

7

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The Internet and the Personal Computer Value Chain

We're in a fashion industry where there are several product turns a year.

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Fi-**C**OMMERCE IS AFFECTING the terms of competition in many industries because it makes it possible to rearrange and restructure segments of the value chain. This chapter explores the impact of e-commerce on the personal computer (PC) industry. The PC is particularly appropriate for study for a number of reasons—most important because it is the device linking most persons to the Internet and because the PC industry played a significant role in exploring new business models that were later adopted by other industries. The most prominent experimenter with the new business model was Dell Computer. Not only PC firms but nearly every other firm involved in producing and selling a product has evinced interest in the Dell model.¹ Dell Computer was successful in an industry characterized by

1. The essays in this volume by Helper and MacDuffie (chapter 8) and by Hammond and Kohler (chapter 13) indicate the interest in the Dell model.

cutthroat pricing, rapid technological change, foreign competition, global value chains, and changing consumer tastes. The PC industry, as one of the first to adopt the Internet as a business tool, can provide insights into what might prevail in other industries.'

The PC Industry

In contrast to many industries where a dominant design emerges and then a period of consolidation occurs, in the PC industry fierce competition and price wars continue to be the norm. Since the immediately successful introduction of the IBM PC in 1981, IBM and other large global players such as Compaq, Dell, and Hewlett Packard have dominated the dramatically growing PC market. In 2000, it was estimated that PC sales in the United States alone would be over \$85 billion.¹ Despite the emergence of major brands, at least 30 percent of the market remains controlled by no-name brands (in industry parlance, "white boxes") produced by firms ranging from very small local shops to the large distributors such as Ingram Micro. In the retail segment, cost continues to be a major differentiating factor, but even in the institutional market price is significant. In 2000, nearly twenty years after the introduction of the PC, no single business and distribution model was entirely dominant. Moreover, due to the low barriers to market entry, there has been a constant stream of new entrants, some of which have sufficient capital and the highly compelling new business model they need to become significant players.

The roots of this competitive dynamic can be traced to IBM's decision to purchase the microprocessor and the operating system software from outside vendors.² The unexpected result for IBM was a loss of control of the PC standards. The providers of the microprocessor and operating system, Intel and Microsoft, were free to sell their products to other vendors, thus unleashing a slew of "clones." The result was that no single company was able to integrate the entire value chain, and with the exception of operating system software (Microsoft) and, to a slightly lesser degree, micro-

2. This chapter considers the situation only for PCs, by which we mean desktop computers that use the Windows operating system and a compatible microprocessor. Niche products such as the Apple Mac, Playstation, Nintendo, Atari, and Amiga exhibit different dynamics. Also, the notebook and handheld computer sectors have a different structure.

3. Petska-Juliussen and Juliussen (1996).

4. Langlois and Robertson (1992).

processors (Intel and AMD), there is competition at every link of the chain. The market availability of all components on the open market combined with the extreme ease of assembly make the PC a quintessentially modular product. This means that in nearly every stage of the value chain there is intense competition. Bresnahan and Richards described these dynamics as "vertical competition," an environment in which firms at each stage of the value chain encourage competition at the other stages.⁵ So, for example, Microsoft certifies microprocessors made by firms other than Intel as Microsoft-compatible; Intel develops microprocessors to work with the Linux operating system. Price competition is continuous and fierce: even acquiring a dominant position cannot entirely protect a firm (with the possible exception of Microsoft).

The pace of change, both technically and economically, is driven by innovation in components and software. Constant dramatic improvements in performance for roughly the same price are explained by the fact that two of the most costly and important components in a PC, semiconductors and hard disk drives (HDDs), are subject to rapid technological improvement. The first and most famous improvement dynamic is described by Moore's Law, which states that the performance of semiconductors will double approximately every eighteen months.⁶ Moreover, the new chip can be sold at roughly the same price as a chip with one-half the capability sold for eighteen months earlier. Intel, the leading microprocessor producer, has made the rapid development of new product generations and subgenerations a cornerstone of its business model.⁷ Similarly, in the 1990s the per-megabyte cost of HDD magnetic storage experienced a rapid decline as areal density of data storage doubled every seventeen months.⁸

The persistent tendency for the price of the most technology-intensive components to drop for any specified performance level is difficult enough to manage. There are also periods of extreme price instability due to factors such as overcapacity in certain components or increased competition in a

5. Bresnahan and Richards (1998).

6. Gordon Moore is one of the founders of Intel, the world's most prominent semiconductor company and most important producer of microprocessors for the PC.

