7

MARTIN KENNEY
JAMES CURRY

The Internet and the Personal Computer Value Chain

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

ED JURICA, VICE PRESIDENT
OF INFORMATION SERVICE, COMPUSA

E-COMMERCE 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.[2]

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.[3] 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.[4] 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.[10]

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.[11] 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.[13] Compaq established itself as a competitor with comparable quality but slightly lower prices.[14] 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.[16] 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-Nots 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).

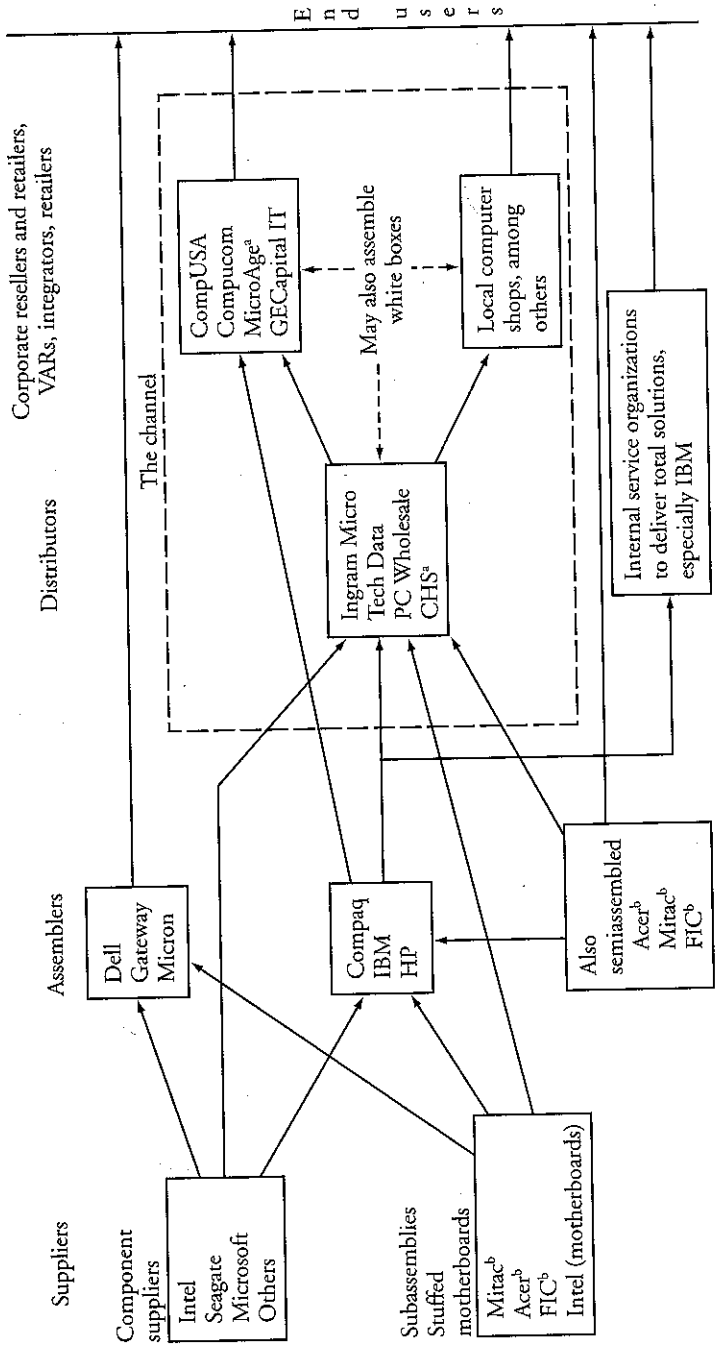

Figure 7-1. *PC Value Chain before the Internet, circa 1995*

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*

	Company		
Rank	*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.[20]

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.pcdata.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 that 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. Jimeniz and Greenstein (1998).
24. Dell (1999c).

for entering orders into a computer) with an Internet-based interface was not a great technical and business strategy leap. Internet-based sales grew dramatically. In December 1996 Internet-enabled sales were $1 million per day.[25] This had grown by February 2000 to web-related sales of $40 million per day or 50 percent of total sales. Dell's savings from moving transactions to the Internet were substantial. For example, Dell estimated that order-status calls, which can cost up to $13 each, can be handled over the Internet for essentially no cost. Dell estimated its savings through avoided order-status calls were more than $21 million in 1999. In addition, each online purchase transaction produced an average of 40 percent fewer order-status calls for Dell and 15 percent fewer technical support calls, at a savings of $3 to $8 per call.[26]

