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Matching Dell

Between 1994 and 1998, the revenue of Dell Computer Corporation rose from $3.5 billion to $18.2 billion, and profits increased from $149 million to $1.5 billion. The company's stock price rose by 5,600%. During the same period, Dell grew twice as fast as its major rivals in the personal computer market and tripled its market share. In the first half of 1998, Dell reported operating earnings that were greater than the personal computer earnings of Compaq, Gateway, Hewlett-Packard, and IBM combined.[1] On *Forbes* magazine's list of the richest Americans, Michael Dell, the 33-year-old founder of Dell Computer, ranked fourth with an estimated worth of $13 billion. He trailed only Bill Gates, Warren Buffett, and Paul Allen on the list and was worth more than Gates had been at the same age.[2]

Dell Computer had pioneered the widely publicized "Direct Model" in the personal computer (PC) industry. While competitors sold primarily through distributors, resellers, and retail sites, Dell took orders directly from customers, especially corporate customers. Once it received an order, Dell rapidly built computers to customer specifications and shipped machines directly to the customer.

The success of the Direct Model attracted the intense scrutiny of Dell's competitors. By 1997, headlines such as "Now Everyone in PCs Wants to Be Like Mike," "Compaq Reengineers the Channel: Will It Be Enough to Slow Dell's Momentum?" and "In Search of Greener Pastures, Gateway Moves on Dell's Turf" peppered the PC trade press.[3] By late 1998, virtually every major PC manufacturer had taken some step to match Dell's approach.

The Personal Computer Industry

History. Electronic computers emerged from military research undertaken during World War II. In 1949, the magazine *Popular Mechanics* predicted that "Computers in the future may…perhaps only weigh 1.5 tons." For the following three decades, large mainframe and minicomputers, produced by vertically integrated firms such as IBM and Digital Equipment Corporations (DEC), dominated the market. As late as 1977, Kenneth Olsen, founder of minicomputer maker DEC, opined, "There is no reason for any individual to have a computer in their home."[4]

Professors Jan W. Rivkin and Michael E. Porter prepared this case from public sources with the assistance of Research Associate Faramarz Nabavi as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation. The case draws on a report prepared by Charlie Bruin, Markus Cappel, Tom Galizia, and Laila Worrell, all MBA 1998.

However, electronic hobbyists were already purchasing mail-order and retail kits which allowed them to assemble primitive computers at home. These kits pieced together components that were either altogether new or newly affordable: microprocessors made by start-ups such as Intel, random-access and read-only memories, power supplies, and so forth. (A **Glossary** at the end of the case defines technical terms.)

Between 1975 and 1981, a series of firms began to offer increasingly integrated, pre-assembled personal computers.[5] Start-ups such as Apple Computer and MITS, and midsize firms such as Tandy / Radio Shack and Commodore, led the early market, gaining popularity among hobbyists and educational institutions with easy-to-use machines for ordinary people. Established firms including Texas Instruments, Hewlett-Packard, Zenith, NEC, Xerox, IBM, Toshiba, Sanyo, Sony, Olivetti, Wang, and DEC soon joined the entrepreneurs and began to produce PCs.

IBM launched its first PC in 1981 and, two years later, held 42% of the market. With a world-renowned corporate sales force and service organization, IBM commanded 61% of the market for mainframe computers and produced many of the components for its mainframes.[6] In launching its PC, however, IBM purchased many components. It commissioned a start-up software firm, Microsoft, to write the operating system for its PC and adopted a microprocessor architecture designed by Intel. Publishing most of the specifications for its PC system, IBM established an "open architecture" to encourage software developers to write programs for the IBM PC and to spur other firms to make compatible peripherals such as printers. Most of the industry rapidly rallied around the IBM standards. By 1983, the major alternative standard, a proprietary system championed by Apple, held only 20% of the market.[7]

IBM used its huge sales force to sell personal computers to large corporate accounts. Volume discounts encouraged large firms to centralize PC purchases through corporate MIS departments, with whom IBM sales people had strong relationships. To serve small businesses and individuals, IBM turned to retail stores such as Sears and Computerland.[8] It also encouraged the development of a network of distributors and dealers known as *value-added resellers.* These resellers not only sold PCs to customers, but also guided them through the purchase of what was still an unfamiliar product. Resellers commonly handled installation, configured software, pieced together customer networks, and serviced machines on an on-going basis. In small and midsize businesses, employees rarely had the skills to do what resellers did, and few companies had enough PCs to justify hiring trained personnel.

As demand for IBM's PCs exploded, other firms began to offer "IBM clones." Compaq entered the market with a low-priced portable clone in 1982 and booked $100 million of revenue during its first year, making it the fastest growing firm in American history. A host of other start-ups followed Compaq's lead and entered the market with IBM clones. Among these entrants was Dell Computer Corporation, incorporated in 1984. During the same period, most established competitors such as Hewlett-Packard shifted from proprietary architectures to the IBM standard.

Like IBM, makers of IBM clones relied on resellers and retail stores to reach customers. While IBM initially steered resellers away from the largest corporate accounts, start-ups such as Compaq without internal sales forces encouraged resellers to cater to large customers. In time, even IBM relied heavily on resellers to service large accounts.

By 1986, IBM realized that it had set a standard, but in doing so, had spawned a set of imitators while ceding the rights to the most valuable components of the PC—the microprocessor and the operating system—to Intel and Microsoft. In 1986, IBM declined to adopt Intel's third-generation microprocessor, the 386 chip. In introducing its PS/2 line of computers in 1987, IBM tried to make the PC more proprietary. Compaq both adopted the 386 chip and led a group of nine clone makers in affirming the existing industry standards. Though IBM subsequently accepted the 386, its market share fell from 37.0% in 1985 to 16.9% in 1989.[9]

Throughout the 1980s and 1990s, PC performance improved and prices fell at a rapid clip. Intel's 386DX microprocessor, introduced in 1985, was priced at $299 and could perform 2.5 million instructions per second (MIPS)—a price of $120 per MIPS. Intel's Pentium II microprocessor, launched in 1998, was priced at $699 and could carry out 675 MIPS—$1 per MIPS.[10] In addition, the range of software available for the personal computer expanded dramatically.

Microsoft released its new operating system Windows 3.0 in 1990, and over the next four years, the user-friendly Windows became ubiquitous on PCs configured to the IBM standard. Indeed, the standard soon became known as "Wintel," reflecting the combination of the Windows operating system and Intel's x86 microprocessor architecture. By 1991, between 85% and 90% of computers sold conformed to Microsoft / Intel standards, with the remainder using the proprietary Apple operating system and a Motorola microprocessor.

The initial surge in sales of personal computers crested in 1990, just as a recession gripped the United States. In newspapers around the world, Dell Computer ran advertisements showing that its prices were much, much lower than Compaq's list prices. Compaq usually discounted its PCs well below the list price, but the advertising campaign was highly effective. In response, Compaq slashed its prices by as much as 32%, introduced 41 new products in 1992, and added new distribution channels.[11] A vigorous price war followed.

Demand growth recovered in the mid-1990s, buoyed by strong economic growth and the emergence of new, popular services involving computer networks. Proliferation of electronic mail and growth of the World Wide Web gave customers, especially individual consumers, new reasons to purchase a personal computer. PC prices continued to decline. Compaq offered a powerful personal computer for less than $1,000 in 1997, and other companies rushed to offer similarly inexpensive PCs. By December 1998, the prices of the least expensive PCs had plunged to $499. In the United States, 45.5% of households owned a computer in 1998, and the figure was expected to rise to 49.5% by 2000.[12] Household ownership levels were lower but also growing in Europe and Asia. See **Exhibits 1** and **2** for market size and share data over time.

Products in 1998. PC makers followed well-established standards to piece together modular components of hardware and software. The resulting machines differed widely in their processing speeds, memory capacities, portability, software configurations, modem speeds, and screen sizes, for instance.

Hardware components such as housings, keyboards, memory chips, motherboards, disk drives, monitors, modems, and connectors could be purchased in highly competitive global markets served by numerous companies. In contrast, microprocessors were supplied by only a handful of companies. Intel dominated this market, providing 80-90% of the microprocessors for Wintel PCs.[13] By 1998, roughly 96% of new PCs followed the Wintel standard.[14] Virtually all of the rest employed the Apple standard with PowerPC microprocessors. Other semiconductor makers such as AMD and Cyrix offered low-priced microprocessors which competed with Intel's and used a similar architecture, but historically, these companies had made few inroads into Intel's near-monopoly. In the sub-$1,000 market, AMD and Cyrix appeared finally to have made some headway in unseating Intel. Roughly half of the sub-$1,000 PCs sold during 1998 were equipped with an AMD processor.[15]

Intel ordinarily made its microprocessors available to all major purchasers at a standard price, thereby maintaining a level playing field among the leading PC makers. When Intel released a new generation of microprocessors, demand typically exceeded supply. Intel then rationed its new product, allotting microprocessors to PC makers in proportions that were based roughly on past purchases. The price of a microprocessor of a given generation declined rapidly as a generation aged, as did the price of PCs made with them. PC margins were typically highest during the early days of a microprocessor generation.

