Refining and Extending the Business Model With Information Technology: Dell Computer Corporation

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The exceptional performance of Dell Computer in recent years illustrates an innovative response to a fundamental competitive factor in the personal computer industry—the value of time. This article shows how Dell's strategies of direct sales and build-to-order production have proven successful in minimizing inventory and bringing new products to market quickly, enabling it to increase market share and achieve high returns on investment. The Dell case illustrates how one business model may have inherent advantages under particular market conditions, but it also shows the importance of execution in exploiting those advantages. In particular, Dell's use of information technology (IT) has been vital to executing both elements of its business model—direct sales and build-to-order—and provides valuable insights into how IT can be applied to achieve speed and flexibility in an industry in which time is critical. Many of the insights gained from this case can be applied more generally to other time-dependent industries, suggesting that the findings from the Dell case will have implications for a growing number of companies and industries in the future.

"It isn't so much that we have a new economy, as we have a new understanding of the importance of technology in the economy." Paul Roemer, quoted in the *Wall Street Journal*, May 1999.

"Dell Computer Corporation is perhaps the purest example of the efficiencies made possible by information technology." *New York Times*, 2 January 1997.

The exceptional performance of Dell Computer in recent years illustrates an innovative response to a fundamental competitive factor in the personal computer industry—the value of time. Product life cycles in the personal computer (PC) industry have shrunk from about 22 months in 1988 to 6 months in 1997 (Mendelson & Pillai, 1998), and the price/performance of key components has continued to double every 18 months or less. As a result, excess inventory depreciates rapidly. In addition, getting new, quality products to market on time is critical to maintaining competitiveness in an industry where customers are willing to pay a premium for the latest technologies and reward quality by repeat purchases.

Dell's strategies of direct sales and build-to-order production have proven successful in minimizing inventory and bringing new products to market quickly, enabling it to increase market share and achieve high returns on investment in a highly competitive industry. The impact on the industry of Dell's success is seen in the efforts of other leading PC makers and distributors to develop their own direct sales and/or build-to-order capabilities (Stafford, 1999).

The Dell case illustrates how one business model may have inherent advantages under particular market conditions, but it also shows the importance of execution in

exploiting those advantages. In particular, Dell's use of information technology (IT) has been vital to executing both elements of its business model—direct sales and build-to-order—and provides valuable insights into how IT can be applied to achieve speed and flexibility in an industry in which time is critical. The importance of IT in time-dependent industries has been confirmed by Mendelson and Pillai (1999), who surveyed 67 business units and found a strong correlation between an industry's "clock-speed" and the use of IT to enhance internal and external communications.[1]

Many of the insights gained from this case can be applied more generally to other time-dependent industries, such as fashion clothing, publishing, transportation, food service, flowers, and many segments of the electronics and communications industry. As more products incorporate digital technology, and more commerce is conducted electronically, it is likely that more industries and markets will be characterized by the kind of time-based competition that marks the PC industry (Curry & Kenney, 1999). This suggests that the findings from the Dell case will have implications for a growing number of companies and industries in the future.[2]

TIME-BASED COMPETITION IN THE PC INDUSTRY

The PC industry is driven by rapid technological improvements in components, particularly microprocessors, other semiconductors, and storage devices. The improved performance of hardware has been matched historically by increased complexity of software, creating demand for the latest hardware. This means that time is a critical competitive factor in the industry in two ways: first, excess inventory loses value (at an estimated 10% per month; Gutgeld & Beyer, 1995) and costs money; second, products incorporating the most advanced technologies are in high demand and carry a price premium. As a result, companies that minimize inventory and bring new products to market faster can reduce costs, increase market share, and maintain higher margins (Curry & Kenney, 1999).

Two factors come into play in determining the ability of PC companies to manage inventory and introduce new products. The first is the standardized, modular nature of the PC. PCs are built from standard components, using common architectural interfaces determined largely by Intel, Microsoft, and, earlier, IBM. PC makers also can outsource much of their production and purchase components from a well-established production network of contract manufacturers and components suppliers (Dedrick & Kraemer, 1998a; Langlois, 1992). This makes it quite easy for PC companies to introduce new PCs with the most advanced technologies. By the 1990s, PC makers could no longer gain much of an edge by virtue of design and manufacturing, as everyone had access to the same tech-

FIG. 1.   Indirect distribution channel of the PC industry.

nical information and supply base. The difference among PC companies was determined increasingly by the second factor—the structure of distribution.

The traditional distribution system of the PC industry is an indirect model often referred to as "the channel" (Figure 1). The PC maker sells its products to distributors, who buy products from many manufacturers and then sell them to a variety of retailers, resellers, system integrators, and others, who sell products and services to the final customer. This distribution system was an effective means for distributing high volumes of PCs with a variety of configurations to reach a broad customer base.

However, it had inherent weaknesses that left it vulnerable in a time-based competitive environment. First was its reliance on market forecasting to drive production. Even the most successful PC makers, such as IBM, Apple, and Compaq, were chronically bedeviled by their inability to accurately forecast demand in a market driven by ever shorter product cycles. They were either caught with short supplies of hot products, causing them to lose sales to competitors, or stuck with excess inventories of slow sellers, which clogged the distribution channels and often had to be sold at a loss to move them out. Even with the best forecasting, the indirect model was plagued by the need to hold inventory at each step in the channel in order to fill orders. In the early 1990s, it was common for PC makers to have up to 90 days of inventory on hand and in the channel.

The high inventory costs and lack of responsiveness of the indirect channel meant that there was an opportunity for someone who could find a way to circumvent the channel. The company that seized this opportunity was Dell, which pioneered a new business model based on selling PCs directly to the final customer, and building the PC only when an order was received (Figure 2). Selling directly removes two links in the supply chain where inventory could build up and also enables Dell to know its final customers, provide better service to them, and promote repeat or expanded sales to them. Build-to-order production allows Dell to introduce new technologies as soon as customers

FIG. 2.   Dell's direct distribution channel.

want them and makes it possible to adjust production to demand very quickly. It also means that Dell does not purchase components and assemble PCs until it has received payment from the customer, giving the company a negative cash conversion cycle in which it receives payment from customers before it must pay suppliers.

Already a significant channel in the early 1980s, the direct channel increased from 25% in 1984 to 35% of the PC market in 1998.[3] The use of the Internet as a direct sales channel is likely to mean continued growth in direct sales as a share of the PC market, as direct sellers can reach additional potential customers at a low marginal cost.

DELL COMPUTER: BACKGROUND AND HISTORY

Michael Dell founded Dell in 1984 while he was still a college student at the University of Texas in Austin. From the beginning, Dell sold directly to the final customer and built PCs to users' specifications. This basic business model has not changed over the years, although it has been modified and refined as the company has grown.

Dell started with telephone sales of upgraded IBM-compatible PCs, then shifted to assembling and marketing its own brand of PCs in 1985. It provided customers with a 24-hour hotline for complaints and guaranteed 24- to 48-hour shipment of replacement parts. As its customer base grew, Dell also implemented a direct toll-free technical support line. In 1990, Dell shifted course when it began selling through retail outlets such as CompUSA, Circuit City, and Price Club. Revenues grew rapidly, but problems arose in managing what had become a billion-dollar company, and Dell experienced its first quarterly loss in 1993 (Dell, 1999).