7. Don Clark, "A Big Bet Made Intel What It Is Today: Now It Wagers Again," *Wall Street Journal*, June 6, 1995, pp. A1, A5. Intel's strategy was to sell its newest and fastest microprocessor at a high price. As faster models are introduced, the prices of earlier models are significantly reduced. However, in 1999 this strategy came under significant pressure due to the introduction by AMD of an entirely compatible family of microprocessors of comparable speed at lower prices.

8. McKendrick (1997).

particular component segment. For the PC value chains, this means that inventory problems extend far beyond simply having capital in process and storage costs. They expose the inventory's owner not only to a persistent depreciation but also to the risks associated with more unpredictable price declines.⁹ The PC value chain is conditioned by the loss-of-value dynamics, which means that making the supply chain more efficient—from component producer through to the consumer—is an overriding concern. Any strategy decreasing the holding period for inventory makes an immediate and significant contribution to profitability:⁹

The Value Chain before the Internet

The complicated network that is the PC value chain is depicted in a highly simplified form in figure 7-1. The value chain was never fully integrated. Even with the first PCs, SCI and Avex, former NASA contractors from Huntsville, Alabama, won contracts to assemble motherboards and add-on cards (respectively) for the original IBM PC in 1981." The IBM sales channel consisted of IBM salespersons and computer stores it qualified, such as Businessland. Almost from its introduction, demand for the IBM PC outstripped supply, and nearly immediately there was a flood of fully compatible or almost compatible clones, legal and illegal. The cloners could purchase the operating system from Microsoft and the microprocessor unit (MPU) from Intel; all they had to copy was the BIOS. IBM's head start, brand name, and control of the ROM-BIOS was sufficient until 1984-85 to control the industry and restrain new entrants.

In 1984 Compaq emerged as the first creditable competitor of IBM. With the cloning of the ROM-BIOS chip, any firm anywhere could enter the marketplace. Very quickly, a number of firms, particularly in Taiwan, began subcontracting for the large U.S. firms and various retailers.¹² As the premium brand, IBM was able to extract a rent from customers in the

9. Examples of crisis vary. One example is the 1997 collapse of the Korean currency and economy that prompted Korean firms to flood the world economy with DRAM (dynamic random access memories) chips at devastatingly low prices. Also, *any* event that slows *consumer* purchasing *affects assemblers* with PCs in the pipeline because turnover slows, but the PC's value inexorably declines.

10. Curry and Kenney (1999).

11. Sturgeon (1999).

12. Dedrick and Kraemer (1998).

form of 18 percent net operating margins." Compaq established itself as a competitor with comparable quality but slightly lower prices." However, a market for components was maturing under the IBM/Compaq price umbrella. The improving component quality and the assurance of compatibility simplified market entry for second-tier producers, especially in the low-end market. These clones were offered at significantly lower prices and still were profitable because Compaq had a 67 percent price premium over a comparable Gateway 2000 computer.¹⁵

The strength of the IBM and Compaq brands offered them much pricing protection, and thus there was little stress on optimizing the value chain. This set the stage for the entry of still more low-cost vendors. At that time, parts and completed machines could remain in inventory or in the channel for relatively long periods of time because there was little significant time-based competition. Components and even finished PCs could be sourced from abroad with little profit penalty. This provided Taiwanese OEMs with the headroom for their market entry.

As table 7-1 indicates, in 1990 the PC market was in transition; five of the top ten firms in unit sales were Japanese or European and, if IBM is included, seven of the top ten positions were occupied by existing firms. In 1990 it appeared that the established computer firms were poised to control the industry. However, the industry was actually at an inflection point.

In 1990 there were three important sales channels: computer company salespersons, computer superstores, and local computer stores or vendors (white box vendors and value added resellers). However, the dominant firms, IBM and Compaq, were experiencing market share loss due to direct sellers such as Dell and Gateway 2000 (now renamed Gateway), Taiwanese firms, and no-name clones, all of which undercut the market leaders on price." In 1992 Compaq responded to its low-cost competitors by dramatically lowering its margins and engineering costs out of its value chain. As a relic of the earlier period when Compaq integrated most production to protect quality, as late as 1992 Compaq was still building its own power