The core piece of software on a PC was the operating system. Virtually all PCs with x86 microprocessors employed an operating system made by Microsoft, usually some version of Windows. A number of vendors offered "application software" such as word processors, spreadsheets, database management systems, financial organizers, Web browsers, and electronic messaging software. In this market, also, Microsoft held a preeminent position, accounting for nearly 80% of the market for so-called "office productivity applications" (e.g., word processors, spreadsheets) and 10% of the overall $56 billion market for application software.[16]

The hardware and software that comprised a PC were often sold as an integrated bundle. PC makers such as IBM, Compaq, and Dell would deliver computers with a Microsoft operating system already installed and, in turn, would pay a fee to Microsoft. Increasingly, PCs were delivered with pieces of application software also already installed.

As processing costs declined, the lines between PCs and other devices blurred. At the lower end of the processing and memory spectrum, handheld electronic organizers had begun to compete with the personal computer for applications such as electronic mail and portable computing. At the higher end, PCs had become increasing hard to distinguish from workstations. Historically, workstations had been several times faster and more expensive than PCs and had employed specially designed microprocessors and distinct operating systems. In recent years, however, PCs based on the fastest x86 microprocessors and Windows NT had begun to compete with the low end of the workstation market. PC makers had also extended their product lines to include servers, powerful computers that sat at the hubs of computer networks.

Customers. PC buyers were usually divided into four categories: large and midsize businesses / government; small businesses and offices; individual consumers; and educational institutions. **Exhibit 3** shows the portion of PC units and sales revenue accounted for by each set of customers.

Large and midsize businesses and government institutions usually had significant MIS departments that purchased, maintained, and supported PCs in a centralized fashion. Staff members were highly knowledgeable about PCs. They were charged with providing a reliable network of high-performance computers while also controlling information system costs. The capital cost of a PC was only a portion of the total cost associated with the machine. Once a PC was purchased, MIS staff had to tag it for identification purposes, configure software, install the machine at the user location, train the users, and help users when they encountered problems. By one estimate, corporations spent between $8,000 and $12,000 annually to support each desktop PC.[17] Most large organizations had a motley collection of PCs of various brands and vintages, making maintenance, support, and reliability of machines problematic.

Small businesses and offices typically lacked MIS staffs. Reliability, performance, support, service, price, brand, and channel recommendations (see below) all played roles in the choice of a PC by such organizations. By 1998, virtually all businesses had extensive experience with personal computers.

Individual consumers purchased PCs for home or home-office use. In choosing among brands, individuals relied heavily on the evaluations of independent organizations such as *Consumer Reports.* Individual buyers were a diverse lot, but tended to be more sensitive to price and more interested in a computer's brand name than were business buyers.[18] Some consumers also paid attention to the brand of the microprocessor. Since 1990, Intel had spent an estimated $3 billion on brand advertising for its microprocessors. Among individual consumers in the U.S., 30% of purchasers were first-time buyers in 1998. This figure was expected to decline to 16% by 2000.[19]

In the eyes of some industry observers, buyers were divided into two true camps: Apple and Wintel. Many long-time owners of Apple computers were highly, almost emotionally, attached to the Apple standard, and they cursed the ascendancy of Wintel. Wintel customers, in contrast, tended to

be less attached to a particular brand of computer. Apple was more successful in selling its PCs to individuals and educational institutions than to businesses, though it thrived among desktop publishers.

Channels. Personal computers flowed from manufacturers to customers via four channels: retail stores, distributors (working with small resellers), integrated resellers, and direct distribution.[20] **Exhibit 4** shows the portion of PCs passing through each channel in various regions of the world.

Retailers such as Circuit City and CompUSA in the United States and Time Computers in Europe took delivery of PCs directly from manufacturers. Machines then passed through distribution centers owned by the retailers on their way to stores. In stores, retail displays and sales people played a significant role in helping customers select among models and manufacturers. Retail shelf space was limited, and even large superstores typically carried only 3-5 brands of PCs. Computer retailers operated on very thin margins. CompUSA, for example, earned overall gross margins of 14.1% and gross margins of roughly 7-9% on computers. It registered a net margin of 0.6% in 1998.

A handful of large distributors such as Ingram Micro (with 1998 sales of $22.0 billion) and Tech Data ($7.1 billion) supplied a full range of computer hardware and software to nearly 100,000 resellers.[21] These resellers, typically small owner-managed firms, worked with business customers to design, buy, configure, install, and support computer networks. According to one survey, 93% of end users accepted reseller recommendations for computer purchases.[22] Beyond charging for their value-added services, distributors and resellers typically marked up hardware by a total of 5-7%, though this mark-up had fallen in recent years.[23]

A few resellers were large enough to deal directly with manufacturers rather than buy through distributors. Integrated resellers such as MicroAge and Vanstar operated distribution centers, fielded extensive sales and service organizations, and in some cases, managed the PC networks of clients on an on-going basis. Vanstar, for instance, split its operations into three distinct segments. The largest, involved in the procurement and installation of corporate PC networks, earned a gross margin of 9.7% in 1998. A second segment devoted to network design and consulting reported a gross margin of 44.4%, while a third involved in on-going network support and maintenance earned a gross margin of 53.1%. Overall, Vanstar's net margin in 1998 was a thin 1.3%.

A fourth and final channel led directly from the manufacturer to the customer. A handful of PC manufacturers took orders directly from customers, either over the telephone and Internet or by means of internal sales forces. They then delivered PCs via third-party shippers such as UPS.

Manufacturers usually agreed to buy back channel inventory that did not sell. In addition, they provided price protection to resellers and distributors: if the price of a computer fell while it was in the distribution channel, the manufacturer would reimburse the reseller or distributor accordingly. By one estimate, inventory buy-backs and price protection cost PC manufacturers 2.5 cents on every dollar of revenue. Manufacturers spent another 2.5 cents advertising to resellers and distributors, funding the market development activities of channel players, and managing product returns. PCs typically took four to five weeks to pass from the PC maker through distributors and resellers to customers.[24]

Manufacturing. Computer makers used basic assembly-line techniques to assemble PCs from standard parts. By the early 1990s, a manufacturer could buy and install the capital equipment required for an efficient PC assembly line, capable of assembling 250,000 PCs per year, with an investment of roughly a million dollars.[25] Contract manufacturers, many in Asia, also stood ready to make PCs on behalf of other firms. **Exhibit 5** shows the structure of the costs typically incurred to assemble a PC that would retail for roughly $1,000.

The prices of components used to make PCs had typically declined 25-30% per year. In 1998, prices declined even faster, at a rate of roughly 1% per week. The financial crisis in Asia (where

many component makers were located), increased competition faced by Intel, and gluts in the markets for several components all contributed to the faster decline in prices.[26]

Marketing and sales. PC manufacturers took a variety of approaches to marketing and sales. Companies such as Apple, Hewlett-Packard, and IBM spent as much as 2-3% of sales on advertising in order to develop recognizable brands. Others produced unbranded "white box" PCs and did not advertise to end users at all. Sales forces varied from the 25,000-strong sales organization of IBM to the virtually nonexistent sales forces of white-box PC makers. White-box manufacturers served 23% of the market in North America, 50% in Europe and Asia, and as much as 90% in China.[27]

Dell Computer Corporation

> *"It was too late to challenge the technical standard and the dealer network had been done already. Compaq was already very strong in retail. A new marketing and distribution strategy was something new, however."*[28]

While a freshman at the University of Texas at Austin, 18-year-old Michael Dell started a part-time business in his dorm room: he formatted hard disks for personal computers and added extra memory, disk drives, and modems to IBM clones, selling them for as much as 40% less than comparable IBM machines. Reluctant to reveal this distraction from his studies, Dell hid PCs in his roommate's bathtub when his parents came to visit.[29]

When revenue reached $80,000 per month in 1984, Dell dropped out of college and founded Dell Computer Corporation. Already, companies such as Exxon and Mobil were clamoring for 50 to 100 of Dell's machines at a time.[30] In 1985, Dell shifted from upgrading the machines of other manufacturers to assembling Dell-branded PCs. Revenue rose each subsequent year. (See **Exhibit 6** for financial results.)

The basic elements of Dell's Direct Model came together early in the company's history and remained in place in 1998. The company dealt directly with end customers. It served primarily corporate customers and offered them high-performance PCs at relatively low prices. PCs were customized to buyer specifications, and assembly commenced only after Dell received an order.