In 1994, Dell concluded that even though it was successful selling through retail channels, it was not making money doing so. Dell decided to withdraw from the retail market and return to its roots as a direct seller, a move that not only helped the company's profitability but also enabled it to put all of its efforts into executing the direct model. Dell also brought in a new chief operating officer, Mort Topfer from Motorola. Topfer led Dell's efforts to refine its internal operations and tighten its integration with suppliers and business partners.

Dell has focused on improving service and support to its large business customers by installing custom software, keeping track of customers' PC inventory, allowing individual business users to order PCs directly rather than having to go through a central purchasing office, leasing computers, and allowing electronic payment via the Internet. As put by Michael Dell, "We are becoming the PC outsourcing company, not just the PC supplier" (Heidrick & Struggles, 1997). The company also revamped its design, manufacturing, procurement, and logistics processes to reduce costs, and speed up the entire supply chain. Finally,

it expanded its markets internationally and developed successful notebook and server product lines.

The result has been an extraordinary run of growth in revenues, profits, and market value for the company. Sales reached $18.2 billion in 1998, with profits of $1.46 billion, and Dell's share of the worldwide PC market grew from 3% in 1995 to 9.2% in the first quarter of 1999. Dell's stock price grew by over 40 times from 1994 to 1999, and the company's market capitalization topped $100 billion.

Dell's success has garnered the admiration of Wall Street and made it a favorite subject of the business press, which has offered a variety of explanations for that success. Michael Dell himself has weighed in with a 1999 book titled *Direct from Dell: Strategies That Revolutionized an Industry*. Most of these explanations have focused on the advantages of Dell's business model, yet the analyses fail to explain how Dell executes that model and particularly how it uses IT as a key competitive tool to do so. The remainder of this article uses a case study approach to look more closely at exactly what constitutes the Dell model, how the company continues to improve its operations, and how it uses IT to refine and extend the direct model.

The case study utilized literature review, buttressed by interviews with key Dell executives, interviews with selected Dell customers and suppliers, and plant visits. Such an approach runs the risk of being caught up in the optimistic views of the business press and Dell itself (or himself), but we sought to maintain healthy skepticism about what we heard and read. Some of the data in the case relies directly on Dell as a source, and we made every effort to check and confirm it with other sources. Other data come from analyses of the PC industry and of Dell's strategy and performance by IDC, McKinsey, Dataquest, Forrester Research, and Hoover's Company Profiles, or public documents such as annual reports and audited 10-K reports filed by Dell. Descriptions of Dell's IT practices and organization were provided by Dell IT executives (current and former). Finally, because Dell is sometimes a source for independent news stories, we evaluated all stories in terms of what we knew from industry studies, our interviews, and our personal knowledge of the PC industry—having studied the industry in the United States and the Asia-Pacific region for the last 8 years (Dedrick & Kraemer, 1998b).

It is difficult to attribute specific performance results to specific IT initiatives in any company, and this case is no exception. We have reported as accurately and objectively as possible how Dell uses IT, what benefits it reports, and what problems it has experienced. We also acknowledge that it is difficult to isolate the specific effects of IT from Dell's business model or its execution. However, we have tried to develop concrete examples that show logical linkages with IT that permit attributing some results to IT.

DELL'S BUSINESS MODEL

Other than its unsuccessful venture into the retail channel, Dell has stayed faithful to its original business model, which combines direct sales and build-to-order production. This business model is simple in concept, but is quite complex in execution. While other PC makers rely on resellers, retailers, and other agents to carry much of the burden of marketing and sales, Dell has to reach out to customers largely through its own efforts. And while other PC makers can run high-volume assembly lines to achieve economies of scale, Dell must fill each order to meet customer specifications, a process that puts heavy demands on shop floor employees, suppliers, logistical systems, and information systems. It has taken Dell 15 years to achieve its present skill in making the direct model work, a point driven home by Michael Dell himself and by the difficulties other firms have had in trying to imitate parts of the model. A closer look at the direct sales and build-to-order processes helps illustrate how Dell makes them work individually and in concert with each other.

Direct Sales

The direct sales approach is built on two key elements: direct customer relationships, and products and services targeted at distinct customer segments. Direct sales means that Dell must reach out to potential customers, either through its own sales force or through advertising and other marketing efforts. Dell does sell through resellers and integrators in some cases, especially outside the United States, but for the most part it does not use the services of the channel, nor does it support the profit margins of the channel.

Direct Customer Relationships

Dell's use of the direct approach reportedly provides it with nearly a 6% cost advantage compared to indirect sellers (Kirkpatrick, 1997). It also provides Dell with detailed knowledge about its customers.[4] Vendors that sell through resellers and retailers often don't know who their final customers are, so they must rely on secondary market research to identify their own customer base. The direct approach also allows Dell to identify customer trends early so it can respond with the desired products before its competitors can.[5]

The direct approach allows Dell to build a relationship, which makes it quick and easy for customers to do business with Dell. IT staff at Boeing report that Dell has adapted its IT systems, user interfaces, and procurement processes to Boeing's, making it easy for Boeing employees to buy Dell computers because they can use a familiar process. Dell uses EDI for processing orders directly into its order management system because Boeing is required to operate

that way (rather than using the Internet) as a federal government/Department of Defense contractor, and because Boeing staff are familiar with EDI. Dell also has incorporated its product information into Boeing's in-house procurement catalog, again adjusting to Boeing's way of doing business. As a result, Dell is able to capture new and replacement PC business because it is easy to do business with Dell, and contracting with another vendor would involve switching costs.

The drawback of direct sales is that Dell lacks the extensive reach of the channel, which has thousands of large and small firms providing sales, marketing, service, and support to customers of all sizes in all markets. To overcome this problem, Dell has segmented the market by size and focused much of its own marketing efforts on large customers who could be reached directly by Dell's sales force. Only after establishing a strong brand name with larger customers and developing the online infrastructure to reach new customers at a low marginal cost has Dell seriously targeted the widely diffused small business and consumer markets. Dell also sells to resellers and integrators in some cases and works with distributors to offer non-Dell products such as software and peripherals. For example, Dell is reported to be the second largest reseller of Hewlett-Packard printers (Schick, 1999). This flexibility helps Dell expand its marketing reach while maintaining its direct sales strategy for the bulk of its business.

Customer Segmentation for Sales and Service

Dell segments its customers into Relationship, Transaction, and Public/International customers.[6] Dell's segmentation of customers helps it respond to changes in demand among different customers, to develop new customer segments, and to "grow" the most profitable segments.

Relationship customers are Fortune 1000 companies that purchase at least $1 million annually. They currently number about 50 companies, including Boeing, Exxon, Ford, Goldman Sachs, MCI, Microsoft, Mobil, Oracle, Procter & Gamble, Sears, Shell Oil, Toyota, and Wal-Mart. Relationship customers accounted for 70% of Dell's sales in 1997, up from 59% in 1992, reflecting Dell's emphasis on growing its business with large profitable clients (Table 1). Dell concentrates its resources on these customers, offering highly customized services to gain and keep their business.