In 1996, with the introduction of the Premier Pages program offering a password-protected, Dell-developed web page, its largest customers, such as Ford Motor and Shell Oil, could order directly from Dell. Each page is uniquely designed for each customer and contains account team information and procurement and purchase-order processes unique to the customer.[27] The efficiency of this web-based ordering system allowed one global customer, Shell Oil, to save 15 percent of its annual PC purchasing costs. Another firm was able to reduce its procurement staff from fifteen to four.[28] These web pages created a link with these customers and provided Dell with a pipeline for the introduction of new IT products. There were also benefits for the customer. Control and tracking was simplified because all PC purchases and billing were centralized. Dell could even put the corporate property numbers on the computer in the factory, eliminating the necessity of having someone find and place the property tags on the machine after it was put into service. The Internet permitted Dell to increase the service it provided its corporate customers.[29]

Dell also inaugurated "valuechain.dell.com," which connected the company with its largest suppliers. Through this site, the suppliers could find out Dell's requirements for their incoming materials, receive statistics from Dell's manufacturing lines, and obtain data on the reliability of their components. This permitted Dell and its suppliers to monitor each other in

25. Dell (1999c, p. 93).
26. Dell (1999a).
27. Dell (2000a).
28. Dell (1999b).
29. Dedrick, Kraemer, and Yamashiro (1999).

real time. The transparency of the system allowed Dell's managers to observe inventories passing through their supplier's operations.[30]

The efficiencies of the direct sales model were accentuated by the diffusion of the Internet. The edge the direct marketers experienced before the Internet translated nicely into still further advantages. In contrast, for those using the channel and those in the channel, the situation would only become more dire, even though the Internet also provided them with opportunities to become more efficient.

Trying to Score on Mike

The commercialization of the Internet created challenges for all PC firms and allowed the entrance of some new players whose business models were predicated on using the Internet. Competing with the direct marketers was difficult enough, even when the direct marketers were limited by their dependence on catalogs and labor-intensive telephone ordering. With the introduction of Internet-based ordering, the cost advantages (combined with the other advantages) became overwhelming. Recognition of the problem was simpler than fashioning a credible response. On the one hand, a dramatic move to direct sales methods meant alienating the existing sales channels. On the other hand, remaining with the push system, no matter how sophisticated, meant that the direct sellers would retain their advantage. This problem faced not only manufacturers such as Compaq and IBM but also distributors such as Ingram Micro and Tech Data, value added resellers (VARs) such as Compucom and General Electric IT Services, and retailers such as CompUSA and Fry's Electronics (see figure 7-2, where value added resellers and retailers are combined).

The New Entrants

The possibilities for marketing PCs created by the Internet were not lost among entrepreneurs. The Internet quickly attracted a number of start-ups that intended to sell PCs from their websites; the dotted boxes in figure 7-2 represent these. Moreover, one failing bricks and mortar retailer, Egghead Software, closed its stores and transferred its operations entirely to the web.

30. Dell (2000b).

Creating an electronic storefront was quite simple from two dimensions: the first was the ease with which a retail engine can be implemented on the web; the second pertains to the ease of organizing fulfillment. In the PC sector the existence of distributors such as Ingram Micro simplified entry in much the same way as Ingram Books facilitated the establishment of Amazon.com. The Internet storefronts had significant advantages—they carried no inventory, they required no sales staff, most of their orders were handled electronically, and they operated twenty-four hours a day, seven days a week.

The Internet retailers also had weaknesses. The first of these was their dependence on distributors for fulfillment. So, for example, in fiscal year 1998 Cyberian Outpost purchased 38 percent and 10 percent, respectively, of its products through two major distributors, Ingram Micro and MicroAge. Buy.com had an even closer relationship with Ingram Micro, which was contracted to provide all of its computer hardware and software products.[31] Buy.com was completely dependent on Ingram to provide timely and accurate order fulfillment. The core competency of the online retailers was the attraction of customers and the development of their brand name. Their long-term viability was uncertain, because these computer products were commodities and profitability could be difficult to attain.

Another methodology was a referral system, whereby an Internet firm such as a portal referred customers to an assembler or distributors. Leaders at this were Yahoo! and CNET. For example, CNET claims that in fourth quarter 1999 it was the top referrer of traffic to the online transaction areas of Dell, Gateway, IBM, Acer, and Apple Computer.[32] The significance of these referral programs for the PC industry is difficult to gauge. However, they offered yet another channel from the manufacturer to the end user and could outflank the bricks and mortar channels. CNET has made a major advertising commitment in an effort to raise the visibility of its site and make it the premier technology-related reference site.