Sales and marketing. While most competitors supplied machines based on orders from distributors, resellers, and retailers, Dell took orders directly from customers. Businesses and government institutions accounted for 77% of Dell's sales, home and small office users 18%, and educational institutions 5%. Very large customers, who purchased more than $1 million in PCs each year, provided 70% of the firm's revenue.[31] No single customer represented more than 2% of Dell's sales.[32]

Dell used indicators of a company's potential PC purchases, such as the number of employees and the number of PCs per employee, to divide customers into two groups: Relationship buyers and Transaction buyers.[33] Relationship buyers were large companies and institutions that could be counted on to place repeated orders for multiple PCs. Dell assigned a team of outside sales reps and inside sales reps to each Relationship account. Over a thousand outside sales reps spent their time in the field, understanding customer needs, courting customer personnel, helping customers configure their information systems, and promoting Dell's products and services. Inside sales reps, located in call centers, received telephone calls from assigned customers. Because Relationship customers typically specified particular PC configurations that their employees were allowed to order, the inside reps serving such customers simply took orders and provided product and delivery information. Both inside and outside sales reps had access to on-line information about a customer's entire

purchase history and worked closely with Dell personnel responsible for after-sale service and technical support. Dell tended to realize its highest gross margins among Relationship buyers.[34]

Transaction buyers included small-to-medium businesses and home computer users. The company reached these customers via advertisements in trade journals and business publications, catalogs, and direct marketing. Customers who wanted to buy a PC or obtain information could reach an inside sales rep by calling 1-800-BUY-DELL (a different number than that used by Relationship buyers). Inside sales reps for Transaction buyers provided product information and actively encouraged customers to purchase more advanced PCs. Traditionally, Dell avoided the inexperienced Transaction buyer. Morton Topfer, Vice Chairman of Dell, explained: "Consumers at retail don't know what they are looking for, other than price. We, on the other hand, like to sell to the educated consumer."[35]

In late 1990, Dell departed from its Direct Model and entered the retail channel. The move, Michael Dell said, would "[provide] us with the opportunity to generate significant new business and increase Dell's market penetration," especially among "PC customers—particularly at the entry level—who want to physically 'touch and feel' a unit before they buy."[36] Accordingly, Dell produced two lines of standard PCs and reached distribution agreements with computer superstores such as CompUSA and warehouse clubs such as Sam's Club. Sales through the retail channel were brisk, but Dell soon found that it was losing money on retail sales. **Exhibit 7** compares the margins which Dell earned in the direct and retail channels. Retail losses contributed to Dell's poor financial results in 1993, as did a major recall of notebook computers. In 1994, Dell withdrew from retail stores.

As Dell had grown, it had subdivided its customer base into finer and finer categories. In 1994, buyers were classified as large customers or small customers. By 1996, the large customer classification had been split into large companies, midsize companies, and government and educational institutions. By 1998, large companies had been split into global enterprise accounts and other large companies; government and educational accounts into federal, state and local, and educational; and small customers into small companies and consumers.[37] In addition, sales efforts were divided by region and, within region, by country. Michael Dell explained that such divisions were accomplished "for a lot of reasons. One is to identify unique opportunities and economics. The other is purely a managerial issue: you can't possibly manage something well if it's too big."[38]

Dell launched its Web site www.dell.com in July of 1996, and increasingly, customers were using the site to contact Dell. Transaction buyers could obtain product information, configure a computer system, check pricing, place an order, and track an order's progress. They could also gain access to the complete catalog of service and support information used by Dell's service representatives.

For thousands of Relationship customers, Dell had designed custom Premier Pages[SM]. On these secure Web pages, an employee of a customer might find pager numbers for their Dell account team or a list of computer configurations that had been approved by the customer's purchasing manager, for instance. By December of 1998, transactions totaling $10 million per day involved www.dell.com.[39]

Occasionally, Dell sold to resellers. In December 1997, for instance, it sent a flyer to a limited number of resellers offering older systems to resellers at prices 15-20% below the prices quoted at www.dell.com. However, Dell did not allow returns or provide price protection.[40] Roughly 5% of Dell's systems were purchased by resellers.[41]

Production, logistics, and procurement. Dell manufactured machines that were—within the guidelines of a broad menu—tailored to customer needs. The company made customized PCs based on actual orders and held no finished goods inventory of standardized machines. Dell operated manufacturing facilities in Austin, Texas; Limerick, Ireland; Penang, Malaysia; and Xiamen, China. A

fifth site was slated for Alvorada, Brazil. Daily meetings matched production schedules with sales flows. Keith Maxwell, Dell's vice president for worldwide operations, commented:[42]

> [The current production system] requires that the whole organization be integrated. You've eliminated buffers. When you have no buffers and you have no inventory, the whole organization has to work together. There is no way to let things pile up, because you have no piles.

Once received, an order was sent electronically to the appropriate manufacturing facility. There, a computer generated a parts list for the order and assigned the order a bar code for tracking purposes. Dell's older facilities were organized in assembly-line fashion: as the chassis of the machine traveled down the line, the hardware specified by the parts list was added. Its newest facility in Austin employed five-person manufacturing cells: parts for a PC were compiled in a bin, the bin sent to a cell, and the computer assembled there. The company found that the cells delivered machines with fewer defects more efficiently.[43]

After assembly, the machine moved to a software loading zone. There, special machines and a very-high-speed computer network installed software specified by the customer: an operating system, commercial application software, and diagnostic software. For some corporate customers, Dell also loaded proprietary software. The fully equipped machine proceeded to a "burn-in" area, where it was tested for several hours. Finally, it was boxed along with accessories and shipped to the customer. Dell maintained shipping contracts with a number of third-party shippers such as UPS and Airborne Express.

The production process, from order entry to shipping, took about a day and a half.[44] In the midst of the Asian economic crisis in October of 1997, for instance, Dell received an emergency order from the Nasdaq stock exchange for eight servers. The exchange's existing servers were being strained by unprecedented trading volumes. Dell shipped the customized, tested servers within 36 hours.[45] At the same time, the production process could handle large orders. Also in late 1997, for example, Dell built 2,000 desktop computers and 4,000 servers for Wal-Mart, loaded the machines with proprietary software, and shipped them to 2,000 Wal-Mart stores.[46]

Dell worked closely with suppliers to arrange just-in-time delivery of parts. Dell had whittled its days of inventory down from 32 in 1995 to 7 in 1998.[47] Since 1992, it had reduced the number of suppliers for its Austin facility from 204 to 47.[48] With remaining suppliers, Dell maintained close electronic links, communicating replenishment needs to some vendors on an hourly basis. The electronic links allowed Dell to direct some suppliers' shipments straight to its customers. Computer monitors supplied by Sony, for instance, never passed through Dell's facilities. Rather, Dell communicated the order for a monitor to Sony and to its shipper. The shipper picked up the computer at Dell's site, picked up the monitor at Sony's, brought the boxes together, and delivered them simultaneously to the customer. A web site customized to Sony gave both Sony and Dell continuous access to ordering and manufacturing information.[49] Michael Dell explained:[50]

> …what's the point in having a monitor put on a truck to Austin, Texas, and then taken off the truck and sent on a little tour around the warehouse, only to be put back on another truck? That's just a big waste of time and money, unless we get our jollies from touching monitors, which we don't.

Dell encouraged suppliers to locate warehouses and production facilities close to its assembly operations. Co-location was particularly easy to arrange near Dell's major facilities in Austin, where local and state government officials had worked since the 1950s and 1960s to attract high-technology companies. Now known as "Silicon Hills," the Austin region included 72 semiconductor manufacturers and related suppliers, 160 computer and electronics manufacturing firms, more than 600 small and midsized software companies, and 825 technology consulting and services firms.[51]

Products and services. Dell provided two lines of desktop computers, one designed to be reliable, stable, and highly compatible with corporate networks, the other intended to incorporate the latest technology. Desktop computers ranged from $1,250 machines for individual consumers to $4,000 PC for corporate networks. The company also offered two lines of notebook computers, with a similar distinction between the lines. A line of network servers and, since 1998, a line of workstations filled out the company's product range.[52] Dell's workstations and servers used Windows NT and x86 microprocessors.

In addition to selling hardware, Dell offered to install off-the-shelf software and a customer's proprietary software. On a custom basis, it installed and tested computers and networks at customer sites. A new venture, Dell Financial Services, offered leasing, technology planning, and asset management services.