Relationship customers are serviced by field-based sales representatives in customer sites, and an equal number of telephone service representatives is dedicated to these accounts. Each sales representative is dedicated to a single customer (or a region in some instances), and is responsible for understanding its IT environment and service needs. For instance, about 30 people take care of Boeing's 140,000 Dell PCs and operate as its PC

TABLE 1
Dell's global sales characteristics

	1992	1993	1996	1997	1998
Net sales ($M) (global)	$2,014	$3,475	$7,759	$12,327	$18,243
By market segments (U.S. market only)	Relationship 59% Transaction 41%	Relationship 64% Transaction 36%		Relationship 70% Transaction 30%	
By channels (global)				Direct 85% Indirect 15%	
By markets (global)	U.S. 73% Europe 27% Asia 0%	U.S. 71% Europe 27% Asia 2%	Americas 66% Europe 28% Asia-Pacific 6%	Americas 69% Europe 24% Asia-Pacific 7%	Americas 68% Europe 26% Asia-Pacific 6%

Note: From interviews at Dell Computer Corporation; Das Narayandas and V. Kasturi Rangan, "Dell Computer Corporation," Harvard Business School Case No. 9-596-058 (Boston, MA: Harvard Business School Publishing, 1995, Rev. March 11, 1996; Table 4); and *Dell Annual Report*, Fiscal Year Ending January 1999.

department—forecasting future PC purchases, managing the current inventory, and securing needed service and support.[7] Each sales representative at the customer site is paired with an inside representative at Dell who is responsible for order processing.

Transaction customers, which represent 30% of U.S. sales, are small and medium-sized enterprises (about 20%) and home office customers and consumers (about 10%). Transaction customers are served by several thousand inside sales reps who can call up historical sales records to assist the customers in choosing systems that match their prior purchase pattern.

International markets are served by a combination of stand-alone subsidiaries and distribution agreements tailored to local business and government environments. A more flexible approach is needed because the notion of buying directly from the manufacturer is a new concept in many international markets. Also, the infrastructure to support the direct model is lacking. However, Dell has chosen to enter both China and Brazil with direct sales, feeling that these large emerging markets will support the direct model.

By selling directly, incorporating the right technology as it becomes available, and timing the changeover well, Dell can take advantage of higher profit margins on new technology while also taking advantage of falling prices on components.

Build-to-Order Production

Dell's production system applies principles of lean manufacturing and just-in-time production, which were first employed by Japanese manufacturers such as Toyota and have been applied extensively in the U.S. PC industry. These principles aim to minimize parts inventories by requiring suppliers to restock parts only as they are needed, and often to maintain ownership of parts until they are used. In effect, the PC company is pushing the upstream inventory problem onto the suppliers, a practice that is viable at least for larger vendors who have the clout to make such demands (Kraemer & Dedrick, 1998).

Dell's build-to-order strategy goes even farther than lean production, however, in order to achieve mass customization of products. Build-to-order requires Dell and its suppliers to have available specific components as they are needed to fill an incoming order. For instance, while Compaq or IBM might order hard drives in batches of different models for different production runs, Dell must have on hand enough of each drive model to quickly fill orders of varying and unpredictable sizes. This requires very close coordination between Dell's sales and manufacturing arms and between Dell and its suppliers. It achieves this by refining its business processes, developing close relationships with a limited number of suppliers, and using IT to facilitate communication within and outside the company.

Dell has continually worked to improve the speed and flexibility of its production system. The build-to-order production system is the focal point of Dell's business operations, the common contact point for sales, procurement, logistics, manufacturing, and delivery.

The process is illustrated by what happens when customers place an order via the Internet. They are aided by configuration management software that enables them to choose from a menu of hardware and software options. The configuror ensures the items chosen are compatible with the rest of the system and prices the system, permitting the customer to iterate through various choices. They also can call Customer Service, which can link directly into Dell's inventory to determine whether the required components

are available. If not, a sales representative can push available inventory at a lower price, promote newer components at a higher price, or provide them at the same price in order to close the sale. Also, suppliers will be notified to restock those components.

After Dell receives an order, the configuration details are sent to the manufacturing floor. Assembly starts in "kitting" with a chassis and a spec sheet (bill of materials, special instructions, and software to be loaded) for the order that travels with the chassis throughout the process. The spec sheet is printed from a computer file that is updated with information about the specific components installed and the employees doing assembly for each machine at each step in the process. This enables quick identification of the relevant components, suppliers, or employees when problems develop in assembly or later in system use by the customer. In kitting, parts such as cables, connectors, motherboard, and memory are pulled from inventory to go with the chassis as it moves down the line. In "build and test," other components such as hard drive, floppy drive, CD-ROM, or DVD are inserted.

After all the hardware has been installed, the system is sent to software downloading where the operating system, applications, diagnostics, and even customer software are loaded onto the hard drive. After the software is loaded, the system is powered and tested, after which it is sent to "boxing." Here the completed system is placed in a box, the keyboard, mouse, external cables, manuals, and warranties are loaded, the shipping label is placed on the box, and the box is shipped. An electronic message is sent to an outside, independent producer of the monitor for the system to ensure that the monitor is delivered to the customer at the same time as the system. Once the system is shipped, customers can log onto Dell's web site and track their orders through Federal Express.

To sum up, using direct sales eliminates inventory in the channel, provides Dell with information on and access to the final customer, and allows Dell to offer other services to the customer. Using build-to-order allows Dell to offer the latest technologies, which carry a higher margin; allows it to customize its products to user specifications; and means that Dell doesn't lay out cash for parts until it receives payment for the PC. Together, direct sales and build-to-order help create a strong relationship between Dell and its customers, as both require direct interaction and allow Dell to gather information on its customers' needs.

Refining the Model: Business Process Improvement

Dell continually refines the direct model through business process redesign and continuous process improvement. It also makes extensive use of IT to support information linkages and enable process improvement throughout the value chain.

Procurement, Logistics, and Inventory. The build-to-order process drives Dell's supply chain. The flow of orders and production determines how many of each part and component are needed, and suppliers must plan and adjust their own manufacturing, procurement, and logistics accordingly. Dell's supply chain reaches around the world, and especially across the Pacific, where it reportedly purchased $1.6 billion in systems, parts, and components from Taiwanese companies alone in 1998 (Dell set to boost, 1999). Managing such a far-flung supply chain to meet the requirements of build-to-order is critical to Dell's success, and requires close coordination and information sharing with suppliers.

Dell has streamlined both procurement and inventory by redesigning its computers so that different models utilize as many of the same components as possible (Zuckerman, 1997). This reduces the number of inventory parts and the complexity of managing their procurement. Between 1992 and 1997, Dell reduced its 200-plus suppliers by 75%. Fifteen of these are key suppliers who provide about 85% of Dell's materials. Dell works with these suppliers in multiyear planning and negotiating, thereby reducing the complexity of managing its supply chain.