The PC industry is nothing if not innovative. Another strategy for selling more PCs is to launch "affiliate" sales programs. A San Francisco startup, PeoplePC, pioneered affiliate buying in 1999, when it announced deals to provide PCs to employees of Ford and American Airlines.[33] PeoplePC

31. Buy.com, Inc., "SEC S-1 Filing," October 27, 1999 (www.buy.com [March 10, 2001]).

32. CNET, Inc., "CNET, Inc. Announces Fourth Quarter Financial Results," February 3, 2000 (www.cnet.com [March 10, 2001]).

33. Rachel Konrad and Michael Kanellos, "Dell to Supply PCs for American Airlines," *CNET News.com*, April 6, 2000.

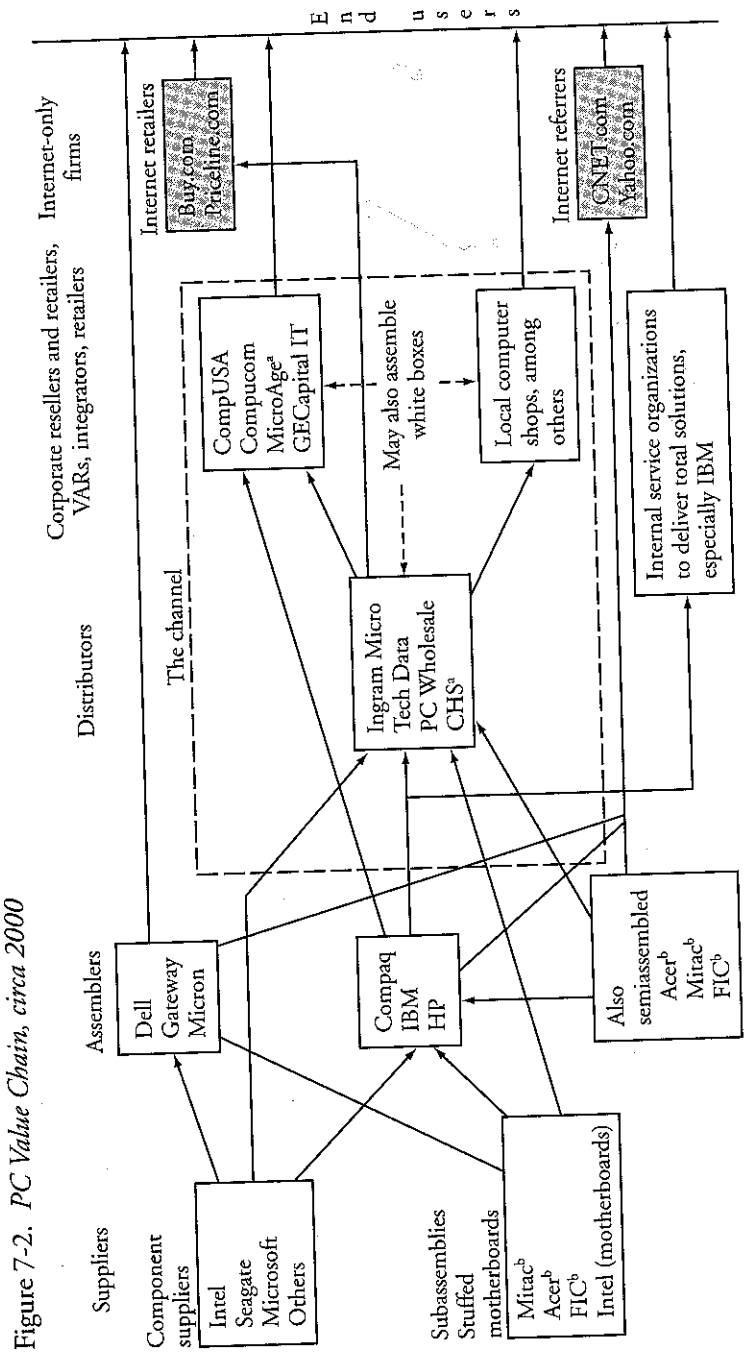

Figure 7-2. *PC Value Chain, circa 2000*

Source: Martin Kenney.
a. Corporate resellers and retailers tend to be no larger than VARs, integrators, and the like.
b. Taiwanese vendors.

teamed with HP and Uunet to offer a PC and Internet access at $5 per month for three years. Ford sees this as a way it can communicate more regularly with its employees, and the UAW supported the program as a way to communicate more effectively with its members.[34] These affinity programs could expand; Intel and American Airlines have announced similar programs.

In contrast to the experiences in some other retail sectors where e-commerce start-ups captured significant market share, in computers the start-ups have had difficulty capturing a profitable market space. This is, in part, due to the difficulty nearly all participants have in achieving sustained profitability. Moreover, in contrast to other sectors such as books and CDs, in PCs the established leaders such as Dell quickly implemented WWW-based sales and other activities. The new entrants did not unleash a wave of creative destruction; rather, they formed a new pipeline to the customer.