After a sale, Dell supported its products in several ways. Online, Dell offered 50,000 pages of customer support information. A customer with a problem could also reach a technical support staff of 1,300 representatives via a hotline that was manned 24 hours a day. Upon receiving a call, support personnel would retrieve a file containing details of the customer's computer, starting with the original order and recording all subsequent service calls. Using the diagnostic software installed in the factory, the customer and the support specialist could resolve the problem over the telephone in approximately 90% of cases. For problems requiring an on-site visit, Dell contracted out service to companies such as Xerox, Wang Global, and Unisys rather than employ service personnel itself. Most problems requiring an on-site visit were resolved with 24 to 48 hours.[53] Dell was working with service providers to create measures of service quality and to improve the flow of data between them and Dell.[54] Dell also conveyed information concerning defective parts from the service providers back to its suppliers.[55]

In most industry surveys, customers rated Dell's sales, products, and services highly relative to the competition. **Exhibits 8** and **9** report the results from a survey of corporate PC buyers and from *Consumer Reports*, respectively. **Exhibits 10a** and **10b** show, for the consumer and business portions of the market, the prices of Dell PCs relative to comparably configured machines offered by rivals.

Firm infrastructure. For much of its history, Dell was managed as an entrepreneurial start-up with few formal control systems. Growth pains culminated in a net loss in 1993. Dell's supply of cash fell as low as $20 million in 1993, a thin cushion for a company with annual sales of nearly $3 billion.

Subsequently, Michael Dell hired a number of seasoned managers, including veterans from Motorola, Apple Computer, Sun Microsystems, Intel, and Electronic Data Systems. Morton Topfer, formerly at Motorola, took the position of Vice Chairman and focused especially on operations and manufacturing. Dell himself, at 33 the longest tenured chief executive in the PC industry, concentrated on products and market trends.[56]

In 1998, senior management paid special attention to several performance metrics. The company monitored days of inventory by product component. It managed receivables and payables such that, on average, it received payment for its products five days before it had to pay suppliers. Managers examined margins, selling price, and overhead by customer segment, product, and country.[57] As an overall indicator of company performance, the senior management team focused on return on invested capital.[58] Dell's FY 1998 return on invested capital was 186%.

Competition

Dell's financial returns and rapid growth caused its rivals to take both notice and action. (**Exhibit 11** compares Dell's growth rate, profitability, and other characteristics to competitors'.) Dell faced a diverse set of competitors, typified by IBM, Compaq, Hewlett-Packard, and Gateway.

IBM. Since sparking the growth of the PC market in the early 1980s, IBM had fallen to third place among PC makers in terms of dollar market share worldwide. IBM remained the largest information technology corporation in the world, offering an extremely broad range of IT hardware, software, and services. Its personal computing products covered the spectrum from sub-$1,000 PCs to high-end servers and workstations. IBM's vaunted sales and service organization gave it full access to corporate MIS managers. The sales force accounted for 5% of its PC sales, distributors and resellers for 70%, and retailers for 18%.

IBM was among the first PC makers to recognize the challenge posed by direct distribution.[59] Starting in the early 1990s, it launched a series of initiatives to improve coordination with distributors and resellers: a Joint Manufacturing Authorization Program was followed by an Integration and Assembly Program and an Enhanced Integration and Assembly Program. In these programs, IBM shipped "heavily configured" PCs to authorized distributors and resellers, who then completed the configuration of the machine to customer specifications and forwarded it on to the customer.

In 1995, IBM moved to an Authorized Assembly Program (AAP). Here, IBM shipped "lightly configured" PCs, known as Model 0s, to downstream partners. Model 0s were barely functional computers, containing only a motherboard, a floppy drive, and a video card. Partners in the channel completed the assembly to customer specifications, using components purchased from IBM. Until September 1998, components were always shipped from IBM facilities. Hence a microprocessor might travel from Intel's warehouse in Arizona to IBM's facility in North Carolina and back to a partner's assembly plant in Arizona.[60] IBM set component prices such that total costs, including assembly costs, were the same for a channel-assembled and IBM-assembled PC.[61] Under AAP, IBM continued to build Model 0 PCs based on forecasts, not on actual customer orders.

A number of major distributors and resellers, including MicroAge, Ingram Micro, and Tech Data, had invested tens of millions of dollars to build plants that assembled IBM PCs (and by 1998, PCs with other brand names).[62] By 1998, roughly half of IBM's shipments of desktop PCs to MicroAge, for instance, were thought to be Model 0s.[63] Overall, between one-quarter and one-third of IBM's PCs were finished by one of 14 channel partners.[64]

AAP enabled IBM and its partners to deliver customized PCs rapidly without holding large amounts of inventory. One partner reported that the program improved the inventory turnover rate of its IBM stock from 10-12x to 20x. At the same time, the partner's fill rate—the portion of time that it had a desired product in stock—rose from 80% to 95%. The program also reduced the need for resellers to "tear down" new PCs, that is, take them apart and reconfigure them to meet customer needs. Tear downs were costly and appeared to cause quality problems. MicroAge reported that 2.0% to 2.25% of IBM-built machines had defects after a tear-down while only 0.5% of its AAP-assembled machines had problems.[65]

Even as it increased coordination with channel partners, IBM explored ways to expand its own direct sales. To combat IBM clones, IBM had launched an autonomous division named "Ambra" in 1992. The division produced low-end PCs at low cost by contracting out most operations, and it sold Ambra PCs by mail-order and telephone. The Ambra division was shut down in 1994.[66] In April 1998, IBM opened a web site that allowed customers to buy PCs.[67] The site referred business customers to resellers, who then set prices and fulfilled orders. Individual consumers could use the web site to purchase standardized PCs directly from IBM, without going through a retail outlet. For consumers, the site offered the Aptiva line of PCs, which Taiwan-based Acer built on behalf of IBM.

Later in 1998, IBM introduced its first program to enable businesses to buy a small set of products directly: the Netfinity Direct program allowed large enterprises to purchase a particular line of IBM servers without going through resellers.

Exhibit 12 shows financial results for IBM as a whole. Personal computers represented 23% of IBM's corporate revenue. Its PC division lost $39 million before taxes in 1996, $161 million in 1997, and $992 million in 1998. The company reported, however, that PC operations returned to profitability in the fourth quarter of 1998.[68]

Compaq. Founded in 1982, Compaq surpassed IBM in 1994 to become the world's largest manufacturer of personal computers. By 1998, Compaq offered a broad range of computers, from sub-$1,000 PCs to $2 million fail-safe servers.[69] With its $3 billion acquisition of Tandem Computers in 1997, Compaq doubled its sales and support staff to 8,000 people and gained access to the corporate data centers which Tandem's fail-safe computers had served.[70] Its $9 billion acquisition of DEC in 1998 gave Compaq, among other assets, DEC's highly regarded service and consulting staff of 22,000 people. In the words of Eckhard Pfeiffer, Compaq's CEO, "We want to do it all, and we want to do it now."[71]

The company employed the full range of PC channels, selling 67% of its PCs through 44,000 distributors and resellers, 25% at retail, and 4% direct.[72] Compaq served individual consumers and business customers in quite different ways. For consumers, Compaq built standard PCs to stock, either in its own factories or the factories of Asian contractors. It distributed to consumers primarily through retail stores. Compaq launched an online catalog in 1993, but abandoned the initiative in the face of channel resistance.[73] In 1996, Compaq introduced a toll-free telephone number that allowed consumers to order PCs directly from the company. According to one analyst, "the results have been tepid, mainly because Compaq kept its prices high to avoid angering dealers."[74]

Compaq's production and distribution system for business customers had evolved over time. In late 1995, Compaq moved from a production system in which it built business PCs according to its own forecast to one in which it built according to forecasts made by channel members. This permitted Compaq to reduce the inventory it held for PCs from 60 days to 30 days. Because resellers and distributors held 35 more days of inventory, a Compaq computer delivered in mid-1997 was typically 65 days old before it reached a customer through the reseller channel.