Dell has tough standards for its suppliers—quality must be world class or a supplier is dropped, the bulk of components must be warehoused within 15 minutes of Dell factories (McWilliams, 1997), and suppliers must ensure 2 hours of inventory in the plant at all times. These requirements reduce inventory costs for Dell and support its just-in-time production processes. Through these partnerships and others with transportation companies, Dell has achieved virtual integration of its operations from inbound logistics to production to outbound logistics and transportation.

Product Design and Process Engineering. Dell spends about $250 million annually on what it calls R&D.[8] The aim is to evaluate new technologies to determine whether, when, and how to incorporate them into new products; improve product quality and reliability from components through finished product; reduce cost throughout the value chain; and improve the speed of assembly, repair, and servicing. Some illustrations of Dell's R&D output include the following product and process improvements:

- Redesigned PCs to reduce the total number of screws to five for the entire system.
- Shortened cables to create more room in the chassis for ease of assembly, expansion, and replacement.
- Reduced software download time 75% by using fiber optics.
- Reduced number of machine touches by over half through process redesign.

- Added software to Microsoft Windows 98 to test all hardware installations in the factory, reducing customers' setup time from 45 minutes to 2 or 3 minutes (Dell, 1999).

The ongoing improvements in design and production processes have helped Dell cut the estimated production cycle time for a desktop computer—from beginning of the build process to placement on a delivery truck—to 7 hours (McWilliams, 1997). At the newest Austin plant, named Metric12, sometimes a PC can be built, software installed and tested, and everything packed in a box for shipping within 5 hours (Ramstad, 1997).

Sales and Service. The customization that occurs in production is carried over to sales and service. For instance, Dell installs custom software on the machines that it builds for corporate customers. It also maintains an inventory of its customers' computers and has a sales and engineering staff dedicated to servicing key corporate customers.[9] It seeks to lower the total cost of ownership for its corporate customers by helping them manage their PC inventories and offering technologies that reduce the cost of hardware and software maintenance in networks (Dell outlines strategy, 1997).

Dell provides a toll-free technical support line, 30-day money-back guarantee, and next-day, on-site service (free for first year of ownership) (Why Dell is a survivor, 1992). Dell avoids having to staff a large service and support organization by working with service partners such as Wang, Unisys, NCR, and BancTec. It has managed its service operations so well that in the 1997 *PC World* Reliability and Service Survey, Dell was ranked as Best Overall in reliability and service (In *PC World*'s semi-annual, 1997).

The foregoing improvements in logistics, procurement, inventory, product design, production processes, sales, and service are keys to Dell's success in the PC market. Another is Dell's use of information and technology to support these improvements and to enable the use of new business processes such as Internet sales and service. The result is the refinement and extension of the business model through IT.

DELL'S USE OF INFORMATION AND TECHNOLOGY

The direct model is simple in concept but involves great complexity and precision in actual execution. Thus, Dell's management and IT people believe they have to help refine and extend—not redefine—the business model.

Refining the Business Model

Dell uses information to drive operating practices, all the way from customers and far-flung suppliers to shop floor and outbound distribution (Rollins, 1998). It has developed performance metrics to analyze production operations, balance inventory between suppliers and customers, manage cash collection, and monitor profitability, market share, and return on invested capital. Dell also continually monitors margins, average selling price, and selling overhead by customer segment, product, and country. Table 2 outlines how Dell uses IT to refine its business model.

Dell also uses information to manage relationships with customers. It outsources customer service but operates as broker between the customer and the third-party maintainers (TPMs) that actually provide service. Dell's call center service people trouble-shoot the customer's problem and trigger one electronic message to ship the needed parts and another to dispatch a TPM to the customer. As a result, Dell knows the kinds of problems customers face, the parts causing the problems, and the performance of its TPMs. Dell uses this information to develop computerized sets of frequently asked questions (FAQs) and problem solutions, to train service representatives, to identify problematic suppliers, and to identify problematic TPMs.

Advanced IT systems are in evidence throughout Dell's business processes. Orders are entered by sales representatives or directly by the customer online into the Dell Order Management System (DOMS). In the DOMS, the order is first routed to the finance department, where the customer's means of payment is checked. If approved, the order then goes to engineering, which reviews it to be sure that the desired configuration is technically feasible. Then it goes to the plant, where a worker receives a printout of the order, with complete information on hardware and software configuration and any special requirements. The order is then checked against inventory to ensure that the required parts are available in the build area.

Information on the order is available on PCs to the two builders and one tester in each assembly team. The printout travels with the parts and the computer as it is assembled, tested, burned-in, downloaded with software, and packaged for shipping. After the PC is assembled and tested, an Ethernet cable is attached to download software from a bank of servers in a nearby room. Corporate customers can have software preloaded, including their own proprietary software, and can have startup screens and various interfaces configured so that the machine is ready to use out of the box. Finally, the PC is ready to be shipped to the customer, complete with shipping label and bar code for the customer. As each build stage is completed, the original order is updated by bar-code scanning of information, which facilitates tracking the performance of components, suppliers, and manufacturing and test cells. Each PC is shipped with a service tag number on it. The customer can type that number into Dell's Web site and get a customized Web page that has all the support information for that PC. This includes documents with help tree files, diagrams,

TABLE 2
Refinement of the Dell model

Business strategy	Information links	IT applications	Performance effects
Direct sales	Customer orders are transmitted directly to Dell, where program does second check for technical and financial feasibility	Call center automation, Premier Pages, Dell On-Line, Dell Product Services (DPS)	Accurate forecasting of demand Segmentation of demand Early indication of shifts in demand
Build-to-order	Order information travels with product through the build process, enabling inventory control, the meeting of special customer requirements, download of custom software, etc.	Dell Order Management System (DOMS), e-mail, Lotus Notes	Better control of operations Reduced inventory and transit points Better communication during build process Improved monitoring and evaluation of production and supplier quality
Direct distribution	Information sharing notifies suppliers to ship monitors to arrive with PC Aggregation of information includes orders, inventory turnover, production throughput, supplier quality, on-time distribution	Dell Logistics System, Lotus Notes, e-mail Information to Run the Business (IRB)	Accelerated outbound logistics No inventory Optimization of production, quality, and distribution, globally and locally

and graphics of the machine so that customers can solve many of their own problems (Brandt, 1998).

While the use of IT greatly increases efficiency in production processes, it also is increasingly important in linking Dell to its broader network of suppliers, business partners, and customers, thereby enabling Dell to achieve "virtual integration" throughout the entire value chain (Magretta, 1998). Suppliers now have real-time windows into Dell's information systems and can track sales of products or components they provide. This enables suppliers to build and ship inventory in response to changes in demand faster than if they had to wait to receive a purchase order from Dell. Access to Dell's order information helps the supplier to better manage its own inventory and helps both Dell and suppliers to avoid missing out on sales opportunities because of inventory limitations.

