGI shipped PC graphics accelerator cards for a short while), while Clark predicted that the company needed to pursue new opportunities or they would fail and become "the Cray computer of the 90's" (Goldberg, 1994). Tension grew between Clark and the executive team, causing a rift between some of the top engineers and the management. Clark was quoted, "I've come to conclude that at companies, as they get large, management simply cannot and will not look at new opportunities" (Goldberg, 1994). Clark's complaint about management and the fact that management did not want to accept ideas from the top engineers shows how the management was disconnected from the engineering ideas and vision. The executives weren't completely sure what new areas the company should get into, and they passed on a few ideas that could have been profitable and decided to focus mainly on graphics workstations. They passed on Clark's ideas about interactive television and game consoles, which has since turned out to be a profitable market shown by the by the success of Media Center PCs and video game consoles from companies such as Microsoft, Sony, and Nintendo. The management also decided to discontinue shipping PC graphics cards, which Kurt Akeley, one of SGI's co-founders, mentioned was the wrong decision. He stated that they should not have given up after initially failing. This is because PCs with advanced graphics cards was the competition to the SGI workstation that mainly contributed to SGI's loss of market share.

One of SGI's most costly mistakes was that the company did not react well enough to competition from PCs (render farms running Linux). SGI focused mainly on producing expensive workstations and even supercomputers at a time when less expensive personal

computers with NVidia or ATI graphics cards were being networked together to do the same work as the SGI workstations. Instead of trying to create a better solution for personal computers, SGI decided switch to using the Intel Itanium chip in its workstation computers. The idea was that this chip would give a performance increase over the current RISC-based MIPS architecture, and in doing so would give the SGI workstations the processing power they needed to be better than the competition. The performance of the Itanium chip was disappointingly low when it was released and the chip was delayed for two years, costing SGI to loss more market share to competitors. This supports the notion that if you do not follow the industry changes related to Bell's Law of computer classes (the change from the workstation class of computers to networked personal computers), then you will not survive in the computer industry.

This switch in architecture was not only disappointing, but it also had a negative effect on the way customers viewed the company. Before the switch was announced, SGI's MIPS-based architecture was coupled with a version of a Unix-based operating system. After the switch to Itanium, SGI also experimented with products running the Windows NT operating system. The switches to different architectures and operating systems caused customers to question which technology would ultimately be supported. The customers using the MIPS-based architecture felt abandoned. When analyzing SGI's business model, Robert Weinberger, marketing manager for HP's workstation group said "Big worldwide Fortune 1000 companies want to make sure that the things they're buying today are mainstream strategies for that vendor. And the noise I hear from Silicon Graphics is, 'Gee it isn't. It's something we've been doing, but now we're doing something else.'" Customers are less willing to buy an expensive workstation if they are afraid it will not be supported in the long term. SGI developed the Unix-based Irix operating system, and shipped it with their workstations. Some of the subsequent versions of Irix were not compatible with older SGI hardware and software, causing customers to buy all new hardware and forcing them to either totally rewrite software or buy new software for the new OS. This compatibility problem did not help SGI as they faced new competition from other companies selling graphics workstations and PCs.

As SGI's profits increased, more people and companies took notice and wanted to take a piece of their market. Not only did SGI receive competition from PCs, but also companies trying to make money on graphics workstations. This competition was a change for SGI because they were accustomed to being the leader in a niche market without a lot of competition. In its early years, SGI was "able to avoid head-to-head competition with HP, Sun, DEC, and others because those companies underestimated the importance of 3D graphics. HP and all the other workstation vendors kind of left the door open in one particular segment of the market. SGI was smart enough to recognize that and rush through" (Goldberg, 1994). Bob Pearson, Sun's director of advanced desktop systems marketing once said "Visual computing has been a niche and SGI has flourished in that niche, but now it's becoming mainstream and the rules of a mainstream game are different than they are for a niche game. It's volume, price points, distribution. It's easier for Sun or HP to duplicate what SGI has done at higher volume and lower price points." SGI was forced to compete with other companies that offered similar products at lower prices, and this led to SGI developing a wider variety of products at different price levels. The problem for SGI was that suddenly there were a lot more options for customers in the graphics workstation market, and SGI was no longer always on the cutting-edge as they had been before. Kurt Akeley mentioned "SGI's business model was too expensive, but that had been determined early on,

with the decision to go for margin and to support early-adopter customers with hard-to-solve problems, rather than to go for volume (as Sun did). My sense is that this decision was essentially impossible to reverse—at least extremely difficult.” As more customers chose the cheaper options, SGI lost market share.

