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WHY OS/2 FAILED: BUSINESS MISTAKES COMPOUNDED BY MEMORY PRICES

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ABSTRACT

In 2006, IBM ended their support of OS/2, closing the book on an ambitious effort to create a modern operating system for the personal computer. IBM and Microsoft released the OS/2 operating system in December 1987 to replace the primitive DOS with a more sophisticated, preemptive multitasking operating system for personal computers. This article argues that OS/2 failed because of the U.S.-Japan Semiconductor Trade Agreement of 1986, subsequent accusations of DRAM chip dumping by the United States, and the resulting tariffs on Japanese memory chips, led to a memory chip shortage that drove up memory prices. OS/2 required substantially more memory than DOS and users balked at upgrading their machines. The window of opportunity to adopt OS/2 passed, memory prices fell, and Microsoft Windows 3.0, introduced in May 1990, found extraordinary success in the market niche that OS/2 and its graphical user interface, Presentation Manager, had aspired to fill.

I. INTRODUCTION

In July 2005, IBM announced that they would end all sales of their OS/2 operating system by the end of the year and end all customer support by the end of 2006. IBM also revealed that they currently had "fewer than 80 customers that hold more than 10 licenses" of OS/2. (Kawamoto, 2005) This signaled the end of an odyssey that began two decades earlier as a joint effort by IBM and Microsoft to replace the DOS operating system with a robust, modern operating system for personal computers.

The original PC/MS-DOS 1.0 contained only 4,000 lines of programming code. DOS 2.0, released in 1983, contained five times that much code, and DOS 3.0, released in 1984, doubled the amount of code again, reaching 40,000 lines. But DOS was a primitive operating system at best, unable to effectively multitask or even effectively manage user memory above its 640 kilobyte limit. From the perspective of operating system sophistication, the personal computer remained a toy compared to the operating systems found on workstations, minicomputers, and mainframes. When

IBM released the IBM AT in 1984, based on the Intel 80286 microprocessor, corporate customers expected a more sophisticated operating system than DOS to run this faster 16-bit processor. IBM promised to deliver this and signed an agreement with Microsoft in 1985 to jointly develop a better operating system that could truly preemptively multitask and offer the other sophisticated services that advanced operating systems offered. IBM and Microsoft also agreed to joint ownership of the new operating system.

IBM and Microsoft had both already started pilot projects to build a next generation operating system. At Microsoft, the projects were called DOS 4.0 (not what later shipped under that name in 1989) and MT-DOS (multitasking DOS). IBM, of course, had considerable experience writing operating systems for larger computers. These projects were used as the programming source base for OS/2. Microsoft's site in Redmond, Washington, and IBM's site in Boca Raton, Florida, wrote and tested most of OS/2 1.0 Standard Edition (SE). IBM's site in Austin, Texas wrote most of the communications and database parts for OS/2 1.0 Extended Edition (EE). Extended Edition was a version of OS/2 specifically for corporate customers and included Communications Manager and the powerful Database Manager. IBM's sites in Hursley, United Kingdom, and Cary, North Carolina, wrote Presentation Manager (PM). The project went through many names, "DOS 5, DOS 286, Big DOS and CP/DOS." (Deitel & Kogan, 1992, p. 13)

As the new operating system came ever closer to being ready in late 1986, IBM was also about ready to release a complete redesign of their personal computer line. These PS/2 computers were intended by IBM to wrest control of the personal computer market back from the clone makers that had cut into IBM's market share and profits. The PS/2 line included a new bus, the Micro Channel Architecture, which IBM hoped to license to other manufacturers, so that PC clones would create some royalty revenue for IBM. IBM decided to call the new operating system OS/2, associating it in the public mind with its new PS/2 line, though OS/2 also ran on clone personal computers. The PS/2 line was launched in April 1987 at the same time that OS/2 1.0 SE was announced. OS/2 began shipping in December 1987.

The new operating system provided robust preemptive multitasking but would only run one DOS program at a time. In order to run simultaneously, all other programs had to be native OS/2 applications. The graphical user interface, Presentation Manager, was not ready for release, and came out with OS/2 1.1 in November 1988. Primarily concerned with their corporate customers, IBM positioned OS/2 as the "first offering" of their Systems Application Architecture (SAA), a concerted effort by IBM to coordinate all their different products into a common family, eventually giving software a common look and feel, and reducing confusion in

the marketplace over IBM products. ("IBM Highlights, 1985-1989," p. 15) Home users of personal computers were not interested in SAA.