Traditional Assemblers: Compaq, IBM, and Hewlett Packard

The Internet actually reinforced the competitiveness of the direct marketers and increased the difficulties for the traditional assemblers. The late 1990s were difficult for the traditional assemblers as they continued to lose market share to the direct marketers and were slammed by component price decreases, which devalued their inventory. The Internet posed a powerful dilemma. Since a significant share of their sales is through VARs and other system integrators, shifting away from the channel would create significant costs related to augmenting their own customer service divisions. If they did not begin direct sales, then they would likely continue to lose market share. This was not an idle threat; major firms such as Packard Bell/NEC and AST Research/Samsung had already been driven out of the market. Moreover, the channel could always switch their efforts to selling white boxes, essentially augmenting their full-service product lines with their own PCs. To top it off, it was estimated that Compaq's profit on each consumer PC sold was as little as 4 percent.[35]

The chaos among the traditional assemblers was profound. For example, after online retailers began selling Compaq PCs, in February 1999 Compaq responded by forbidding such sales because they undermined its

34. Joe Wilcox, "Ford Wires Employees with PCs, Net Access," *CNET News.com*, February 3, 2000.

35. Joe Wilcox, "HP Surges Ahead of Compaq in Retail," *CNET News.com*, March 30, 2000.

Table 7-2. *Compaq's Distribution Moves, 1996–2000*

October 1996	Implements web-based intranet
July 1997	Implements build to order program and channel configuration program—distributors/resellers complete final PC assembly
November 1998	Unveils Prosignia line of PCs, marketed and sold by direct order only
January 1999	Forms Compaq.com business division to oversee Internet and direct sales
May 1999	Launches distribution alliance program—contracts resellers to produce direct order computers
January 2000	Purchases Inacom, a distribution partner with 4 U.S. assembly and distribution facilities

Source: Ken Popovich, "Compaq's Latest Direct Bid: Purchasing Inacom," *PC Week*, January 10, 2000, p. 10.

offline retailers. Consider the difficulty of the situation: the direct marketers were constantly increasing their market share, and the assemblers were wrestling with the impacts of the Internet on their business models. Abandoning the channel may save costs, but it also meant abandoning intermediaries who still play a very important customer service role. Having said that, reaction by the assemblers was slow. From an analysis of Compaq's press releases, it appears that only in October 1996 was there any announced reaction to the potential of the web, and then it was only the creation of a WWW-based intranet. This is approximately two years later than Dell.

It was not until July 1997 that Compaq truly responded to the threat. The most important measures in this response can be seen in table 7-2. Compaq's first significant measure, to develop a channel assembly program, can be seen as a response to the threat of the mid-1990s, and not to the looming new competitive disadvantages posed by e-commerce. Only in November 1998 did Compaq unveil a line of computers meant to be sold on the web. But perhaps most telling was the striking admission in 2000 by Compaq's president that the company did not have "the ability to take an order, do the configuration online, and be able to track the order and fulfill it."[36] In January 2000 Compaq bought the fulfillment operations of one of its distribution partners, Inacom, so that it could integrate the value chain.

36. Ken Popovich, "Compaq's Latest Direct Bid: Purchasing Inacom," *PC Week*, January 10, 2000, p. 10.

Compaq was not alone. IBM's experiences in the retail channels were, if anything, worse. The difficulties were so overwhelming that as of January 2000 IBM withdrew its consumer market brand, Aptiva, from the retail market.[37] This decision freed IBM to enter the BTO direct marketing arena. By 2001 it appeared as though IBM's direct marketing initiative was successful. In the retail channel, the largest beneficiary of IBM's withdrawal was Hewlett Packard, which managed to capture most of the market share IBM abandoned. In the business sector, IBM's competitiveness was based on its ability to deliver total systems' solutions. In these cases, IBM could build to order, and the cost of the PC was hidden in the cost of the entire solution.

The Distributors

The early literature on e-commerce posited that through using the Internet it should be possible to make direct links between manufacturers and end users, thus disintermediating distributors.[38] Of course, this is what the direct model already did. In the PC value chains, distributors such as Ingram Micro, Tech Data, Avnet, and CHS have been critical players.[39] The breadth of their offerings is staggering. For example, Ingram has more than 280,000 different stock keeping units (SKUs), which range from the smallest passive component to finished system and software. These distributors are fully capable of assembling and delivering a finished PC directly to the customer. To facilitate their operations and expedite delivery, these firms have built a network of warehouse/logistics facilities, enabling them to deliver orders the next day in most of the contiguous United States.[40]