In an attempt to enter new markets, SGI purchased Cray Research and Alias Research. Alias produced software for creating 3D computer graphics and Cray Research developed supercomputers. “SGI's long-term strategy was to merge their high-end server line with Cray's product lines” (“Cray”, 2006). SGI hoped to take advantage of Alias’s advanced graphics software in their workstations. SGI ended up selling both companies after not realizing their goals for either acquisition. In fact, SGI sold the UltraSPARC-based Starfire part of the Cray business to Sun Microsystems shortly after buying Cray, and Sun used this to create the extremely successful Enterprise 10000 range of servers (often priced over \$1 million) which helped Sun compete with IBM in the high-end server market. Autodesk now owns Alias, which still sells the popular Maya software used to create 3D graphics and animation. Kurt Akeley mentioned “I’ve never understood the motivation to acquire Cray. The Alias/Wavefront acquisition kept key ISVs in the SGI fold, though of course this kind of acquisition never really succeeds, since the acquired groups must continue to do what is in their best business interest. This business error is made continually (even by Microsoft).” SGI was looking for these acquisitions to launch the company into new markets, but SGI didn’t have the vision or management to truly benefit from the acquisitions.

Losing Jim Clark’s vision and leadership was another mistake for SGI that could have been avoided. Clark has become a leader in the computer industry, and he has proven multiple times that he has the vision and insight to start successful projects. Clark originally tried to sell the “Geometry Engine” technology that started SGI to IBM and DEC, but when they passed on it, he decided to start his own company. SGI’s early success proved that IBM and DEC made a mistake when they passed on Clark’s technology. Soon after leaving SGI, Clark helped start Mosaic Communication Corporation, which later went on to create the popular Netscape Navigator internet browser, and after that, Clark went on to start the successful Healtheon project that would later become acquired by WebMD. Clark is an insightful and persuasive entrepreneur, and losing his leadership was a significant loss to SGI.

3 Conclusions from SGI

After analyzing SGI’s history, lessons can be learned from the company’s mistakes. There were three main problems that caused SGI to fail:

1. The upper management failed to have the insight about the future of the graphics industry to make the right decisions for the company. They passed on technologies that could have brought them success, and decided to focus on technologies that didn’t have as bright a future. If there is a disconnected relationship between upper management and the engineers of a company in which the ideas from the engineers get ignored, this can be very damaging to a company’s future because the innovative ideas that a company needs to survive and enter new markets never get realized.

2. They relied on one computer class and one product for too long. The workstation was losing market share to the networked personal computer, and SGI would was unable to successfully change focus and compete in the personal computer market.

3. When SGI faced heavier competition, they did not innovate at a fast enough pace to keep them ahead of the pack. Their offerings were too expensive when compared with the comparable customer's offerings, with no great technical incentive such as better technology to account for the higher price.

SGI never recovered from these problems and went bankrupt in 2006.

Comparison

– James Vasil

1 Comparison

History books (Schein, 2003) are filled with the names of companies that were once very important in the computer industry but are only talked about in the past-tense today. We have described the causes of some significant failures of computer companies and now we want to see what we can learn from their mistakes. For this reason, this section will examine which potential causes of failure were most important in each company's failure.

1.1 External Forces

1.1.1 Customers

With the exception of NeXT, the companies that we studied were all considered the leader in their field at one point in time. These companies excelled at many of the skills that business schools stress—they planned well, thought about the long term, and were very focused on the needs of their customers. One can, however, have too much of a good thing! In particular, by focusing too much on **current** customers, these companies ignored many **potential** customers that had different needs. Christensen (2000) heads one section of his book "Held Captive by Their Customers" (p. 19) and this phrase seems an apt summary of this concern. Even when a company recognizes that one of its product lines is dying off--as DEC may have done with minicomputers--it is still necessary for some continuing investments into that area to prevent their customers switching to a competitor's product and judging the right amount of investment to make seems to be difficult. Perhaps IBM's recent decision to get completely out of the PC market will eventually be seen as a very timely exit from a market that was on the brink of becoming a commodity.