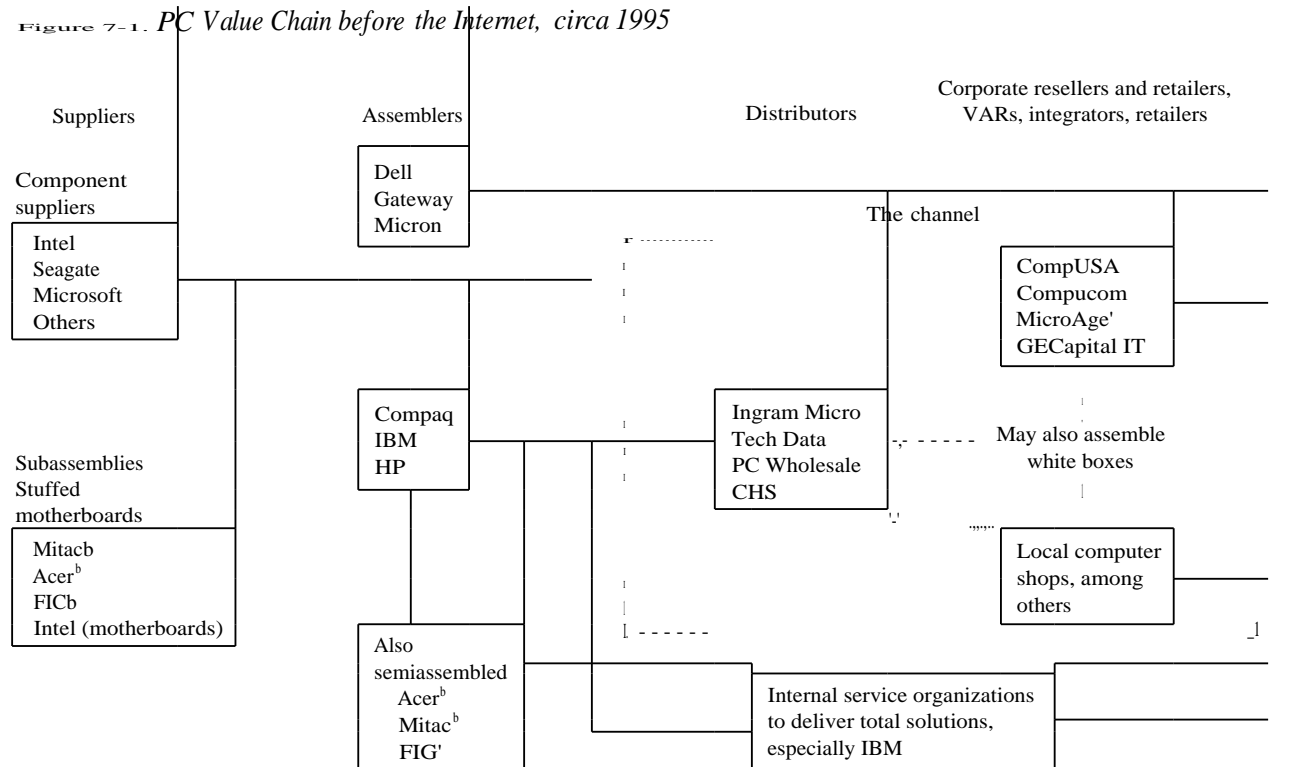
13. "Compaq: How It Made Its *Impressive* Move out of the Doldrums," *Business Week*, November 2, 1992, pp. 146-51.

14. Rick Whiting, "Personal Computer Have-Nuts Fight for Bigger Slice of Market," *Electronic Business*, October 30, 1989, pp. 34-35.

15. "Compaq: How It Made Its *Impressive* Move."

16. Cortino (1992).

Figure 7-1. PC Value Chain before the Internet, circa 1995



Source: Martin Kenney.

a. Corporate resellers and retailers tend to be no larger than VARs, integrators, and the like.

b. Taiwanese vendors.

Table 7- 1 . *Global Ranking for PC Sales, 1990, 1997, 1999*

Rank	Company		
	1990	1997	1999
1	IBM	Compaq	Compaq
2	Apple	IBM	Dell
3	NEC	Packard Bell NEC	IBM
4	Compaq	Dell	Packard Bell NEC
5	Toshiba	Hewlett Packard	Hewlett Packard
6	Olivetti	Gateway	Gateway
7	Groupe Bull	Apple	Apple
8	Fujitsu	Acer	
9	Unisys	Fujitsu	
10	Commodore		
11	Hewlett Packard		
12	Dell		
13	Packard Bell		
14	Gateway 2000		

supplies, even though high-quality power supplies made in Taiwan were available on the market for a fraction of Compaq's cost.¹⁷

The industry growth combined with the downward pressure on prices to convince PC assemblers to purchase even more Taiwanese parts and even finished computers. U.S. contract manufacturers continued to manufacture PCs and related products but moved to diversify their customer base, retreating from the lower-margin PC business. According to Sturgeon, the Taiwanese quickly became more adept than U.S. producers at building motherboards, peripheral devices, and later finished computers.¹⁸ Initially, these parts were for the generic "clone" market and later for branded companies such as Dell and Packard Bell. IBM and Compaq were forced to follow suit. One Taiwanese assembler, Acer, went further and designed and sold PCs under its own name.