In July of 1997, Compaq announced a new effort to coordinate efforts with distributors and resellers, an Optimized Distribution Model (ODM). Under ODM, PCs would be built only after an order was received, and orders and delivery would continue to go through distributors and resellers. Relatively standard machines would be built to order in Compaq's plants and delivered rapidly, ready for installation, to resellers. More complicated, customized machines would be assembled in a two-step process: Compaq would ship stripped-down PCs, similar to IBM's Model 0s, to channel partners. Members of the channel would handle the final assembly and configuration. Compaq expected to finish 80% of its corporate PCs in its own factory, with channel partners completing the other 20%.[75]

Under ODM, Compaq would offer only two weeks of price protection, down from as much as seven weeks. In late 1998, the total inventory in the Compaq / distributor / reseller channel was estimated to have declined to 45-50 days.[76] Analysts thought that ODM might eventually reduce total inventory to 25 days.[77]

Following the DEC acquisition, announced in January of 1998, distributors and resellers were concerned that Compaq would use DEC customer relationships to sell directly to corporate accounts, especially to large corporations. In June, Compaq confirmed that it would do so. Compaq's vice president of marketing and communications assured that "the price of systems bought through the channel will be the same as systems purchased directly from Compaq, and resellers will still make a profit."[78]

In November of 1998, Compaq unveiled its DirectPlus Program, intended to sell customized PCs directly to small and midsize companies. Under the program, Compaq would offer a new line of computers via the telephone and Internet. The line would be available only through DirectPlus, and prices would be lower than those charged by resellers for comparable Compaq machines. Compaq offered to pay resellers a referral fee of 6-7% on orders that they passed along to DirectPlus. To accompany the new computer line, Compaq introduced support services, software modules, and leasing programs that might attract small and midsize business customers. Compaq intended to ship DirectPlus orders as early as the next business day and, on average, within five days.[79] Observers expected Compaq to turn over some manufacturing of the new line to resellers who had invested in assembly operations.[80]

Exhibit 13 provides financial information for Compaq. Prior to recent acquisitions, PCs constituted virtually all of Compaq's revenue. According to analysts, Compaq relied heavily on profits from its PC server business. In February of 1998, IBM cut its server prices sharply, passing along cost savings made possible by its efforts to streamline production and distribution. In March, Compaq announced that it would break even in the first quarter of 1998 rather than post a profit expected to exceed $500 million.[81]

Hewlett-Packard. Hewlett-Packard (HP) was founded in 1939 as a maker of scientific instruments but, by 1998, offered a broad range of scientific equipment, computers, printers, and other computer peripherals. In the PC business, HP maintained a reputation for high quality and performance and sold to more demanding customers. Its product range was comparable to Compaq's, but it earned a smaller portion of its revenue from the low end of the consumer and business markets. The company sold 75% of its PCs through distributors and resellers, 23% through retail channels, and less than 1% directly to customers via its sales force.

In September of 1997, shortly after Compaq announced its ODM program, HP unveiled a similar Extended Solutions Partnership Program (ESPP). Under ESPP, HP would build large corporate orders to customer specifications in its factories. Orders would be delivered to resellers or, at the reseller's request, shipped directly to the customer. Ten channel partners would complete assembly of some HP machines. A Web site would allow customers to order products over the Internet for delivery through resellers. HP hoped that the program would allow it to reduce price protection to two weeks, cut down defects, and shave 5% - 15% off of its prices.[82]

HP courted distributors and resellers and steadfastly refused to attach the word "direct" to any of its efforts related to business customers. Even before Compaq announced its DirectPlus program, 59% of resellers reported that they were more willing to promote HP products as a result of IBM's and Compaq's movement toward direct sales.[83] Following the DirectPlus announcement, HP initiated an advertising campaign aimed at resellers to small and midsize businesses and announced incentives for resellers to switch from Compaq to HP products. Duncan Campbell, HP's worldwide group marketing manager for personal systems, explained, "We are pleased that Compaq is going direct. They have made a bad call, and the channel should make them pay."[84]

Nonetheless, in October 1998, HP launched a modest effort to set up direct sales on the World Wide Web.[85] HP Shopping Village, a web service previously providing refurbished HP computers to individuals, was expanded to allow consumers to buy new PCs directly from HP. Business customers could use a similar web site to purchase HP PCs, but like IBM's web site, HP's required business customers to complete purchases through resellers. Lew Platt, CEO of HP, hinted that business customers might not have to go through resellers in the future: "You can't ignore what Dell has done…. I could give you a list of names of really large customers who have said to HP, 'Either do business with us directly or you are not going to do business with us.'"[86]

Exhibit 14 provides financial information for Hewlett-Packard. Personal computers constituted 20-25% of corporate revenue in 1998 and earned an operating margin estimated at 3%.[87]

Gateway 2000. Founded in an Iowa farmhouse in 1985, Gateway 2000 was the world's second largest direct marketer of PCs, trailing only Dell. Like Dell, Gateway took orders from customers, produced PCs to their specifications, loaded software on the PCs, and shipped machines directly to customers. The company maintained a force of inside and some outside sales reps, provided extensive telephone- and Web-based technical support, and contracted with third-parties for on-site technical service. The company prided itself on efficient, high-quality manufacturing facilities in South Dakota, Virginia, Utah, and Malaysia and reported that it was usually among the first PC makers to introduce the latest Intel microprocessors.

Gateway's product line ranged from sub-$1,000 PCs to servers and workstations. Its core customers were sophisticated home and small office users, and accordingly, its sales of both inexpensive and high-end PCs were relatively modest. In 1998, 58% of Gateway's sales were to home and small office computer users, 28% to businesses, and 13% to educational and government institutions.[88] Roughly a third of Gateway's revenue from business customers came from small businesses. The company's advertisements—in newspapers, family-oriented magazines, and computer trade publications as well as on television—featured its mascots, a set of Holstein cows. Black and white Holstein spots were featured on Gateway's distinctive packaging.

Gateway grew at annual clip of 39% from 1991 to 1996 and surpassed Dell's U.S. sales briefly in 1994. In 1997, however, sales growth slowed to 25%, and net income fell by half. Attempts to clear excess inventory, charges related to an acquisition, and an aborted effort to develop a new customer information system were said to have contributed to the decline in profits.

Slowing growth prompted a number of initiatives. The 1997 acquisition of Advanced Logic Research eased Gateway's entry into the PC server business. At the same time, the firm set up Gateway Major Accounts, Inc., a company within the company, to service large corporate, government, and educational accounts. The company also opened 144 Gateway Country Stores, retail showrooms, in the United States in 1997 and 1998. In the stores, customers could view Gateway products and place orders. The stores did not stock products.

In 1998, Gateway scaled back its brief efforts to lure major accounts and refocused its energy on small businesses. Observers reported that "Gateway couldn't afford to pay for the expanded sales team it needed to knock on the doors of big corporate clients."[89] A new division, Gateway Partners, was slated to work with resellers.[90] The firm also removed the Holstein cows from its ads and moved its administrative headquarters—including its IT services, marketing, and finance divisions—from North Sioux City, South Dakota, to San Diego, California. The company had tried but failed to fill roughly 250 job openings in South Dakota.

Exhibit 15 provides financial information for Gateway.

Recent Developments

In late 1998, Dell claimed that its advantage in inventory turnover remained very large,[91] but the price differential between Dell's products and its competitors' had all but vanished.[92] Manufacturer and channel inventories for PCs from Dell's rivals were declining as planned, but availability was now a problem. Customers reported that they could not obtain certain models of IBM PCs and, to a lesser extent, Compaq PCs.[93] A skeptic of channel assembly argued, "There are so many mechanics involved in this and so many egos to go with it. You have to change cultures before this will work."[94]

An observer of the channel reported that "a number of [distributors, resellers, and retailers are] exploring 'strategic alternatives' as a direct result of moves by these manufacturers."[95] MicroAge,

one of the resellers that had set up assembly operations, had established the brand name "Pinacor" for its distribution operation. Its assembly facility was allegedly running at 25% capacity in late 1998.[96] The retailer CompUSA had started to sell inexpensive computers under its own brand name.[97]

In public statements, Dell's senior management appeared unconcerned about the efforts of its rivals. "The things HP, IBM, and company have done have added more credibility to us than anything we could have done," said Vice Chairman Morton Topfer.[98] Concerning Compaq's plan to sell direct, Michael Dell joked, "It's like we're the best baseball player and Compaq is the best basketball player. Now they want to play baseball."[99]

Exhibit 1 PC Market Size, 1982 – 1998

	82	84	86	88	90	91	92	93	94	95	96	97	98
United States													
Units (mm)	3.0	6.7	6.9	8.7	9.5	9.5	11.8	15.6	18.7	23.0	26.5	31.5	36.3
Dollars (bn)	4.5	12.8	14.5	20.6	23.3	22.0	24.6	30.1	37.4	53.9	64.8	70.0	74.6
Worldwide													
Units (mm)					23.8	25.8	30.8	39.0	47.0	58.9	69.2	79.9	90.3
Dollars (bn)					60.9	59.8	63.7	73.1	100	131	161	170	170

Source: International Data Corporation

Exhibit 2a PC Market Shares in the United States, 1980 – 1998 (unit share, in percent)

	80	83	87	89	90	91	92	93	94	95	96	97	98
Apple	29.3	20.0	14.0	10.7	10.9	13.7	13.2	13.4	11.5	10.6	6.4	4.1	4.6
AST/Tandy	37.6	5.0	2.0	1.7	1.8	2.7	2.8	4.0	3.5	2.3	2.4	-	-
Compaq	-	-	7.5	4.4	4.5	4.1	5.7	9.4	11.7	10.8	12.9	16.0	16.7
Dell	-	-	-	0.9	1.0	1.6	3.7	4.8	4.2	4.9	6.8	9.3	13.2
Gateway	-	-	-	0.2	1.0	2.5	3.6	4.3	5.1	5.1	6.1	7.1	8.4
HP	5.3	-	-	-	-	-	-	-	2.4	3.8	5.3	6.6	7.8
IBM	-	42.0	28.0	16.9	16.1	14.1	11.7	13.0	8.7	7.9	8.3	8.7	8.2
Packard Bell	-	-	-	3.3	3.9	4.7	5.3	6.4	14.3	14.4	11.4	8.8	6.2
Others	27.8	33.0	48.5	61.9	60.8	56.6	54.0	44.7	38.6	40.2	40.4	39.4	34.9