IBM and Microsoft released regular updates to the new operating system, making substantial improvements as new components were added. OS/2 1.2 came out a year later, and included support for a new file system, High-Performance File System (HPFS). In October 1990, IBM followed this with OS/2 1.3, which tightened up on the memory requirements of the product so that it could continue to run on 80286 machines. The Intel 80386, a 32-bit microprocessor that enabled multiple virtual sessions of the earlier 8086/8088 microprocessors, had been out for five years by this time and in shipping personal computers for four years. IBM remained committed to its original promise that OS/2 would continue to run on 80286 machines even though the 80386 was a far superior choice.

The original software development kits from Microsoft and IBM were expensive, priced too high for the casual programmer to purchase. Other companies, especially Microsoft, learned its lesson from this and later provided software development kits at lower prices, or even for free, realizing that independent software developers (ISVs) were the true lifeblood of any successful operating system. Despite this mistake, most people in the personal computer field expected OS/2 to succeed. Over a dozen books were published on OS/2 in 1988, mostly for programmers, which reflected how much the computer industry subscribed to the idea that OS/2 offered the next great frontier. Many more books followed. Major software venders such as Lotus and WordPerfect devoted significant programming resources to porting their main applications to OS/2.

While OS/2 would actually run on a system with only one megabyte of RAM, another megabyte of RAM was necessary to get the system to do anything really useful. (Lafore & Norton, 1988, p. xv) Most users found that they really needed three or four megabytes of RAM. This requirement for more memory proved to be the Achilles heel of OS/2.

II. MEMORY CHIP PRICES

Not considered in any accounts of OS/2 is the effect of memory prices on the adoption of OS/2. The first version of OS/2 was released into the midst of a severe shortage of dynamic random-access memory (DRAM) microchips. Intel had invented the memory chip market in 1971 when they released the Intel 1103 single kilobit DRAM in 1970. By the early 1980s, Japanese and Korean firms were aggressively streamlining DRAM manufacturing techniques and gaining an ever-larger share of the American DRAM market. American DRAM manufacturers faced the financial

collapse of their market in 1985, forcing Intel to make the painful decision to quit the market altogether and rely on its microprocessors for revenue. Most other American DRAM manufacturers also quit the market. Texas Instruments, which held important integrated circuits patents, innovated in the legal realm and aggressively sued their competitors for royalties, eventually yielding billions of dollars. (Shell, 2004, pp. 119-128)

Micron Technology, based in Boise, Idaho, chose to lobby the federal government for help by filing an anti-dumping complaint with the Department of Commerce. A public relation campaign also ensued. This led to the U.S.-Japan Semiconductor Trade Agreement in 1986, imposing voluntary quotas and pricing on Japanese and Korean imports. The entire DRAM dumping issue reflected a wider concern in America at that time with the success of Japanese imports and a fear that American companies were failing to effectively compete. In March 1987, "the House of Representatives voted unanimously, and the Senate voted 93-0 to encourage the administration to apply sanctions on Japanese chips." (Yoffie & Gomes-Casseres, 1994, 465) Later that year, the Reagan Administration accused the Japanese of reneging on the trade agreement and imposed a 100% tariff on Japanese DRAM products. This further exacerbated the shortage of DRAM chips and drove up prices. Most American companies had already left the DRAM market by the time that the tariffs were imposed, so those companies were not in a position to manufacture DRAMs and make up the shortage.

As a point of interest, not everyone believed that the Japanese were actually dumping DRAM chips onto the American market. The Cato Institute, dedicated to the principles of the free market and free trade, argued that the tariffs were bad public policy and that the Japanese were actually selling DRAM chips at higher prices in the United States than their home market. (Richman, 1988, note 22) Of course, even if the Japanese companies were selling DRAM chips at lower prices in their home market, Japanese firms may have still been dumping in their export markets because there may have been unique economic conditions within their home market, such as different economic transaction costs.