NeXT seems to have had a slightly different problem related to customers and it seems possible that the "sophisticated, performance driven individuals in academia and publishing" simply didn't exist in sufficient quantities or weren't sufficiently unhappy with the other products to flock to their new one. Perhaps Jobs et.al. did not believe "that the vast majority of successful new business ventures abandoned their original business strategies when they began implementing their initial plans and learned what would and would not work in the market" (Christensen, 2000, p. 179).

1.1.2 Technology

A central need shared by any computer company is to have an intimate understanding of current technology. In his lecture, Gordon Bell discussed changes in technology (Bell, 2006) and separated these into two categories: advances in price/performance characteristics as predicted by Moore's Law, and the emergence of completely new classes of computers that tend to follow Bell's Law ("Bell's Law," 2006). Christensen (2000) discusses change in more general terms and would categorize Moore's Law and Bell's Law as being specific examples of changes due to "Sustaining Technologies" and "Disruptive Technologies." The impact of these two different types of changes on an existing company are very different so we will discuss them separately.

1.1.2.1 Sustaining Technologies

Most new technologies foster improved product performance. I call these "sustaining technologies".... What all sustaining technologies have in common is that they improve the performance of established products, along the dimensions of performance that mainstream customers in major markets have historically valued (Christensen, 2000, p. xviii).

Sustaining technology-type changes were not, in general, at the foundation of any of the failures we reviewed. It is true that mistakes were made in this area (e.g. Apple's not being ready for the rapid advance of PC performance or NeXT betting too much on the 88000 processor) but none seem to be the principle reason for the company to have failed. One possible exception might be the heavy bet that DEC placed on ECL technology. But even in this case the harm to the company may well have been more due to the timing of this mistake relative to the state of the company than the fact that they didn't see the coming advances in CMOS performance.

1.1.2.2 Disruptive Technologies

Disruptive technologies bring to a market a very different value proposition than had been available previously. Generally, disruptive technologies underperform established products in mainstream markets. But they have other features that a few fringe (and generally new) customers value. Products based on disruptive technologies are typically cheaper, simpler, smaller, and frequently, more convenient to use (Christensen, 2000, p. xviii).

Given even a superficial understanding of recent computer history (Mainframe Computers -> Minicomputers -> Microcomputers), it should not be surprising that three of the failures we reviewed were due--at least in part--to disruptive technologies-type changes. These are the classic cases of IBM not entering the minicomputer market in a timely manner and DEC not being successful in microcomputers plus SGI being unable to compete with PCs with enhanced graphics capabilities.

The most interesting question may well be **why?** As in "why were the big, successful companies unable to deal with disruptive technologies?" Part of the story is that "customers and financial structures of successful companies color heavily the sorts of investments that appear to be attractive to them" (Christensen, 2000, xviii). Needless to say, the complete story is much more complex (and interesting). If you are interested in learning more, reading "The Innovator's Dilemma" (Christenson, 2000) is a great place to start.

1.1.3 Incentives/Disincentives

There was little evidence that incentives such as patents, prizes, or government development contracts contributed to the failures we examined. On the face of it, this is not too surprising since the purpose of incentives is to encourage development of new ideas. But this result also suggests that incentives were not used to encourage any of the disruptive technologies that did contribute to the failures. And perhaps this observation is somewhat interesting.

Disincentives like lawsuits, antitrust actions, and government regulations may have contributed a little to these failures although the only instance of this that seems worthy of further investigation

are the antitrust actions against IBM. Even in this example it seems likely that the litigation was, at best, a secondary contributor to the failures.

1.2 Internal Forces

1.2.1 Management

Articles in the popular press frequently lay the blame for failures like these solely on the management of the companies. The stories of these failures show that this is a bit too simplified an explanation. It is equally clear, however, that the upper management at each of these companies did make significant blunders in how they responded to changing technology. The late and relatively unsuccessful entry into the minicomputer and microcomputer markets by IBM and DEC, respectively, are fairly typical examples of how companies respond to disruptive technologies. The fact that the management of SGI disregarded the company's founder's vision of where technology was headed is perhaps a bit more extreme.