Source: Data for 1980-91 from Das Narayandas and V. Kasturi Rangan, "Dell Computer Corporation," HBS Case 596-058. Data for 1992-98 from International Data Corporation

Exhibit 2b PC Market Shares Worldwide, 1990 – 1998 (unit share, in percent)

	90	91	92	93	94	95	96	97	98	**Headquarters**
Acer	-	-	-	-	2.8	3.6	4.1	3.5	3.1	Taiwan
Apple	7.1	9.6	9.0	9.4	8.5	8.0	5.4	3.2	3.4	California
AST/Tandy	2.7	1.9	1.9	3.0	3.0	-	-	-	-	California
Compaq	3.6	3.4	5.1	7.9	10.3	10.0	10.5	12.7	14.7	Texas
Dell	-	-	2.3	3.0	2.8	3.2	4.3	5.9	8.6	Texas
Gateway	-	-	-	1.8	-	-	-	3.4	4.0	South Dakota / California
HP	-	-	-	1.8	2.8	3.5	4.3	5.6	6.3	California
IBM	12.7	11.1	10.4	10.8	8.7	8.2	8.9	9.0	8.8	New York
Packard Bell	-	2.0	2.3	2.9	7.1	7.3	6.1	5.2	4.2	California
Toshiba	-	2.6	2.0	2.0	2.5	2.5	3.9	4.1	3.5	Japan
Others	73.9	69.4	67	57.4	51.5	53.7	52.5	47.4	43.4	

Source: International Data Corporation

Exhibit 3a U.S. PC Sales by Customer Category (market share by dollar value)

	1994	1995	1996	1997	1998
Large / midsize business & government	45.0%	47.4%	44.6%	43.1%	42.3%
Small business & office	24.3%	22.7%	24.8%	24.1%	23.7%
Consumers (home)	27.4%	34.7%	32.6%	28.0%	28.7%
Education	3.2%	5.2%	5.0%	4.8%	5.4%
Total market size ($ bn)	37.4	53.8	64.7	70.3	74.6

Exhibit 3b U.S. PC Sales by Customer Category (market share by units)

	1994	1995	1996	1997	1998Q2
Large / midsize business & government	39.8%	32.0%	34.7%	38.3%	38.5%
Small business & office	24.0%	22.2%	23.8%	23.3%	22.8%
Consumers (home)	32.7%	39.7%	36.8%	33.7%	32.8%
Education	3.6%	6.0%	4.8%	4.8%	5.8%
Total market size (millions of units)	18.7	23.0	26.5	31.5	36.3

Source: International Data Corporation

Exhibit 4 Portion of Sales Through Each Channel by Region, 1998 (by dollar value)

Channel	Americas	Europe / ME /Africa	Asia / Pacific / ROW
Retail	21.7%	17.1%	26.4%
Distributor / Reseller	41.2%	63.3%	49.2%
Direct	29.7%	17.8%	23.5%
Catalog, Phone, Online	17.8%	9.7%	3.1%
Sales Representatives	11.9%	8.1%	20.4%
Other	7.4%	1.8%	0.8%

Source: International Data Corporation

Exhibit 5 Approximate Manufacturing Cost Structure of a Basic Personal Computer

Components	Cost
Microprocessor	$50 - 600
Motherboard, hard drive, memory, chassis, power, packaging	$250 - 350
Keyboard, mouse, modem, CD-ROM and floppy disk drives, speakers	$90 - 140
Monitor	$100
Windows 98	$50
Assembly labor	$50
Total	On average, $800-900

Source: Mary Kwak and David B. Yoffie, “Apple Computer 1999,” HBS Case 799-108, pp. 7-8.

Exhibit 6 Summary of Dell Computer Corporation Financial Performance ($ million)

	1992	1993	1994	1995	1996	1997	1998	1999
Revenue	890	2,014	2,873	3,475	5,296	7,759	12,327	18,243
Gross margin	282	449	433	738	1,067	1,666	2,722	4,106
SG&A	182	268	423	424	595	826	1,202	1,788
R&D	33	42	49	65	95	126	204	272
Operating income	69	139	(39)	249	377	714	1,316	2,046
Net income	51	102	(36)	149	272	518	944	1,460
Current assets	512	853	1,048	1,470	1,957	2,747	3,912	6,339
Inventory	127	303	220	293	429	251	233	273
Total assets	560	927	1,140	1,594	2,148	2,993	4,268	6,877
Stockholders' equity	274	369	471	652	973	1,085	1,293	2,321
Operating cash flow	0	(39)	113	243	175	1,362	1,592	2,346
Capital expenditures	33	47	48	64	101	114	187	296
Ratios:								
Gross margin / revenue	31.7%	22.3%	15.1%	21.2%	20.1%	21.5%	22.1%	22.5%
SG&A / revenue	20.4%	13.3%	14.7%	12.2%	11.2%	10.6%	9.8%	9.8%
R&D / revenue	3.7%	2.1%	1.7%	1.9%	1.8%	1.6%	1.7%	1.5%
Net income / revenue	5.7%	5.1%	-1.3%	4.3%	5.1%	6.7%	7.7%	8.0%
Revenue / EOY assets	1.59x	2.17x	2.52x	2.18x	2.47x	2.59x	2.89x	2.65x
EOY assets / equity	2.04x	2.51x	2.42x	2.45x	2.21x	3.71x	3.30x	2.96x
Net income / EOY equity	18.6%	27.6%	-7.6%	22.9%	28.0%	64.3%	73.0%	62.9%

Source: Company annual reports; Compustat. Note that fiscal year ends January 31; consequently, "1999" results are predominantly for calendar year 1998.

Exhibit 7 Dell Margins in Direct and Retail Channels in 1994

	Dell Direct	Dell Retail
Price	100.0	88.0
Cost of sales	81.0	81.0
Gross margins	19.0	7.0
Operating expense	14.0	10.0
Operating income	5.0%	-3.0%

Source: Das Narayandas and V. Kasturi Rangan, "Dell Computer Corporation," HBS Case 596-058, p. 11.

Exhibit 8 Ratings of PC Vendors by Corporate Managers with PC-buying Responsibility

	Dell	Compaq	IBM	Gateway	HP
User satisfaction					
Overall	1st	4th	5th	2nd	3rd
At high price point	2nd	2nd	5th	4th	1st
At midrange price point	2nd	3rd	5th	1st	4th
At low price point	2nd	3rd	5th	1st	4th
Raw technology					
System speed	1st	3rd	5th	2nd	3rd
Reliability	1st	2nd	4th	4th	3rd
Compatibility	1st	5th	3rd	1st	4th
Configurability	1st	5th	3rd	1st	4th
Upgrades	1st	3rd	5th	2nd	4th
Hardware quality	1st	4th	5th	3rd	2nd
System management	1st	4th	5th	2nd	2nd
Pricing					
1998 price cuts	2nd	5th	2nd	1st	4th
Price	2nd	3rd	5th	1st	4th
Value	2nd	4th	5th	1st	4th
Cost of in-house support	2nd	5th	3rd	1st	4th
Ownership costs	1st	4th	5th	1st	3rd
Service and support					
Warranties	2nd	4th	3rd	1st	5th
Support staff	1st	5th	3rd	1st	4th
Repair times	2nd	4th	3rd	1st	5th
Channel-based support	3rd	5th	4th	2nd	1st
Web-based support	1st	3rd	5th	3rd	2nd
Overall service / support	1st	4th	5th	2nd	3rd
Customer relationship					
Vendor reputation	2nd	4th	3rd	5th	1st
Technical direction	2nd	4th	5th	3rd	1st
Overall comfort with vendor	2nd	4th	5th	3rd	1st

Source: James Connolly, Kevin Burden, and Amy Malloy, "Direct Hit," *Computerworld,* November 16, 1998, pp. 81-88. Based on survey of 1,447 corporate managers with PC-buying responsibility for an average of 1,340 users each.