Even while Compaq was cutting margins in an effort to recover sales, the small but rapidly growing direct sales firm Dell abandoned its efforts to enter the retail chain. The unsuccessful experience of selling into the retail channels taught Dell the advantages of the order-taking model. Because

17. "Compaq: How It Made Its Impressive Move."

18. Sturgeon (1999).

Dell operated on a true supermarket system, in which the customer "pulled" the merchandise through the system, it had far *less* inventory in process and reduced risk because it built only computers that already had been sold.¹⁹ This permitted Dell to sell computers at a lower price and have higher margins. The result was that Dell grew significantly faster than its competitors, thus increasing its market share."

Build to order direct marketers had two significant advantages over their competitors. First, because they built to order, their inventories reflected only immediate expressed demand, and they experienced far less value erosion. Even minute changes in demand were registered immediately, and losses attributable to faulty demand forecasts were virtually nonexistent. Even better, because Dell's suppliers essentially managed inventory, Dell was nearly free of exposure to declining prices. Second, machines were built upon receipt of payment so there were no losses from product that could not be sold. In other words, the direct marketing model permitted Dell to immediately know customer demand, allowing the company to manage and automate its entire value chain.

The traditional PC firm had two basic responses to the Dell challenge. The first was to develop ancillary services: system integration services for businesses or a bundle of software and services for the home consumers. In the business area, this approach was probably best exemplified by IBM, which provided a wide range of services including preconfigured Internet and e-commerce server systems, business service software (including electronic data interchange-type services such as Lotus Notes), systems installation, and information systems consulting. In 1997, to expand its service-related offerings and diversify its product offerings in the higher value server market, Compaq acquired Digital Equipment Corporation.²¹ In the consumer and small business market, PCs were offered bundled with additional services—most important, Internet access. To maintain or expand market share, particularly among first-time computer buyers, most PC assemblers offered Internet service as part of the purchase of a PC—usually in the form of rebate. For the least expensive PCs, the strategy was to charge full price of Internet service and essentially give away the PC. The recognition here was that the "killer application" was the ability to surf the Internet, not the other PC applications. This created opportunities for low-

19. Dell (1999c).

20. Curry and Kenney (1999); Dedrick, Kraemer, and Yamashiro (1999).

21. Evan Ramstad and Jon Auerbach, "Tech Takeover: Compaq Buys Digital, an Unthinkable Event Just a Few Years Ago," *Wall Street Journal*, January 27, 1998, pp. A1, A8.

cost PC marketers such as E-machines to create alliances with Internet service providers such as America Online's (AOL's) CompuServe. The Internet service providers (ISPs) would rebate approximately half of the cost of an E-machines PC (\$400) in exchange for a long-term service contract with the customer. In 1999 this became less popular, as various Internet firms, particularly the portals, began giving away Internet access.

The second major approach has been to offer extremely inexpensive PCs through the retail channel. These machines experienced less value erosion than did more expensive ones. The direct marketer's overhead militates against high profit margins in these extremely inexpensive machines. In 1999 E-machines, a start-up, had become the number three retail brand in the United States because it was able to import completed PCs from Korea.²² In effect, E-machines created a space at the low end of the market that was not sufficiently profitable for the build to order (BTO) direct marketers to attack.

Ultimately, the difficulty for the nondirect marketers was an inability to abandon their existing channels. Quite naturally, the channel resisted efforts on the part of manufacturers to develop direct sales, particularly for corporate accounts. Consider the situation for the traditional firms and their market channels as represented in figure 7-1. The PC value chain is quite complicated and contains three different demand chain elements: assemblers, distributors, and a polyglot group of resellers, value added retailers, integrators, and retailers. For the manufacturers the status quo is dangerous, given the easy availability of parts. Any constituent in the value chain could change brand-name manufacturers or begin assembling its own white boxes.