37. Joe Wilcox, "IBM to Sell Aptiva Direct," *CNET News.com*, October 18, 1999.

38. Profits are elusive in PC distribution. Most of these firms distribute a wide variety of IT products, and PCs, though large volume, are quite low in profitability. Distribution has great difficulty extracting profits from its sales. For example, in full fiscal year 1999, net sales at Ingram Micro topped $28.1 billion and grew 27 percent over 1998. However, net income was only $183 million versus $245 million for 1998. Tech Data, though smaller ($11.5 billion in sales), was able to earn nearly $192 million in fiscal year 1999 (Tech Data [1999]). For the distributors the problem is that their suppliers can open a website and sell directly to consumers, capturing the distributors' profits and removing time from the value chain.

39. Ingram Micro is interesting because its sister companies include Ingram Books, which is the world's largest book distributor, and Ingram Entertainment, which is a major distributor of entertainment products. Amazon.com was able to quickly enter the book market because it could outsource fulfillment and logistics to Ingram Books.

40. Distributors such as Ingram and Tech Data have sophisticated delivery operations in Europe and are building networks in Asia.

For the assemblers, such as IBM and Compaq, the distributors were critical players in the channel. Though in some cases the distributors and assemblers were linked by EDI systems, for the most part the relationships were relatively distant. The traditional method was to simply ship as many computers as possible to the distributors, give them price protection, and then hope the channel could sell the machines. Of course, this distribution methodology led to bouts of excess inventory and too much handling when compared with the direct marketers. The disadvantages of the traditional value chain were obvious.

In response to a severe inventory crisis in 1997–98, the large assemblers and the distributors introduced a new business model called "channel assembly." This was meant to divide the assembly of a PC into two segments. In the first, the box, motherboard, floppy disk drive, and other components whose value was decreasing only slowly would be undertaken; in the second and final segment, the addition of the parts most susceptible to value erosion—the DRAMs, the microprocessor, and the hard disk drive—was completed in the channel immediately before the PC was delivered. The distributors and VARs have been under enormous pressure and the smaller distributors have been either acquired or left the business. The pain has not been confined to the smaller firms; two leaders, CHS and MicroAge, filed for bankruptcy in April 2000.

Channel assembly was an aspect of the effort to adopt a "pull" model. Ingram Micro renamed its business model "demand-chain management," referring to the idea that demand should "pull" the computers and their components through the system.[41] The need to reduce inventory and other costs also has contributed to a consolidation of the value chain. In May 1999 Compaq decreased the number of its U.S. distribution partners from thirty-nine to four.[42] Another effort to streamline the demand chain was vendor co-location programs, in which the distributor established a configuration operation adjacent to or even in the assemblers' factory. Systems reconfiguration and customer shipping occurred from the vendor's site, resulting in cost and time-to-market efficiencies.

Channel assembly and co-location strategies were not directly related to the Internet. Contemporaneously, in 1998 the major distributors began introduction of electronic commerce tools to encourage customers to

41. Ingram Micro, Inc., "SEC 10-K Filing," March 31, 2000 (www.ingrammicro.com [March 10, 2001]).

42. Ingram Micro, "SEC 10-K Filing."

migrate to web-based ordering. For example, Ingram's web site, www.ingrammicro.com, is meant to be a business center for resellers, that is, the next tier downstream. The site features real-time pricing and availability, online ordering, order status, and an extensive product catalog. Ingram also provided resellers access to real-time ordering, product allocation, order status, product search, and pricing and availability status. This permitted downstream VARs and the like direct access to Ingram's mainframe inventory systems. With these tools, retailers could act as the intermediaries between the customer and Ingram without the customer knowing. Depending on the product, Ingram could even drop ship the product directly under the VARs' label.

The economics of online sales were as compelling to the distributors as they were for Dell—by 1999 all of the major distributors had an e-commerce site for their customers. In conjunction with introduction of the site, many of their smaller customers were transferred to the e-commerce site in an effort to cut costs. So, in effect, the establishment of an e-commerce site was used by the distributors to rationalize their customer chain.

Value Chain Solutions

The electronic components and particularly the PC supply chain were rife with incompatible formats for providing product information, and there was no taxonomy for that information. Parts numbers were not even defined in a standardized fashion. Figure 7-2 illustrates the difficulties when the players in such a complicated value chain all have different definitions and descriptive parameters for their products. This is particularly true when contrasted to the direct marketers, who did not have to depend on this complicated Tower of Babel. What this meant was that the channel-based value chain was plagued by informational inefficiencies, which in an offline world were surmounted by a thick web of personal connections and information sharing. The extremely complicated topography of the PC value chain, characterized by its diverse EDI systems, a reliance on phone, fax, and paper purchase orders, and varying manufacturers' or distributors' websites, rendered the value chain opaque and inefficient. The terrific growth of the direct marketers in 1997 and 1998 encouraged the firms in the channel and those dependent on the channel to search for strategies for decreasing costs, speeding information flow, and making the value chain more transparent. In 1998 a group of major PC and other IT firms formed

an independent nonprofit organization, RosettaNet, dedicated to promoting industry-wide initiatives to adopt common electronic business interfaces.[43] Many of these firms also participated in the formation of Viacore, which is developing an e-commerce hub to translate RosettaNet information for member top-tier demand chain companies.