Extending the Business Model

Dell's IT people do not see themselves as only refining the business model, because the execution of the direct model must continually adapt to new conditions. According to chief information officer (CIO) Jerry Gregoire, they are also involved in *extending* the business model. This means finding ways to extend business with existing customers, to reach new customers, to reach new geographic markets, and to offer new products and services geared to those markets (Table 3).

One example of how Dell extends the business model is its addition of Internet sales to sales through field reps and telesales, thereby extending the reach of direct sales. Internet sales represent another option for customers that enables Dell to reach people in remote locations where it does not have field reps and to reach people who prefer to shop via the Internet. Yet the Internet enables customers to easily bump up to telesales if they desire to speak to a telesales representative. Thus, the Internet not only provides an additional channel to reach customers, but it also provides a channel that extends customer options for reaching Dell.

A second example is its Internet Web pages for corporate customers, which extend direct sales farther into the firms' operations through customization. Dell provides custom Web pages (called Premier Pages) for over 200 of its largest relationship customers (Magretta, 1998), and therefore the IT departments, and in some cases individual employees, of large corporate customers can access a Dell Web site set up especially for their company—a customized version of the site at www.dell.com. The customer

TABLE 3
Extension of the Dell model

Business strategy	Information links	IT applications	Performance effects
Integrate with suppliers	Daily and long-term forecast of demand	Dell Integrated Logistics, i2 Technologies Rhythm forecasting	Accelerated inbound logistics, better forecasting, reduced inventory, reduced supplier risk
	Information sharing in real time	Dell Order Management System	Faster, better decisions and information flows, streamlined ordering system
Integrate with customers	Real-time information about buying patterns	Dell Configurator DellPlus	Greater customer service, satisfaction and loyalty, retention of relationship customers
	Customized direct order, service, and support	Premier Pages	
	Inventory of customer PC assets globally	Dell Online, Internet	
Reach new geographic markets and customer segments	Direct order, service, and support	Same as above	Increased market share in transaction customers and internationally, increased revenues
Virtually integrate across the value chain and globally	Real-time information sharing within Dell, forward to customers and backward to suppliers on a global basis	The entire information infrastructure of the company	Greater efficiency across the value chain and globally

has access to product and service information tailored to that company, and can order PCs directly from a menu of configurations preapproved by the company without going through normal purchasing channels or paperwork. The popularity and demand for such customization subsequently led Dell to develop tools to help customers set up their own customized versions of dell.com, of which there were reportedly 7000 as of 1998 (Magretta, 1998).

A third example is IT inventory management for relationship customers. Because Dell handles large volumes of PC sales to some corporate customers, it knows the computer configurations at different locations on a worldwide basis and maintains this inventory in its Global Data Repository. Therefore, corporate customers can get information from Dell on how much they have spent for what products in what locations over a given time period, thereby enabling them to better manage and plan replacement of their computing inventory.[10]

Dell also uses the Internet as a sales channel through its completely automated Dell Online service. Customers can go to Dell's Web page, try out and price various configurations, and then call in the order or even place the order directly over the Internet. Started in July 1996, Dell's Internet sales reached $14 million per day by 1999.[11] The proportion of these sales that are entirely new sales versus a shift from telephone or other sales methods is unclear, but the per-transaction cost to Dell is reduced when a customer orders over the Internet rather than through a salesperson.

Dell's share of the global direct market was 31.3% in 1997 and is expected to increase further as a result of Internet sales, where the company was an early innovator. The Internet not only enables Dell to reach new customers, it also provides a new means of providing service and support to existing customers.

A broader example of extending the Dell model to customers is selling the notion that large companies can be run on PC-based networks. Dell runs much of its operations on its own servers and uses its G-2 architecture to demonstrate the potential of PC networks to corporate customers, taking many of them on tours of the Metric12 plant. In this way Dell has a powerful vehicle by which to sell corporate executives and CIOs not only on buying Dell PCs but also on outsourcing PC service, support, and management to Dell.

DELL'S ORGANIZATION OF IT

Dell's IT systems serve both to support and to extend the business model, but aligning its IT with the business model and with changes in organization is a major challenge.

Over time, Dell's IT strategies have evolved in response to changes in its business and its organizational structure.

Global Centralization of IT

The need to balance control and flexibility in the organization has been evident in the evolution of Dell's information technology systems. In the early 1990s, IT was so decentralized that management lacked even the basic information needed to make decisions and run the company. There were a data center and some common applications, but most of the applications had been developed independently in various user departments.

This extreme IT fragmentation was at odds with Dell's organizational structure, which was centralized globally on a functional basis, with sales, manufacturing, service, and other functions all reporting directly to Austin. The company's growth was outpacing the ability of IT to provide information needed to manage the business. To bring some order to its IT house, the CIO moved quickly to implement an information system, called Information to Run the Business, or IRB, as a first step in giving Dell's managers some basic indicators such as product quality, financial performance, and product margins. The CIO then developed a three-phase plan for evolving IT in the company.

Phase one was to stabilize the current environment by installing common hardware and operating systems, and software and tools to manage it. The new infrastructure was composed of Tandem and Sun servers, with the overall network controlled by Tivoli network management software. Phase two was an interim upgrade aimed at building capabilities, including DellNet, a virtual private data network owned and operated globally by AT&T; new data centers in Austin, Ireland, and Penang, Malaysia; and upgraded staff skills to operate in the new environments. Phase three was the development of next-generation applications that would achieve tighter integration of data to allow better integration of business functions. At the core of this process was the decision to adopt an enterprise system—SAP/R3—as a means of developing a unified application environment throughout the company. The attraction of SAP is that it offers a full suite of tightly integrated applications, including finance, human relations, sales and marketing, manufacturing and distribution, and customer service and support. Dell was hoping to bring its disparate IT functions together into one seamless system through SAP.

The SAP implementation was dubbed the Genesis Project, and involved a 140-member staff pulled together from corporate and regional information systems units. The team had gone as far as implementing the SAP human resources component when a change in business strategy caused a reconsideration of the whole project.

Regionalization and IT

In 1995, Dell's SAP plans were thrown off track by a decision to reorganize the company along regional lines. The company was broken into four major regions: Americas, Europe, Asia, and Japan. The Americas region, by far the biggest (with about $8 billion of Dell's $12 billion in 1997 sales), was then further subdivided according to business markets (large business, government/international, small business). This reorganization was accompanied by a decision to push more authority and responsibility down to the regional managers, with each region having its own sales, manufacturing, service, and other functions. Given responsibility for their own operations, profits, and losses, the regional managers, not surprisingly, wanted to have control over their own IT budgets and applications as well.

Such a decentralized organization went against the grain of adopting the highly integrated SAP systems, which require uniform processes throughout the company. It was feared that SAP would not have the flexibility needed to handle the diversity in business practices in the different regions (and countries within the regions) and could become an obstacle to growth. As one Dell IT executive stated, "SAP is like cement, flexible when it's poured but rigid once it hardens." Ultimately, the board of directors told management that it "must not put an information system in place that would jeopardize Dell's ability to sustain its desired growth rates."