The highly disaggregated sales system was vulnerable to disruptions. Consider: the assemblers' decisions on which computers to produce were made by forecasting demand six months in advance on the basis of demand information that came upstream from the channel. The assemblers' factories and their suppliers were building for supposed future demand. This was fine so long as demand was constant and predictable, but of course, demand was subject to the vagaries of a market characterized by rapid change. When a firm overbuilt, since the value of a PC was a rapidly wasting asset, it would

22. PC Data, "Retail Desktop PC Sales End 1999 on a Sour Note as Unit Sales Growth in December is Slowest of the Year," January 24, 2000 (www.pcddata.com [March 16, 2001]). E-machines purchases its machines from two Korean firms, TriGem Computer and Korea Data Systems Co., and the Taiwanese firm Jean Company. TriGem Computer also outsources some manufacturing to a facility in Xiamen, China, and another facility in Shenyang, China.

use measures such as rebates and price protection to push the product into the channel. This is known as "channel stuffing." This led to periodic bouts of gross excess capacity that continued until the manufacturers and their suppliers ramped down production. This would appear to be advantageous for the channel because prices would fall and they could collect their rebates, but in fact the inefficiency, excess inventories, and extra effort associated with returning product disrupted the channel's profitability as well.

The traditional system had still other vulnerabilities, centering on its ability to interchange and process information. The actual information interchanges were idiosyncratic, and the descriptors of products varied among firms. This was curious, because the PC is highly standardized. However, there was no one set of agreed-upon criteria for comparison. As important as the information and its format, the interfirm communication media varied but for the most part were based on phone and fax. Often large paper catalogs were used, and most transactions were paper-based. Only the larger vendors had expensive, hard-to-use proprietary electronic data interchange (EDI) systems. Information flowed haltingly through convoluted, error-prone channels, which injected much noise into the system. In summation, by 1996-1997, the traditional assembly-to-channel marketing system was at a competitive disadvantage. Inventory problems, slow responses, and faulty forecasts led to massive financial losses and eroding market share as the direct marketers, particularly Dell, grew far more quickly than the rest of the industry.

Compaq, IBM, and others still sold PCs through the traditional channels, either to the computer superstores and value added resellers or through direct sales to large corporate customers. The white box remained the largest single "brand," because it cost less than the machines of the majors did. However, both the white box makers and the traditional assemblers were losing market share to the direct marketers.

Welcome to the Internet

The widespread diffusion of the Internet created opportunities in nearly every segment of the PC value chain. Already in the late 1980s, Gopher was available for PCs. However, it was not until the Mosaic browser for the PC was released in spring 1993 that the World Wide Web began its dramatic increase in use. The enormous PC-installed base was what made the

WWW such a fast-growing phenomenon and powerful new tool.²³ Conversely, the WWW became the new "killer application" that drove the PC industry. It was not surprising that PC firms recognized the significance of the Internet earlier than most firms and moved to adapt it to their business plans. The commercialization of the Internet created space for new entrants even while it provided opportunities for existing firms to create new connections to their customers. It also created opportunities to reorganize the existing value chain to allow disintermediation of various intermediaries. With all the disruption and confusion among the various constituents, it is clear there is neither a final resolution nor certainty about the ultimate impacts of the Internet on the value chain.

Direct Marketing

Dell, almost immediately, understood that the Internet might be significant for its business. This prescience is not entirely surprising because Dell's business was predicated upon the use of communications technologies, both telephony and mail-order catalogs. In a sense, the direct marketers were e-commerce firms before the emergence of the commercial Internet. Interacting with customers through a telephone made the step to the Internet very short—it was a natural progression. As with some other early adopters such as Federal Express, once a firm established an online presence, customer demand and suggestions led to next steps.

In the late 1980s Dell established a file transfer protocol (FTP) site so its customers could download technical bulletins and other information. In 1994 Dell was the first important personal computer firm to launch a commercial website (www.dell.com). Initially, the site provided only technical support information and an e-mail link for support. Then in 1995 online configuration and pricing options were introduced, though the actual sale was still consummated on the telephone.²⁴ With the introduction of the Secure Sockets Layer in the browser and increased confidence in online credit card purchasing, Dell transferred the entire transaction online.

Dell confronted a unique opportunity; since it had already given up on selling PCs through the channel, it had no legacy distribution channel to consider. For Dell, replacing telephone operators (who were simply conduits

23. Jimenez and Greenstein (1998).

24. Dell (1999c).