Exhibit 9 Ratings of High-end Desktop PCs by *Consumer Reports*

Rank	Maker	Model	Price	Speed	Multimedia suitability	Ease of upgrade	Quality of manuals	Software clutter	Energy efficiency	Quality of display
1	Dell	Dimension XPS	$2,400	❶	❸	❶	❸	❷	❸	❹
2	Gateway	G6-266	$2,647	❷	❷	❶	❶	❷	❸	❷
3	HP	Pavilion 8180	$2,800	❷	❸	❷	❸	❸	❶	❸
4	Toshiba	Infinia 7230	$2,200	❷	❸	❷	❷	❶	❹	❸
5	Sony	VAIO PCV-150	$2,200	❷	❸	❶	❸	❸	❺	❷
6	IBM	Aptiva L61	$2,530	❷	❸	❷	❹	❷	❸	❸
7	Compaq	Presario 4850	$2,950	❷	❹	❷	❹	❶	❹	❷
8	HP	Pavilion 8160	$2,200	❷	❸	❷	❸	❸	❶	❸
9	Compaq	Presario 4814	$2,100	❷	❸	❸	❹	❶	❸	❸
10	NEC	Ready 9753	$2,080	❷	❹	❷	❷	❺	❸	❸

❶ = excellent. ❷ = very good. ❸ = good. ❹ = fair. ❺ = poor.

Source: *Consumer Reports,* "Do You Need All That Speed?" January 1998, pp. 39-42.

Exhibit 10a Prices of Comparable PCs Configured for the Consumer Market

	96Q1	96Q2	96Q3	96Q4	97Q1	97Q2	97Q3	97Q4	98Q1	98Q2	98Q3	98Q4
Configuration												
Microprocessor clock speed (MHz)	133	133	166	166	200 MMX	200 MMX	PII-233	PII-233	PII-266	PII-266	PII-350	PII-400
Memory (MB)	16	16	16	32	32	32	32	32	64	64	64	64
Hard drive (GB)	1-2	1-2	1-2	2+	3+	3+	4+	6+	6+	6+	6+	8+
Monitor size (inches)	17	17	17	17	17	17	17	17	17	17	17	17
Bundled software?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
LAN card?	N	N	N	N	N	N	N	N	N	N	N	N
CD-ROM	6X	6X	6X	8X	12X+	12X+	12X+	12X+	12X+	12X+	12X+	32X+
Modem speed (kB/sec)	28.8	28.8	28.8	33.6	33.6	33.6+	56K	56K	56K	56K	56K	56K
Speakers?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Price ($)												
Compaq	3,299	3,234	2,949	2,624	2,849	2,560	3,014	2,523	2,448	1,539	1,649	1,575
Dell	2,848	2,264	2,296	2,217	2,290	2,039	2,059	2,005	1,838	1,660	1,606	1,606
Gateway	2,439	2,079	2,399	2,179	2,164	2,139	2,039	1,883	1,825	1,575	1,423	1,546
HP	3,198	2,478	2,948	2,799	3,049	2,660	2,914	2,658	2,459	1,590	1,900	1,808
IBM	3,418	2,848	3,149	2,899	2,974	2,640	N/A	2,579	2,348	1,560	1,722	1,709

Source: James Poyner and James Berlino, CIBC World Markets Quarterly Price Survey

Abbreviations: MHz = megahertz, MB = megabyte, GB = gigabyte, LAN = local access network, kB/sec = kilobyte per second, PII = Pentium II, MMX = multimedia enhanced, Y = yes, N = no

Exhibit 10b Prices of Comparable PCs Configured for the Business Market

	96Q1	96Q2	96Q3	96Q4	97Q1	97Q2	97Q3	97Q4	98Q1	98Q2	98Q3	98Q4
Configuration												
Microprocessor clock speed (MHz)	133	133	166	166	200	200 MMX	PII-233	PII-233	PII-266	PII-266	PII-350	PII-400
Memory (MB)	16	16	16	16	32	32	32	32	32	32	64	64
Hard drive (GB)	1-2	1-2	1-2	1-2	1-2	2+	4+	2-4	2-4	2-4	8	8+
Monitor size (inches)	15	15	15	15	17	17	17	17	17	17	17	17
Bundled software?	N	N	N	N	N	N	N	N	N	N	N	N
LAN card?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CD-ROM	4X	4X	4x-8x	6x+	8X+	12X+	12X+	12X+	12X+	12X+	12X+	32X+
Modem?	N	N	N	N	N	N	N	N	N	N	N	N
Speakers?	N	N	N	N	N	N	N	N	N	N	N	N
Price ($)												
Compaq	3,077	2,827	2,808	2,728	3,010	2,854	3,056	2,553	2,040	1,659	2,018	1,932
Dell	2,555	2,420	2,196	2,081	2,428	2,489	2,620	2,084	2,023	1,858	2,030	1,996
Gateway	2,208	1,758	1,943	1,743	2,172	2,013	2,118	1,656	1,499	1,324	1,560	1,762
HP	3,497	2,927	2,637	2,433	2,910	2,788	3,014	2,205	2,400	2,101	1,959	2,129
IBM	3,205	2,828	2,816	2,694	2,985	2,748	2,987	2,514	2,310	1,937	1,889	1,959

Source: James Poyner and James Berlino, CIBC World Markets Quarterly Price Survey

Abbreviations: MHz = megahertz, MB = megabyte, GB = gigabyte, LAN = local access network, PII = Pentium II, MMX = multimedia enhanced, Y = yes, N = no

Exhibit 11 Comparisons of Major PC Manufacturers (All figures 1998 unless noted otherwise)

	Dell	Compaq	IBM	HP	Gateway
Corporate revenue ($bn)	18.2	31.2	81.7	47.1	7.6
Value of PC sales ($bn)	17.7	27.9	16.9	11.8	7.1
Value of PC sales / corporate revenue	96.8%	89.4%	20.7%	25.0%	92.8%
Worldwide PC market share ($)	10.4%	16.4%	9.9%	6.9%	4.2%
Worldwide PC market share (units)	8.6%	14.7%	8.8%	6.3%	4.0%
Worldwide average selling price ($)	2,271	2,100	2,127	2,054	1,961
U.S. PC market share ($)	15.1%	16.6%	9.1%	7.9%	8.1%
U.S. PC market share (units)	13.2%	16.7%	8.2%	7.8%	8.4%
U.S. average selling price ($)	2,343	2,047	2,278	2,088	1,982
U.S. / worldwide PC sales	63.7%	44.4%	40.2%	50.0%	84.9%
CAGR of worldwide PC business, 1994-1998					
Value	51.9%	24.3%	12.9%	40.1%	27.3%
Units	56.2%	28.7%	18.0%	44.8%	36.5%
Corporate financials					
Return on sales	8.0%	-8.8%	7.7%	6.3%	4.5%
Sales-to-assets ratio	2.65x	1.35x	0.95x	1.40x	2.65x
Assets-to-equity ratio	2.96x	2.03x	4.43x	1.99x	2.15x
Return on equity	62.9%	-24.2%	32.6%	17.4%	25.7%
Return on invested capital (1997)	186%	35%	13%	16%	45%
Days of inventory	7.0	34.2	49.4	70.4	10.0
Cost structure					
Advertising / sales	1.1%	1.1%	2.1%	2.6%	N/A
R&D / sales	1.5%	4.3%	6.2%	7.1%	N/A
SG&A / sales	9.8%	16.0%	20.4%	16.6%	13.8%
PC sales by channel (units; worldwide)					
Direct	86.6%	4.4%	7.5%	0.6%	90.3%
Catalog, Phone, Online	37.4%	3.3%	2.4%	0.0%	88.4%
Sales Representatives	49.2%	1.1%	5.1%	0.6%	1.9%
Distributor / reseller	6.9%	66.6%	69.6%	75.1%	4.7%
Retail	0.0%	24.6%	18.4%	23.2%	1.0%
Other	6.5%	4.4%	4.6%	1.2%	4.0%
PC sales by customer category (units; worldwide)					
Home & small office	18.3%	28.5%	30.6%	33.3%	58.2%
Small & midsize business	37.0%	32.6%	32.7%	30.8%	19.1%
Large business	33.6%	27.5%	26.0%	27.2%	9.3%
Government	6.4%	6.0%	6.2%	5.9%	5.1%
Education	4.6%	5.3%	4.6%	2.8%	8.2%
Stock appreciation, 12/30/94-12/31/98	5,617%	432%	402%	174%	374%

Sources: International Data Corporation; Company Annual Reports. Note: Percentages may not equal 100% due to rounding.