The CIO left the company in the summer of 1995 and chief financial officer (CFO) Thomas Meredith managed Dell's IT functions directly for almost 2 years while the Genesis Project continued. Jerry Gregoire was then hired as vice-president and CIO in early summer of 1997. After an initial period of reexamination and discussion with regional managers, Gregoire pulled the plug on SAP, except for the human resources component that was already in place. Beyond SAP's incompatibility with the new decentralized organization, Dell's rapid growth was also an issue in the decision, as stated by another IT executive: "Dell was $2.5 billion when the Genesis project was started and was a $10 billion company by the time of deployment. Deployment is difficult to handle when a company is growing that fast. It is difficult to get business units to be willing to do business one way worldwide. Business growth led to segmentation and a customer orientation that was not consistent with the enterprise (SAP) model." A 1997 *Wall Street Journal* article claimed that Dell canceled the project after its budget swelled and tests showed that it couldn't handle expected sales volumes (White et al., 1997).

Abandoning SAP did not eliminate the need for better integrated systems, however. The regions themselves were becoming large companies, and there was still a strong need for corporate information systems to support top management decision making within each region as well

as across the company. Something needed to be developed that would allow better data sharing and coordination without creating a straitjacket that could inhibit growth. Gregoire's answer was a new IT architecture called G-2.

Dell's IT Architecture

According to Gregoire, G-2 is a blueprint for how to architect systems, execute development, and implement rollout that delivers on the failed promises of client-server computing, that is, low cost to build and manage and easy to use. Gregoire says that in an environment of 60% annual growth in transactions processed, one cannot afford IT projects that take 2 years to implement. The G-2 architecture was designed to be flexible, meaning that changes could be made iteratively, without having to shut down whole systems or retrain workers. The G-2 architecture is layered, with a Web browser user interface sitting on top of an applications layer, a message broker, and a database (Figure 3).

The key to this structure is the message broker layer, which is based on an IBM MQ series application integration system. It serves as an information bus, linking all applications and databases to each other, so they don't all have to talk to each other separately. It also allows new data engines or applications to be added to the system without having to make changes throughout the system. For instance, a new database on customers (e.g., how much they have spent on various products in the past) can be added at the data engine level and be linked via the message broker to Dell's customer service representatives' order management system. This information can be made available as an extra button on the Web browser interface without needing to change the users' applications or retrain the users.
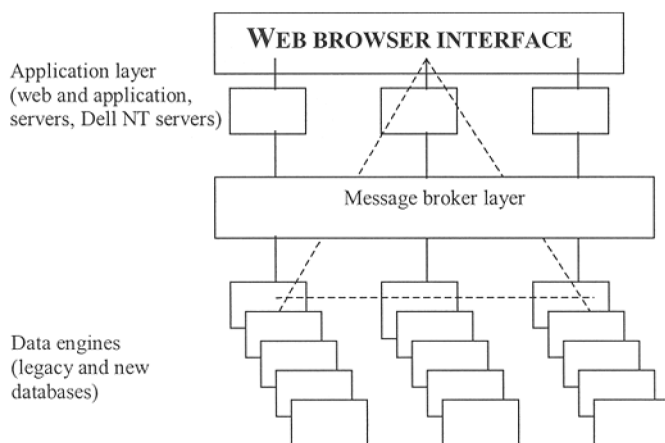

FIG. 3. Dell's G-2 architecture.

The G-2 architecture enables the company to run "best-of-breed applications" rather than only a single enterprise system. It also makes it possible to "run Dell on Dell," using the products that Dell and its strategic partners sell: Dell servers, desktops, and laptops; Windows NT and the Explorer Web interface; and Oracle databases. The G-2 architecture has extended the life of Dell's legacy applications, such as the DOMS and Dell Product Services (DPS), which are written for Tandem hardware, even as other applications are shifted to Windows NT servers, because the message broker layer allows these different systems to talk to each other. Also, migration from legacy applications to NT-based applications can be done incrementally, migrating individual functions over to new applications one at a time, rather than having to rewrite entire applications or move entire databases all at once. Such flexibility enables Dell to expand the capabilities of its information systems to meet the demands of rapid growth without major disruption to the business's functioning. Creating and maintaining all of the linkages and interfaces required for this flexibility is reported to be complex and costly, and problems sometimes result, but Dell's IT people seem to have made application integration work to serve the company's needs.

Dell's IT Organization

Like the company as a whole, the IT is decentralized. Gregoire's management philosophy is that "all IT is local." He argues that when companies have highly centralized IT departments, there are hundreds of other invisible IT departments scattered around the company, doing whatever they want with no coordination among them. He prefers to keep IT decentralized, and follows the 100-person rule, which states that whenever an IT department gets larger than 100 people, it is time to break it up. Such a structure is decentralized, yet is easier to coordinate than hundreds of invisible units. Still, Dell's IT people admit that while their decentralized matrix structure is good for supporting growth and innovation, it can be hard to maintain control. There are clearly trade-offs, and Dell has decided that in such a fast-changing business, it is worth sacrificing some control in return for greater flexibility.

The resulting complexity of Dell's IT organization is illustrated by the Dell Americas' IT structure in Figure 4. Dell's IT subunits are organized in a matrix structure, cutting across business functions and markets, sitting on top of an integrated systems services layer and a functionally oriented applications layer. The five functions are product design, manufacturing, sales, service, and corporate systems, while the three business markets are relationship (large customers), transaction (consumers and small
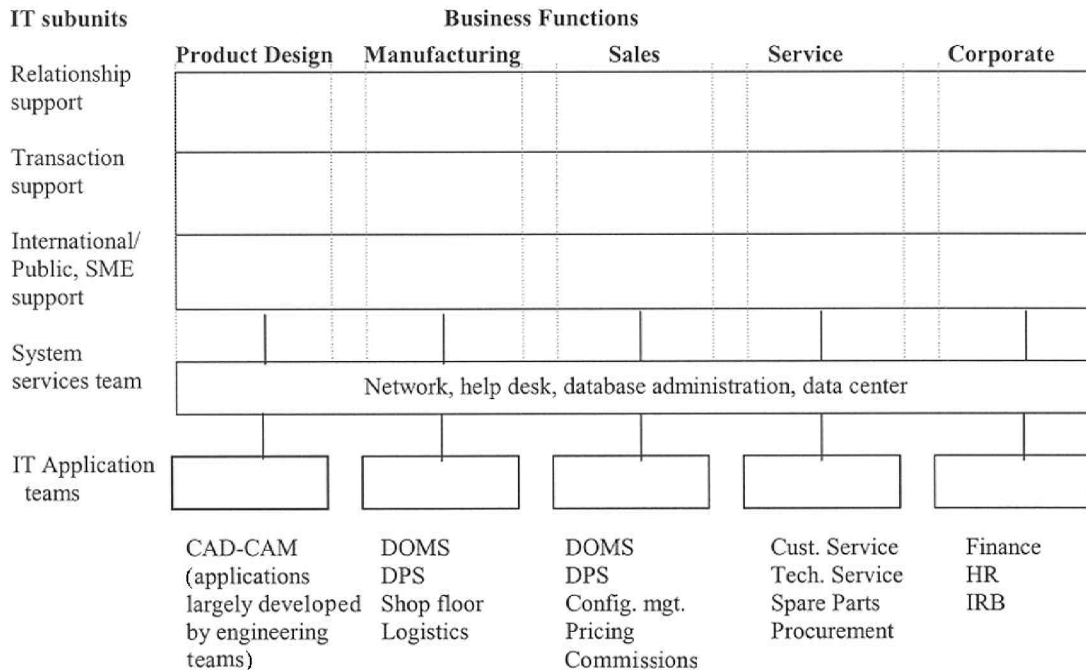
FIG. 4.   Matrix structure of Dell Americas' IT organization.

businesses), and international/public (non-U.S. markets; government, education, small- and medium-sized enterprise (SME)). Each of the three markets represents a subdivision of the Americas region, and each must be supported by applications in some or all of the five functional areas.