Even with a nonprofit organization seeking to develop standards, the disaggregated and chaotic nature of the IT industry's value chain created an opportunity for a business-to-business (B2B) entrant capable of knitting the value chain together and providing customizable solutions to various participants. The only important entrant specializing in electronics is pcOrder.com. The firm's business proposition is that all of the information in the value chain should be moved online. Ideally, pcOrder.com would link all the firms in figure 7-2 into one compatible XML-based system. However, to date most of its efforts have focused on the parts of the value chain from the assemblers downstream. pcOrder.com has a multidimensional business model. The first dimension is a modular suite of customizable software applications for any constituent of the value chain. The second dimension is a standardized database consisting of over 600,000 SKUs from over 1,000 manufacturers, which for a fee VARs and resellers can use to compare, configure, and order products online.[44] Full implementation of pcOrder's solution would make all of the information flow in the value chain electronic, dramatically lower inventory, and render the entire system more transparent.

The pcOrder business model does appear to have some contradictions. For example, though Ingram Micro and Tech Data offer products through the pcOrder database, they also have their own website for VARs. It is really not in the distributor's interest to contribute its data to a pcOrder.com type of website; however, the fear of losing customers does force distributors to participate. The pcOrder database, Techbuyer.com, allows the VARs and resellers to compare configurations and prices online and then order online. This could be a valuable option, because reselling hardware has margins as small as 1–2 percent.[45] For the VARs, the advantage is ease of use, thereby saving time that can be better used for value adding activities.

43. RosettaNet, "3Com and CompUSA Adopt Web-Based Supply Chain Process," press release, February 2, 2000 (www.rosettanet.com [March 10, 2001]).
44. pcOrder.com (1999).
45. Tiffany O'Brien (investor relations, pcOrder.com), telephone interview with Martin Kenney, April 10, 2000.

The use of the system by the resellers and VARs means that the demand chain will become more customer-driven. This does not mean that the distributor's inventory will be eliminated entirely; however, it should be able to dramatically decrease its inventory. In particular, if this system is combined with complete channel assembly, it might be possible to create a value chain that is nearly as efficient as that of direct assemblers while retaining the service and close interaction with customers that was the strong point of the nondirect system. The ultimate outcome is still, of course, indeterminable.

The Post-PC Era

There has been a veritable tidal wave of prose announcing the dawn of the post-PC era. The two technological developments hailed as harbingers of this new era are the Internet and wireless. The claims of the adherents to the "post-PC" position are often difficult to understand. The strong interpretation is that the PC will disappear, to be replaced by another device or set of devices. Considering that the current global installed base of PCs is over 200 million, this claim appears dubious. A weaker interpretation is that the PC will become one of many devices connected to the Internet. The crux of this argument is that the PC will gradually lose its status as the only end-user device attached to the Internet—a more credible argument.

Any claim that handheld devices will replace the PC as the Internet access device of choice is dubious for both convenience and technical reasons. For small bits of information such as stock quotes, time, weather, or even traffic reports, mobile devices such as telephones are a viable option. But handheld computing devices such as the Palm Pilot provide an only barely adequate viewing experience. For a richer experience, full-size monitors (either flat panel or CRT) are far superior—witness the continued increase in the screen size of notebook computers. From the technical perspective, there are significant issues about how to shrink web pages from those developed for a computer monitor to ones that are readable on a mobile telephone or even a Palm Pilot (most of which are gray-scale). There seems little likelihood that non-PC mobile devices will usher in the post-PC world; however, they will end the hegemony of the PC as the only Internet on-ramp device.

There are more formidable competitors of the PC, which deliberately use attributes of the Internet in an attempt to dethrone the PC. These have

combined with macroenvironmental tendencies that will have a significant influence on the viability of the PC. The first tendency is the massive increase in bandwidth and concomitant decrease in cost throughout the telecommunications infrastructure. There can be little doubt that homes and small businesses will soon have high-bandwidth service onto the premises, be it through DSL (a digital subscriber line), cable, or some other media. The second tendency is for computing power on the desktop to no longer be a limiting factor for the vast majority of applications. The third tendency is that there will be a web-centric solution for nearly every desktop PC application. The harbingers of this are free web-based e-mail, calendars, and online photo sharing. Many office productivity applications may also be used online if latency and bandwidth problems are resolved. The Internet thus may have the paradoxical result of cannibalizing some of the functions of the device most important for its diffusion.