Determining the actual prices of memory chips at any given time is difficult, "complicated by the extraordinary rate of introduction of new products embodying technical change and by the complexity of the sales channels and contractual arrangements used to market these products." (Flamm, 1993, pp. 194-195) An estimate put the grey market at 15% of total chip sales in 1989, where users had to turn to purchase memory chips during a time of severe shortages, and prices in the grey market can wildly fluctuate. (Flamm, 1993, p. 163) Illustrating sales on the grey market, in the late summer of 1988, the author purchased a megabyte of RAM for

$900 in southern Arkansas. Anecdotal evidence of memory prices described prices for DRAM chips more than doubling in 1988 from 1987 prices. (Flamm, 1988, p. A19) A later study found much lower memory price increases, using indexed comparisons to show that prices for DRAMS in 1988 increased only 16.5% to 27.3% from the previous year. These lower figures do not match the anecdotal evidence of street prices during that period of time, which fluctuated much more wildly. (Grimm, 1998)

An August 1988 article in Personal Computing argued that a user needed at least three or four megabytes of RAM for OS/2 to run well. The street price in mid-1988 for an extra 2.5 Megabytes of RAM was $2,125, similar to the price for a low-end personal computer. Furthermore, the article quoted Steve Ballmer, a Microsoft executive, when referring to increasing memory prices as "the worse news we've had when it comes to OS/2." (Bermant, 1988, p. 108) While OS/2 stumbled, Microsoft found another path.

III. WINDOWS

Even while working on OS/2 and Presentation Manager, Microsoft persisted in its own Windows efforts. Two earlier efforts at Windows, versions 1.0 and 2.0, sported interfaces that looked truly awful and were awkward to use. Microsoft Windows 3.0, released in May 1990 with a substantial marketing push, became an astounding commercial success. While Windows 3.0 could run on 80286 machines, it shined on 80386 machines. Three factors contributed to the success of Windows. First, Windows ran DOS programs well. Second, programmers at companies that made software applications had already been forced by the Macintosh and OS/2's Presentation Manager to learn how to program GUI programs. This programming knowledge easily transferred to writing software for the more successful Microsoft Windows. Third, the memory shortage had ended, and more users found it easier to buy the extra memory that Windows demanded. OS/2 1.0 was released in 1988 and Windows 3.0 was released in 1990; the price of memory dropped by two-thirds from 1988 to 1991. (Grimm,1998, 12) By the time that Windows 95 was released, a megabyte of retail RAM cost about $50, half of what it cost four years earlier. ("Windows 95," 1995) Only eight months later, the cost of eight megabytes of retail RAM had dropped to $125, a result of dramatic overproduction by DRAM manufacturers. (Needle, 1996) Memory prices continued to drop thereafter and have not stopped, even though American and foreign DRAM manufacturers were accused of price-fixing from 1999 through 2002, which led to fines and convictions.

The success of Windows 3.0 caught ISVs by surprise. WordPerfect, which owned 80% of the word processor market, had been devoting its resources to creating an OS/2 version. Reversing direction, WordPerfect worked feverishly on a Windows

version, finally releasing a version in November 1991, giving Microsoft ample time to turn its Microsoft Word for Windows product into a stout competitor. Other leading software products, such as Lotus 1-2-3, Harvard Graphics, and dBase, began to lose market share after Windows 3.0 changed the personal computer market direction from the command line DOS to the GUI Windows. Lotus 1-2-3 3.0 and WordPerfect 5.1 were the best-selling software packages in electronic spreadsheets and word processors respectively in 1991. By the year 2000, some version of Windows was on over 90 percent of the personal computers in the world, and in application software, Microsoft's Excel and Word programs had replaced most of the market share once enjoyed by Lotus 1-2-3 and WordPerfect. (Campbell-Kelly, 2001, pp. 133-134)

Microsoft Windows proved so phenomenally successful that in 1992, Microsoft actually began running television commercials, something that the computer industry rarely did, despite the example of the 1984 Apple commercial. Television, as a mass medium, had not been used up until then because the market for personal computers had not been a mass consumer product. Now it was.

The success of Windows showed a schism in the mind set between home users and corporate users. Home users seemed to tolerate buggy software in a way that corporate users found intolerable. A crashed system only inconvenienced a person playing a game, writing a letter, or balancing their checkbook, where a crash for a corporate system could cause substantial financial pain.