A significant observation about these failures is that the external changes that precipitated these failures were **not** surprises to the company's managers. These changes caused failures because effective countermeasures could not be implemented. These facts and the internal confusion they caused were probably some of the more significant drivers for the widespread demoralization among employees that was reported at some companies.

There are many contributors to the inability to prevent these failures and the cultures and decision-making processes that had developed at these companies played their parts. For example, much of Schein (2003) is devoted to the culture within DEC. But if one needed a very concise description of the environment at these companies, observing how many of them were described as "arrogant" would be a good place to start.

Another frequent event in these stories is the "loss of key personnel" and the hiring of new, top-level managers who are being brought in to fix the problems. We note that bringing outsiders in to fix things was tried at Apple, DEC, and IBM. And that this tactic worked in none of these cases. It seems reasonable that personnel changes such as these are more characteristic of companies trying to recover after finding themselves in bad shape. If true, this suggests they are not too useful if one is looking for leading indicators of failure!

1.2.2 Product Implementation

We would be remiss if we didn't at least mention the actual products that these companies developed and observe that they frequently had significant flaws. The PCs that DEC produced were great demonstrations of what happens when you design products without understanding the target customer's needs. Likewise, the quality problems in some Apple products are a clear indication that the company wasn't focusing on this need.

One product-related problem that seems more pronounced in this report than expected is the number of times problems related to the Operating System software are mentioned. Perhaps this is due to the hardware orientation of many of these companies. But perhaps there is more to be learned by exploring this aspect of these failures and other similar ones.

Bibliography

- Akeley, Kurt. (2006). Interviewed over e-mail about the history of SGI by Chris Scoville.
- Apple III. In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006, from http://en.wikipedia.org/wiki/Apple_III.
- Apple Lisa. In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006, from [http://en.wikipedia.org/wiki/Apple_Lisa http://en.wikipedia.org/wiki/Apple_Lisa]
- Bell's Law of Computer Classes. (2006, November 10). In *Wikipedia, The Free Encyclopedia*. Retrieved December 3, 2006, from http://en.wikipedia.org/w/index.php?title=Bell%27s_Law_of_Computer_Classes&oldid=86927661
- Bell, C.G. (1984). The Mini and Micro Industries. *Computer*, 17(10), 14-30.
- Bell, G. (2006). Minicomputers: The DEC (aka Digital) Story (slides). Retrieved October 11, 2006, from http://www.cs.washintgon.edu/education/courses/csep590a/06au/lectures/slides/GBell_Oct_11.ppt
- Carroll, P. (1993). *Big Blues: The Unmaking of IBM*. New York: Crown Publishers.
- Ceruzzi, P.E. (2003). *A History of Modern Computing*, MIT Press, 2nd edition.
- Christensen, C.M. (2000). *The Innovator's Dilemma: The Revolutionary National Bestseller That Changed the Way We Do Business*. New York: Harper Collins Publishers.
- Copland (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved December 2006, from <http://en.wikipedia.org/wiki/Copland>
- Cray. (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved November 18, 2006, from http://en.wikipedia.org/wiki/Cray_Research.
- Declining Influence of IBM, The (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved November 18, 2006, from http://en.wikipedia.org/wiki/IBM_PC_compatible#The_declining_influence_of_IBM
- DeLamarter, R.T. (1988). *Big Blue IBM's Use and Abuse of Power*. New York: Dodd, Mead & Company.
- Digital 1957 to Present*. (1978, last edition). Retrieved November 18, 2006, from <http://research.microsoft.com/~gbell/Digital/DEC%201957%20to%20Present%201978.pdf>