The Network Computer (NC) is the device that has attracted the most attention as a possible substitute for the PC. The NC was first touted publicly in 1995 by Larry Ellison, the CEO of Oracle.[46] The argument for the NC is that corporate management information system (MIS) managers would have a much easier time managing the computers on their networks if the PCs were converted into "dumb" terminals. Initially, one of the arguments in favor of the NC was that it would be less expensive than a fully configured PC, which at the time cost an average of $2,500. In the interim, the cost of a PC dropped below $1,000, removing that advantage. The more significant advantage was the lower total cost of ownership of a PC, which is much greater than the initial cost of the PC. Despite the promise of the NC, it never sold well. For example, in 1999 an estimated 700,000 units were sold in the corporate sector, but projections estimated that sales would increase to 6 million units in 2003.[47] In 2001 the NC, though gaining market share, has not yet mounted a serious challenge to the PC. There will be a continuing effort to create an NC or, at least, move the applications software to the web. The most interesting effort in this area was the 1999 release by Sun Microsystems of the office productivity suite, Star Office, which is predicated on networked computing. Given these efforts, it would be a mistake to completely dismiss the NC's potential.

46. Gary Rivlin, "The Network Computer Strikes Again," *The Standard*, March 20, 2000 [www.thestandard.com [March 16, 2001]).

47. Rivlin, "Network Computer Strikes Again."

Another potential threat to the suzerainty of the PC in the home is the television set-top box. The set-top box is meant to provide the computing and connectivity and functionality to allow the TV to take the place of the computer. As the cable modem becomes more prevalent, the television, which is really a monitor (though of very low quality) and an electromagnetic wave reception device, could be converted into a networked entertainment and shopping device. When high-definition television (HDTV) is available, the "television" networked to the Internet could become a significant competitor of the PC, particularly in the family room. The set-top box also has the potential to connect other home devices to the Internet; if the home has a high bandwidth connection to the telecom network, a varied menu of functions, including those of a PC, could be transferred to the Internet. As an example, one new General Instruments set-top box has an IDE port to which a hard drive can be connected. In the home computing environment, the set-top box and the HDTV could be an alternative to the still-difficult-to-use PC.

Another alternative is the "Internet appliance," which consists of a visual output device and an input device such as a keyboard. Normally, these do not have a Microsoft operating system and often have no permanent storage device. Internet appliance offerings have come from Dell, Compaq, and even Microsoft. In April 2000 AOL and Gateway announced an alliance to offer their own Internet appliance.[48] Of course, for all these players, the success of the appliance would cannibalize their PC sales.

The final threat to the PC is from the game consoles. For example, the Sony PlayStation 2 has as much graphics power as any PC and will be equipped with a DVD drive, an IEEE1394 FireWire connector, and at least one PC card slot. The PC card slot could have a network connection in the form of an Ethernet or cable television connection. All of this would be sold for game machine prices. The machine does not have any Microsoft software or Intel-compatible chips. These game machines could banish the PC to the home office. And if web-based productivity applications were offered, the PlayStation could absorb the PC's office functions also. There can be no doubt that both Microsoft and Sony recognize this potential. For example, in late 1999 Sony announced plans to work with Cablevision Systems Corporation to develop and deploy a new-generation digital entertainment and broadband communications platform throughout the New York metropolitan area. For now this system is being designed to connect with Sony set-top boxes. One potential drawback is that users may want their files stored locally. If the wide variety of PC functions is unavailable, is the cost and simplicity of the game machine sufficient to displace the home PC?

48. Stephanie Miles and Jim Davis, "AOL, Gateway Join Internet Appliance Fray," *CNET News.com*, April 5, 2000.

It is impossible to predict the outcome of the competition among the various platforms. The handheld devices will gain market share, but they are not a direct threat to the PC. More uncertain is the outcome of competition with devices intending to move much of the computing from the desktop to the network. If these solutions are adopted, then the future of the PC industry could be dramatically altered. These NCs, set-top boxes, and game machines are not PCs. Should demand shift, a response by the PC industry would be difficult, because, quite simply, the reasons for adoption would not be cost, but rather ease of use and lower total cost of ownership. This is especially true because the traditional profit driver in the PC industry, increases in speed and storage, are becoming less important factors. A PC running a microprocessor a generation or two old is still adequate for most of the market; consumer focus seems to be moving from having the fastest PC to having more Internet bandwidth through a DSL line or cable modem. While technologies such as voice recognition are touted as stimulating future demand for more powerful PCs, so far widespread adoption still seems distant. The next decade will almost surely be one in which multiple Internet access devices will compete.