The IT System Services functions are those that support the whole business, such as network services, the help desk, database administration, and the data center. The actual interactions within the matrix structure are less neat than the figure suggests. For instance, the DOMS application supports both customer services and sales, while sales commissions applications must be linked to finance and human resources. However, with Dell's G-2 architecture, it is possible to link applications and data to the necessary functions via the message broker layer.

IT is highly integrated within Dell's regional operations, and less so across regions. Still there is a great deal of data sharing across regions to support corporate functions and to share useful information throughout the organization. Regional IT executives answer primarily to the regional business manager, who makes budget decisions and choices about what types of applications to develop or adopt. However, CIO Jerry Gregoire maintains the authority to enforce architectural standards across the company and to ensure that long-term infrastructure projects are carried out.

The company must decide to what extent it wants to standardize applications across the company versus letting regions make their own choices as to what systems best suit their needs. So far, there are no hard rules, but in general, flexibility and decentralization are given priority over standardization. For instance, the DOMS, developed in the United States, is used in the United Kingdom but not in France or Germany, and a manufacturing system that was developed in Europe is used in Asia but not in the Americas.

CONTRIBUTIONS OF IT TO DELL'S PERFORMANCE

The contributions of Dell's IT investments to the firm's performance are difficult to disentangle systematically from the other inputs to production and from the many process innovations continually made at all stages of the value chain. However, it is clear that IT and the information it provides, along with process improvement, have contributed to Dell's exceptional performance. The contribution of IT to operational efficiency is reflected in measures related to procurement and inventory, manufacturing production, cash management, and administrative overhead.

- Procurement and inventory: Dell's days of inventory dropped from 32 in 1994 to just 6 by the end of 1998.[12] This inventory level is the lowest in the industry (Table 4) and reflects the aggressive supply chain management strategies noted earlier. These strategies are made possible by the

TABLE 4
Inventory turnover, 1998

	Dell	Gateway	Compaq	PC industry
Inventory turnover	55.5	27.9	12.9	23.6
Days cost of goods sold in inventory	6	13	28	15

Note: From Hoover's Online (1999).

on-line, real-time sharing of information on orders and production not only within the company, but also throughout Dell's supply chain. This extensive and timely sharing of information through linked computer systems for procurement, supply, and order fulfillment essentially enables information to substitute for inventory.

- Manufacturing: Dell's production cycle time is 7 hours, on average, while its order turnaround time is 7 days, on average. The automation of production processes contributes to the speeded-up cycle times.
- Cash management: According to CFO Thomas Meredith, Dell has a cash conversion cycle of -8 days.[13] This is because Dell often receives payment from a customer on an order before it pays its suppliers for parts used to fulfill this order. On average, Dell converts a sales transaction into cash in less than 24 hours (McWilliams, 1997). In contrast, indirect PC sellers must buy components to produce PCs, then push the PCs into the channel and wait for payment.
- Administrative overhead: While Dell has grown tremendously in revenues, it has continually reduced its administrative overhead, defined as SG&A, such that it is among the most efficient firms in the industry. Dell's SG&A declined from 15% in 1993 to 9.8% in 1998. By contrast, over that same time period, Gateway's SG&A has increased from 7 to 14%, and Compaq's SG&A held steady around 12% until jumping to 20% in 1998 due to the acquisition of Digital Equipment Corporation (which came in with much higher overhead levels).[14]

The effectiveness of IT uses aimed at extending the business model is suggested by historical patterns of sales growth by customer market, product line, and international markets.

- The highly profitable corporate (relationship) customer market has exhibited greater growth than the consumer (transaction) market between 1991 and 1997. Relationship customers accounted for 59% of net sales in 1991, whereas they accounted for 70% in 1997. Relationship customers have been specifically targeted for growth through the use of IT to support customer reps in the field, for direct orders placement by large corporate customers themselves, for customized service and support of individual users, and for PC asset management for the corporations.
- Sales growth by product line shows a similar pattern. Although desktop PC sales still dominate, Dell is slowly shifting from sales of desktop PCs to an increasing proportion of more profitable laptops and servers. Over the past 3 years, the proportion of company revenues from desktops and workstations has declined from 81% in FY 96 to 73% in FY 97 (Q3).
- Sales growth has also occurred in international markets, which accounted for 27% of Dell's overall sales in 1990, and 32% in 1998. Dell's sales in Europe grew by 72% in 1998, as it moved into second place in unit sales (GartnerGroup's Dataquest, 1999). Dell even managed to expand its Asia-Pacific sales during the Asian financial crisis of 1998.

The overall effectiveness of Dell's IT-supported direct model is indicated by the company's growth in sales and market share. Over the last 10 years, Dell sales have increased from a mere $389 million in fiscal year 1990 to $18.2 billion in fiscal year 1999 (ending January 1999; we refer to this as 1998 data in comparative figures to provide comparability with other companies' annual data; other years are adjusted accordingly) (Figure 5) (Hoover's Company Profiles, 1998). Net income increased from just
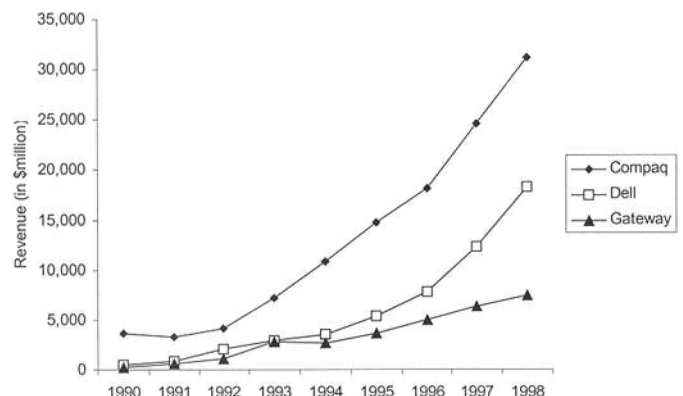
FIG. 5. Sales revenue, 1990–1998, in $millions. From Hoover's Company Profiles.
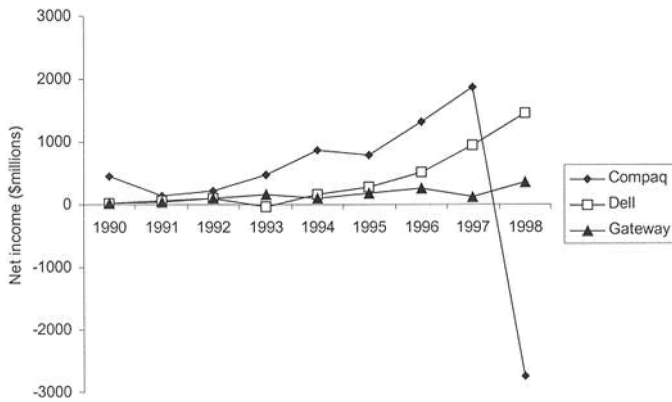
FIG. 6. Net income, 1990–1998, in $millions. From Hoover's Company Profiles.