Microsoft had supported OS/2 whole-heartedly before the success of Windows 3.0. Gordon Letwin, the Chief Architect, Systems Software, for Microsoft, wrote in 1988, "Microsoft believes that OS/2 will be a major influence in the personal computer industry for roughly the next ten years." (Letwin, 1988, 267) The success of Windows 3.0 showed Microsoft that they could go it alone and did not have to share operating system revenue with IBM. (Edstrom & Eller, 1998, pp. 76-111) In September 1990, IBM and Microsoft began their divorce with a halfway measure: "IBM became solely responsible for the development of 16-bit and 32-bit OS/2, while Microsoft continued work on advanced OS/2 kernel technology and the Windows system. As in the previous development agreement, both companies retain[ed] rights to OS/2." (Deitel and Kogan, 1992, 17) The close partnership between Microsoft and IBM that had characterized the 1980s quite quickly became open antagonism. By this time, IBM was in deep disarray as they lost any semblance of influence in the personal computer market to the clone makers, found that personal computers were becoming the dominant market segment in the computer industry, and saw the mainframe market began to shrink. IBM actually began to lose money and lost an astounding $8.1 billion on $62.7 billion in revenue during 1993. That year, IBM brought in a new chief executive officer from outside the company, Louis V. Gerstner,

Jr., who managed to financially turn the company around through layoffs and refocusing the business on providing services. IBM remained the largest computer company in the world, but never dominated the industry as it once had. In contrast to IBM's size, Microsoft passed one billion dollars a year in revenue in 1990.

Microsoft realized that moving away from OS/2 meant that they now had no future direction for a server operating system, since Windows 3.0 was not really a new operating system, just a user interface program that ran on top of DOS. The Windows NT project at Microsoft fortunately provided a solution to this problem. Windows NT began as an effort to create a cross-platform operating system so that Microsoft would not be so dependent on Intel microprocessors. The cross-platform effort never bore much fruit, but Windows NT contained the multitasking features, security features, and memory management that had made OS/2, UNIX, and other minicomputer operating systems so useful. Windows NT 3.1 came out in 1993 but was not particularly successful until Window NT 4.0 came out in 1996. Microsoft now had two Windows operating system lines, one for business users and servers, and one for home consumers.

With Windows 95, where Microsoft chose to change from version numbers based on release numbers to those based on years, Microsoft updated the consumer version of Windows. Windows 95 was an important product because the ease of use and aesthetic appeal promised by the GUI paradigm, successfully achieved by Apple over a decade earlier, had finally been achieved by Bill Gates and his company. Microsoft understood the value of first impressions and the release of Windows 95 in August 1995 launched a $300 million advertizing blitz, including purchasing the rights to the hit song, "Start Me Up," by the Rolling Stones. IBM was not silent, as was reported in the Washington Post:

> Big Blue has made some effort to counter Microsoft's media onslaught with ads that feature the names of companies that have relied on its OS/2 system for years. Yesterday, at corporate headquarters in Armonk, N.Y., IBM officials reiterated the virtues of its own time-tested product and tried to ignore the festivities.
>
> "Microsoft is delivering the same features we delivered seven years ago," said company spokesman Tim Breuer. "We're moving on business as usual here." (Segal, 1995)

IBM's spokesman was correct. OS/2 was a superior operating system to Windows 95, Windows NT 3.51, and MacOS, but the race had been lost for OS/2 to penetrate the vital home market. The story of OS/2 demonstrated that institutionally IBM never

understood the home market. Ironically, Microsoft understood the home market very well, and regularly struggled to understand the corporate market and provide enterprise quality solutions.

Microsoft battled repeated complaints and lawsuits that they unfairly used their dominance in the operating systems market segment to then dominate other software market segments. These complaints were based on two assertions: first, that Microsoft created undocumented system calls that allowed its own applications to take special advantage of the Windows operating system. They had also done this in DOS. Second, that Microsoft set up special deals with personal computer manufacturers, where Microsoft sold their operating systems at a steep discount if the computer manufacturers would then only sell Microsoft applications software. These OEM (original equipment manufacturer) deals encouraged consumers to turn from buying their business applications software from retail stores to buying them from their computer manufacturer. The federal government twice investigated Microsoft for antitrust violations on their software distribution and pricing practices, both times found against Microsoft, and successfully sued once, but no effective legal counteraction was ever taken.

In 2004, Microsoft announced that it estimated that there were 600 million Windows-based personal computers around the world and expected that number to pass one billion in just six more years. Microsoft revenues continued to set records. In 2004, Microsoft employed over 50,000 people, and had a total annual revenue of over $35 billion, of which over $26 billion was gross profit.