- Digital Corporate Philosophy and Organization*. (1977). Retrieved November 18, 2006, from http://research.microsoft.com/~gbell/Digital/Dig_Corp_Philos_and_Org_7704.pdf
- DIGITAL Engineering Handbook*. (1974). Retrieved November 18, 2006, from <http://research.microsoft.com/~gbell/Digital/DEC%20Engineering%20Handbook%20741%20c.pdf>
- Digital Equipment Corporation. (2006). In *Encyclopædia Britannica*. Retrieved December 4, 2006, from <http://www.britannica.com/eb/article-9126078>
- Digital Equipment Corporation. (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved November 19, 2006 from http://en.wikipedia.org/wiki/Digital_Equipment_Corporation
- Disruptive technology. (2006, November 28). In *Wikipedia, The Free Encyclopedia*. Retrieved December 3, 2006, from http://en.wikipedia.org/w/index.php?title=Disruptive_technology&oldid=90613634
- Documenting DIGITAL*. (2006). Retrieved November 18, 2006, from <http://research.microsoft.com/~gbell/Digital/timeline/dechistory.htm>
- Eran, Daniel. (2006). *Tech: The Rise and Fall of Platforms*, Roughly Drafted Magazine. Obtained at <http://www.roughlydrafted.com/RD/RDM/1350A705-DE80-429A-BDC0-AE9272C1555E.html>
- Goldberg, Michael. (1994). *Fire in the Valley*, Wired Magazine Issue 2.01. Retrieved November 18, 2006 from http://wired-vig.wired.com/wired/archive/2.01/sgi_pr.html.
- Heller, R. (1994). *The Fate of IBM*. London: Little Brown and Company.
- History of Microsoft Windows, (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006 from http://en.wikipedia.org/wiki/History_of_Microsoft_Windows
- Hobart, Charles. (2006). Former IBM-PC Team member in Boca Raton, FL. Interviewed in person about the development of IBM-PC by Avichal Singh.
- Jim Clark 1944-*. (2006). Retrieved November 18, 2006 from <http://www.referenceforbusiness.com/biography/A-E/Clark-Jim-1944.html>.
- List of Commercial Failures in Computer Technology. (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved November 19, 2006 from http://en.wikipedia.org/wiki/List_of_commercial_failures_in_computer_technology
- Linzmayr, Owen. "Apple Confidential 2.0: The Definitive History of the World's Most Colorful Company"

- Macintosh 128K. In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006, from http://en.wikipedia.org/wiki/Macintosh_128K.
- Macintosh 512K. In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006, from http://en.wikipedia.org/wiki/Macintosh_512K.
- Maurer, Steven. "Antitrust & Computing" (course lecture) October 25, 2006.
- Mills, D.Q. & Friesen, G.B. (1996). *Broken Promises: An Unconventional View of What Went Wrong at IBM*. Boston, MA: Harvard Business School Press.
- Orlowski, Andrew. (2005). *SGI delisted, becomes penny stock*. Retrieved November 18, 2006 from http://www.channelregister.co.uk/2005/11/02/sgi_penny_stock/.
- Orlowski, Andrew. (2006). *Microsoft man's shadow over bankrupt SGI*. Retrieved November 18, 2006 from http://www.channelregister.co.uk/2006/05/09/sgi_chapter11_analysis/.
- Pugh, E.W. (1995). *Building IBM: Shaping an Industry and Its Technology*. Cambridge, MA: The MIT Press.
- Schein, E.H. (2003). *DEC Is Dead, long live DEC*, Berrett-Koehler Publishers, Inc.
- Shankland, Steven. (1999). *SGI cutting back key projects*, CNet. Retrieved November 18, 2006 from http://news.com.com/SGI+cutting+back+key+projects/2100-1001_3-229334.html.
- Silicon Graphics. (2006). In *Wikipedia, The Free Encyclopedia*. Retrieved November 19, 2006 from http://en.wikipedia.org/wiki/Silicon_Graphics.
- Slater, R. (1999). *Saving Big Blue: Leadership Lessons and Turnaround tactics of IBM's Lou Gerstner*. New York: McGraw-Hill.
- Sobel, R. (1986). *IBM vs. Japan: The struggles for the future*. New York: Stein and Day Publishers.
- Steve Jobs (2006) In *Wikipedia, The Free Encyclopedia*. Retrieved December, 2006 from http://en.wikipedia.org/wiki/Steve_Jobs
- Taylor, Dave. (2006). *Silicon Graphics files for Chapter 11 Bankruptcy*. Retrieved November 18, 2006 from http://www.intuitive.com/blog/silicon_graphics_files_for_chapter_11_bankruptcy.html.
- Wozniak, Steve. (2006). *How We Failed Apple: A founder laments a legendary company's decline*. Retrieved Dec 05 2006 from http://www.woz.org/pages/wozscape/Articles/Newsweek_FailingApple/FailingApple.HT ML