Discussion

The impact of the Internet on the PC industry has been intertwined and contemporaneous with the competitive threat from the direct marketers. This makes it difficult to attribute the attempts to streamline the channel to one threat or the other. There is no question that the direct marketers were able to leverage the Internet to make their operations even more efficient than they already were. The willingness of Dell customers to use the Internet permitted the company to achieve significant savings throughout its entire operation and heightened its competitiveness.

The dawning of e-commerce did attract some new online retail entrants, but in comparison to a number of other industries (such as books and CDs, autos, and services), the new entrants were unable to disintermediate existing players, so they became yet another segment in the value chain. In

this sense, we can say the Internet has had little transformative impact on the PC industry.

From another perspective, the Internet will have a dramatic influence on the value chain. The PC industry is a chaotic shambles of incompatible information systems, inadequate and incomparable product descriptions, and non–value adding human involvement in the communications stream. The threat of BTO and the open and nondiscriminatory Internet standards create an environment in which market competitors can agree without providing any single firm an advantage—one of the difficulties that often emerges when competitors discuss the adoption of an EDI system. The adoption of these standards will have a profound impact on the efficiency of the PC value chain.

The final impact of the Internet on the PC is the dethroning of the PC as the exclusive device for Internet access. Depending on the speed with which greater bandwidth becomes available, it is possible that a network computing device—an NC, a game machine, or even an amalgam of one of these and a PC, perhaps without the Microsoft operating system and an x86-compatible microprocessor—could challenge the PC for primacy as an Internet access device. During the next decade, the computing industry will shift from the PC-centric world to an Internet-centric world. This should allow a "thousand flowers to bloom," in the sense of devices connected to the Internet. Such an evolution does imply a major reorientation of where the locus of technological innovation will reside.

References

Bresnahan, Timothy, and John Richards. 1998. "Local Competition in Information Technology." Paper prepared for Eleventh Annual NBER-TCER-CEPR Conference, "Competition Policy, Deregulation, and Re-Regulation." International House of Japan, Tokyo, December 18–19.

Cortino, Juli. 1992. "Squinting at the Future." *Upside* (December): 46–55.

Curry, James, and Martin Kenney. 1999. "Beating the Clock: Corporate Responses to Rapid Change in the PC Industry." *California Management Review* (Fall): 8–36.

Dedrick, Jason, and Kenneth L. Kraemer. 1998. *Asia's Computer Challenge: Threat or Opportunity for the United States and the World?* Oxford University Press.

Dedrick, Jason, Kenneth L. Kraemer, and Sandra Yamashiro. 1999. "Refining and Extending the Business Model with Information Technology: Dell Computer Corporation." Working Paper. University of California, Irvine: Center for Research on Information Technology and Organizations (May 19).

Dell, Michael. 1999a. "Building a Competitive Advantage in an Internet Economy." Address at the Detroit Economic Club, November 1.

———. 1999b. "The Dell Advantage." Keynote address in San Francisco, March 3.

———. 1999c. *Direct from Dell.* New York: HarperBusiness.

———. 2000a. "E-Business: Strategies in Net Time." Address at the University of Texas. Austin, April 27.

———. 2000b. "Building an E-Government Partnership." Keynote address at the Southwest Government Technology Conference. Austin, Tex., February 16.

Jimeniz, Ed, and Shane Greenstein. 1998. "The Emerging Internet Retailing Market as a Nested Diffusion Process." Working Paper. Northwestern University: Management and Strategy.

Langlois, Richard, and Paul Robertson. 1992. "Networks and Innovation in a Modular System: Lessons from the Microcomputer and Stereo Component Industries." *Research Policy* 21 (4): 297–313.

McKendrick, David. 1997. "Sustaining Competitive Advantage in Global Industries: Technological Change and Foreign Assembly in the Hard Disk Drive Industry." Working Paper 97-06. University of California, San Diego: the Data Storage Industry Globalization Project, IR&PS.

pcOrder.com. 1999. *Prospectus.* Austin, Tex.

Petska-Juliussen, Karne, and Egil Juliussen. 1996. *The 8th Annual Computer Industry Almanac.* New York: International Thomson Publishing.

Sturgeon, Tim John. 1999. "Turn-key Production Networks: Industry Organization, Economic Development, and the Globalization of Electronics Contract Manufacturing." Ph.D. dissertation, University of California, Berkeley.

Tech Data, Inc. 1999. *Annual Report.* Clearwater, Fla.