IV. OS / 2 AND BEYOND

IBM was never able to regain any momentum for OS/2, though OS/2 had quickly matured into a solid and full-featured operating system. Though OS/2 1.0 had missed its opportunity to dominate the market, damaged by the memory chip shortage, IBM persisted and released OS/2 2.0 in April 1992. This version was truly a 32-bit operating system and could run multiple copies of Windows as OS/2 tasks under a legal agreement from prior to the IBM-Microsoft divorce. This was possible because Windows 3.1 was really just a DOS program. A marketing slogan from IBM declared "a better DOS than DOS, and a better Windows than Windows." (Powell, 1997) Oddly enough, this was a valid claim, since if Windows crashed while running as an OS/2 task, it would not also crash OS/2.

Among the innovations in OS/2 2.0 was a GUI that had an object-oriented user interface (an OOUI) rather than an application-oriented user interface. (Mandel, 1994, pp. 225-294) In the first year after releasing OS/2 2.0, IBM sold more than two

million copies, with customers in Europe more enthusiastic about OS/2 than customers in the United States. One can assume that mostly corporate customers purchased this product. IBM also "brought out more than 1,200 32-bit OS/2-specific applications and garnered 12 international awards from computer trade publications." (IBM Highlights, 1990- 1995, 20) OS/2 3.0 Warp, released in October 1994, won the "1995 Product of the Year" award from PC World.

OS/2 3.0 represented IBM's last try to make OS/2 into a significant player, with an elaborate launch that employed the actress Kate Mulgrew of the new Star Trek: Voyager television show. It received poor media coverage and suffered from an embarrassing bug in its installation procedure that had to be quickly fixed. Despite having such an excellent product, OS/2 did suffer from more limited device driver and printer driver support than Microsoft Windows. Manufacturers of video cards, printers, and other hardware add-ons understandably wrote their drivers for Windows first because that operating system dominated the market.

As described earlier, Microsoft understood and used the monopoly power of its position in the marketplace, engaging in aggressive anti-competitive tactics against IBM, punishing any ISV that wanted to write for OS/2, and any OEM who wanted to preinstall OS/2 on their personal computers for customers. (Rohm, 1998, pp. 203-206) Since the failure of OS/2 1.x meant that DOS still ran on most of the world's personal computers, Microsoft deliberately rewarded original equipment manufacturers (OEMs) such as "Compaq, Dell, and Hewlett-Packard" with cheaper prices on DOS and Windows and punished companies like "Gateway and IBM" with higher prices because they "resisted" Microsoft's efforts to "preserve the applications barrier to entry" in the personal computer market. (Jackson, 1999, 33) Microsoft also used licensing conditions with its OEMs to keep them in line and rationed technical information to other companies that might become competitors against Microsoft's operating systems and applications products. (Jackson, 1999, 34, 46-56)

When IBM announced in July of 2005 that they would terminate support for OS/2 at the end of the following year, few observers were surprised. For several years, IBM had been encouraging its OS/2 customers to migrate to the Linux operating system, which IBM had invested heavily in and vigorously promoted. (Mearian, 2003) Die-hard OS/2 fans complained on web sites devoted to the operating system and some encouraged IBM to release the OS/2 programming code as open source. Perhaps one of the reasons that IBM finally closed the coffin lid was that Microsoft earlier that month paid IBM $775 million to settle a long-running lawsuit for anti-competitive practices in the 1990s. This settlement fit in with the legal strategy of Microsoft to settle their outstanding anti-competitive lawsuits in order to end the distraction.

TABLE 1
OS / 2 RELEASES

Release	Date
OS/2 1.0 (16-bit)	December 1987
OS/2 1.1 (included Presentation Manager)	October 1988
OS/2 1.2	November 1989
OS/2 1.3	November 1990
OS/2 2.0 (32-bit)	April 1992
OS/2 2.1	May 1993
OS/2 3.0 Warp	October 1994
OS/2 4.0	September 1996

V. CONCLUSION

Obituaries of OS/2 point to IBM's lack of appreciation for the home market, its lack of vigorous support for ISVs, and the hidebound nature of an arrogant company secure in its dominance. Certainly, the story of OS/2 proved that those with illusions fall hardest. All of these explanations are true, but they fail to consider the mortal wound that OS/2 struggled against. The high prices of memory in the late 1980s prevented OS/2 from becoming widely adopted when it had no serious competitors and IBM failed to realize that its moment of opportunity had passed. Microsoft jumped at the market opening and never looked back.

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