Exhibit 12 Summary of International Business Machines Financial Performance ($ million)

	1991	1992	1993	1994	1995	1996	1997	1998
Revenue	64,792	64,523	62,716	64,052	71,940	75,947	78,508	81,667
Gross margin	37,467	38,675	29,926	29,481	24,322	34,215	34,627	43,282
SG&A	22,977	20,965	19,409	15,916	16,766	16,854	16,634	16,662
R&D	5,001	5,083	4,431	4,363	4,170	4,654	4,877	5,046
Operating income	4,340	3,406	308	5,005	9,919	9,031	9,098	9,164
Net income	(2,827)	(4,965)	(8,101)	3,021	4,178	5,429	6,093	6,328
Current assets	40,969	39,693	39,202	41,338	40,691	40,695	40,418	42,360
Inventory	9,844	8,385	7,565	6,334	6,323	5,870	5,139	5,200
Total assets	92,473	86,705	81,113	81,091	80,292	81,132	81,499	86,100
Stockholders' equity	37,006	27,624	19,738	23,413	22,423	21,628	19,816	19,433
Operating cash flow	6,725	6,274	8,327	11,793	10,708	10,275	8,865	9,273
Capital expenditures	6,497	4,751	3,154	3,078	4,744	5,883	6,793	6,520
Ratios:								
Gross margin / revenue	57.8%	59.9%	47.7%	46.0%	33.8%	45.1%	44.1%	53.0%
SG&A / revenue	35.5%	32.5%	30.9%	24.8%	23.3%	22.2%	21.2%	20.4%
R&D / revenue	7.7%	7.9%	7.1%	6.8%	5.8%	6.1%	6.2%	6.2%
Net income / revenue	-4.4%	-7.7%	-12.9%	4.7%	5.8%	7.1%	7.8%	7.7%
Revenue / EOY assets	0.70x	0.74x	0.77x	0.79x	0.90x	0.94x	0.96x	0.95x
EOY assets / equity	2.50x	3.14x	4.11x	3.46x	3.58x	3.75x	4.11x	4.43x
Net income / EOY equity	-7.6%	-18.0%	-41.0%	12.9%	18.6%	25.1%	30.7%	32.6%

Source: Company annual reports; Compustat. Note that fiscal year ends December 31.

Exhibit 13 Summary of Compaq Computer Corporation Financial Performance ($ million)

	1991	1992	1993	1994	1995	1996	1997	1998
Revenue	3,271	4,100	7,191	10,866	14,755	18,109	24,584	31,169
Gross margin	1,218	1,195	1,698	2,727	3,388	4,196	7,198	9,786
SG&A	722	699	837	1,235	1,594	1,912	2,947	4,978
R&D	197	173	169	226	270	407	817	1,353
Operating income	305	323	692	1,266	1,524	1,877	2,987	958
Net income	131	213	462	867	789	1,313	1,855	(2,743)
Current assets	1,782	2,318	3,291	5,158	6,527	9,169	12,017	15,167
Inventory	437	834	1,123	2,005	2,156	1,152	1,570	2,005
Total assets	2,826	3,142	4,084	6,166	7,818	10,526	14,631	23,051
Stockholders' equity	1,931	2,007	2,654	3,674	4,614	6,144	9,429	11,351
Operating cash flow	394	(59)	240	(101)	943	3,408	3,688	644
Capital expenditures	189	159	145	357	391	342	729	600
Ratios:								
Gross margin / revenue	37.2%	29.1%	23.6%	25.1%	23.0%	23.2%	29.3%	31.4%
SG&A / revenue	22.1%	17.0%	11.6%	11.4%	10.8%	10.6%	12.0%	16.0%
R&D / revenue	6.0%	4.2%	2.4%	2.1%	1.8%	2.2%	3.3%	4.3%
Net income / revenue	4.0%	5.2%	6.4%	8.0%	5.3%	7.3%	7.5%	-8.8%
Revenue / EOY assets	1.16x	1.31x	1.76x	1.76x	1.89x	1.72x	1.68x	1.35x
EOY assets / equity	1.46x	1.57x	1.54x	1.68x	1.69x	1.71x	1.55x	2.03x
Net income / EOY equity	6.8%	10.6%	17.4%	23.6%	17.1%	21.4%	19.7%	-24.2%

Source: Company annual reports; Compustat. Note that fiscal year ends December 31.

Exhibit 14 Summary of Hewlett-Packard Financial Performance ($ million)

	1991	1992	1993	1994	1995	1996	1997	1998
Revenue	14,494	16,410	20,317	24,991	31,519	38,420	42,895	47,061
Gross margin	6,636	7,232	8,194	9,501	11,505	12,291	14,576	14,989
SG&A	3,888	4,165	4,554	4,925	5,635	6,477	7,159	7,793
R&D	1,463	1,620	1,761	2,027	2,302	2,718	3,078	3,355
Operating income	1,335	1,510	1,879	2,549	3,568	3,726	4,339	3,841
Net income	755	549	1,177	1,599	2,433	2,586	3,119	2,945
Current assets	6,716	7,679	10,236	12,509	16,239	17,991	20,947	21,584
Inventory	2,273	2,605	3,691	4,273	6,013	6,401	6,763	6,184
Total assets	11,973	13,700	16,736	19,567	24,427	27,699	31,749	33,673
Stockholders' equity	7,269	7,499	8,511	9,926	11,839	13,438	16,155	16,919
Operating cash flow	1,552	1,288	1,142	2,224	1,613	3,456	4,321	5,442
Capital expenditures	862	1,032	1,405	1,257	1,601	2,201	2,338	1,997
Ratios:								
Gross margin / revenue	45.8%	44.1%	40.3%	38.0%	36.5%	33.6%	34.0%	31.9%
SG&A / revenue	26.8%	25.4%	22.4%	19.7%	17.9%	16.9%	16.7%	16.6%
R&D / revenue	10.1%	9.9%	8.7%	8.1%	7.3%	7.1%	7.2%	7.1%
Net income / revenue	5.2%	3.3%	5.8%	6.4%	7.7%	6.7%	7.3%	6.3%
Revenue / EOY assets	1.21x	1.20x	1.21x	1.28x	1.29x	1.39x	1.35x	1.40x
EOY assets / equity	1.65x	1.83x	1.97x	1.97x	2.06x	2.06x	1.96x	1.99x
Net income / EOY equity	10.4%	7.3%	13.8%	16.1%	20.6%	19.2%	19.3%	17.4%

Source: Company annual reports; Compustat. Note that fiscal year ends October 31.

Exhibit 15 Summary of Gateway 2000 Financial Performance ($ million)

	1991	1992	1993	1994	1995	1996	1997	1998
Revenue	627	1,107	1,732	2,701	3,676	5,035	6,294	7,648
Gross margin	116	193	271	358	616	936	1,076	1,546
SG&A	57	89	122	217	367	608	786	1,052
R&D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Operating income	59	103	149	141	249	356	290	494
Net income	39	106	151	96	173	251	110	346
Current assets	117	246	501	654	866	1,318	1,545	2,228
Inventory	N/A	100	178	120	225	278	249	168
Total assets	128	269	564	771	1,124	1,673	2,039	2,890
Stockholders' equity	64	129	280	376	556	816	930	1,344
Operating cash flow	45	39	130	202	71	458	443	908
Capital expenditures	5	16	36	29	77	85	162	222
Ratios:								
Gross margin / revenue	18.5%	19.0%	15.6%	13.3%	16.8%	18.6%	17.1%	20.2%
SG&A / revenue	9.1%	8.8%	7.0%	7.0%	8.0%	10.0%	12.5%	13.8%
R&D / revenue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Net income / revenue	6.2%	10.4%	8.7%	8.7%	3.6%	4.7%	1.7%	4.5%
Revenue / EOY assets	4.90x	3.78x	3.07x	3.50x	3.27x	3.01x	3.09x	2.65x
EOY assets / equity	2.00x	2.09x	2.01x	2.05x	2.02x	2.05x	2.19x	2.15x
Net income / EOY equity	60.9%	82.2%	53.9%	25.5%	31.1%	30.8%	11.8%	25.7%

Source: Company annual reports; Compustat. Note that fiscal year ends December 31.

Glossary[100]

Application: a program that helps a user accomplish a specific task, for example, a word processing program or a spreadsheet program. Application programs are distinguished from system programs, which control the computer and run the application programs, and utilities, which are small helper programs.

Microprocessor: the semiconductor in a personal computer that performs mathematical and logical operations based on programmed instructions; the central processing unit in a PC.

Motherboard: the main circuit board inside a computer, which contains the microprocessor, memory, and other basic components. Additional boards, called daughter boards, can be plugged into the motherboard.

Operating system: the main control program of a computer that schedules tasks, manages storage, and handles communication with peripherals. The operating system presents a basic user interface when no applications are open, and all applications must communicate with the operating system.

Random-access memory: the working memory of a computer. RAM is the memory used for storing data temporarily while working on it, running application programs, and so forth. "Random access" refers to the fact that any area of RAM can be accessed directly and immediately, in contrast to other media such as a magnetic tape where the tape must be wound to the point where the data is.

Read-only memory: memory that can be read but not changed. Read-only memory holds its contents even when a PC is turned off. Data is placed in ROM only once and stays there permanently.

Video card: a circuit board that enables a computer to display information on its screen. The resolution, number of colors, and refresh rate of a monitor is determined by the kind of video card used, plus the limitations of the monitor itself.

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