$5 million in fiscal year 1990 to over $1,460 million in fiscal year 1999 (Figure 6).

Table 5 provides the worldwide market shares of selected companies for selected years between 1985 and 1998 and shows the increasing market share of Dell as well as the growing dominance of Compaq in the PC industry over this period.

In the U.S. market, Dell has pushed its way into the number two spot, with 12.7% of the market in 1998 (Table 6).

Shareholder Value

Dell has been doing very well in increasing shareholder value, whether measured by return on invested capital, earnings per share, or share price growth. Michael Dell believes that return on invested capital (ROIC) is most reflective of shareholder value and has been structuring business decisions around ROIC for several years (*Dell Annual Report*, 1997) with strong results. According to Dell's 1999 annual report, ROIC increased from about 37% in FY1995 to 195% in FY1999.[15]

Dell's earnings per share, a second measure of shareholder value, have shot up from $.05 in FY 1995 to $.53 in FY 1999 (Hoover's Online, 1998). The continued dramatic

growth in Dell's share price shown in Figure 7 reflects the market's recognition of the shareholder value that Dell has created with the continuing refinement and extension of the business model.

CONCLUSIONS

Dell has grown rapidly to become one of the top three vendors in the PC industry, and has seen an extraordinary increase in share price and market valuation. While many other PC companies have been unable to handle the demands of time-based competition, Dell has continued to thrive in such an environment. The key to Dell's success has been its direct sales and build-to-order business model. This model is simple in concept but highly complex in its execution, especially under conditions of rapid growth and change. Dell has continually refined and extended its business model while striking a balance between control and flexibility.

Dell's use of IT plays a vital role in the implementation of its business model. The company has used IT to coordinate its build-to-order processes from order taking through procurement, logistics, production, service, and support. Doing so has enabled it to reduce inventory, speed up logistics and product cycles, understand user markets, and

TABLE 6
U.S. market share in % (based on unit shipments)

	1994	1995	1996	1997	1998
Compaq	12.6	12.2	13.3	16.9	16.1
IBM	9.0	8.3	8.7	8.7	8.0
Dell	4.2	4.6	6.9	9.4	12.7
Packard-Bell	11.4[a]	11.3[a]	11.6[a]	9.2[b]	8.0 (Q1–3)[b]
Gateway 2000	5.2	5.1	6.3	7.2	8.4
Hewlett-Packard	n.a.	n.a.	n.a.	6.5	7.5

Note: From Dataquest, various press releases.
[a]Includes Packard-Bell only; merged with NEC in 1996.
[b]Includes Packard-Bell/NEC.

TABLE 5
Worldwide market share in % (based on unit shipments)

	1985[a]	1990[a]	1995[a]	1996[b]	1997[c]	1998[c]
Compaq	3	4	10	10.1	13.1	13.8
IBM	25	13	8	8.6	8.6	8.2
Dell	Less than 1	Less than 1	3	4.0	5.5	7.9
Hewlett-Packard	2	1	4	4.0	5.3	5.8

[a]Dedrick and Kraemer (1998b).
[b]Dataquest (1998).
[c]GartnerGroup's Dataquest (1999).
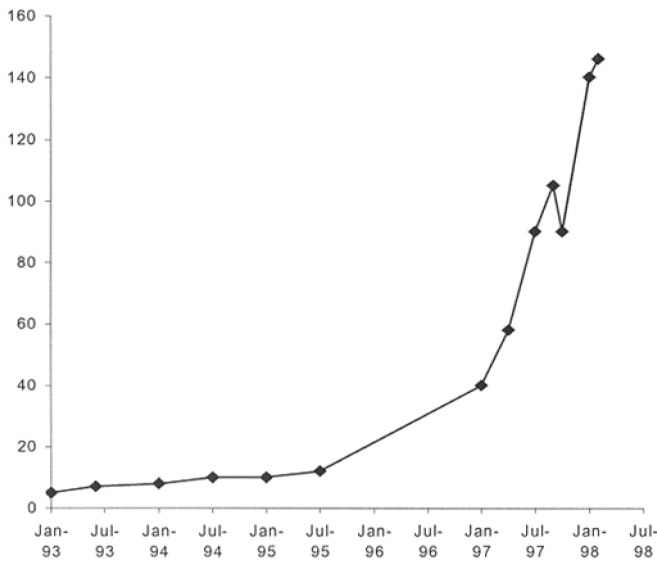
FIG. 7. Dell's share price, 1993–1998. From Wall Street Research Net (1998).

offer additional services to customers. It also has used IT to achieve virtual integration with suppliers and strategic partners by real-time information sharing. The company has extended its reach to millions of potential customers at low marginal cost through its use of the Internet. These refinements and extensions have been made possible by the development of a novel IT structure that is flexible, expandable, and still adequately integrated to support key corporate functions.

Decisions about IT at Dell are subject to the demands of the larger business strategy. Thus, when the company felt that adopting SAP would limit its flexibility, the project was halted and a new IT strategy was developed. Yet the IT organization is deeply involved in extending the business model, and it plays more than a mere support function in the company. IT is a key element of many business strategies, from using the Internet as a marketing channel to giving suppliers a direct link to Dell's information systems to being a model for other enterprises to follow. In fact, Dell's use of its own PC-based technology to run much of its own business is a valuable marketing tool to show customers the capabilities of its product line.

It is very difficult to separate the impacts of investments in IT from other factors such as changes in business processes, effective use of human resources, and general acceptance of the direct model by users. Still, a close examination of Dell's operations makes it clear that IT is fundamental to the functioning of the direct model, and that IT has been a key element in the continued refinement and extension of that model. It simply would be impossible to coordinate such a complex set of business processes at such a high speed without using IT extensively.

One question that naturally arises is: How much of Dell's success is due to its business model versus its execution of that model? The advantages of direct sales are highlighted by the difficulties faced by Compaq as it tries to implement its own build-to-order processes. Compaq risks alienating the channel that accounts for most of its sales if it sells direct, so it has tried to develop a hybrid build-to-order system in concert with key distributors and resellers. However, it has been unable to improve its inventory turnover and has caused confusion among its customers in the process. Meanwhile, Dell has pushed ahead to improve its processes and develop new business lines such as services and online retailing of other companies' hardware and software. This suggests that Dell's business model provides a major advantage in time-based competition. On the other hand, other direct sellers such as Gateway and Micron have not come close to Dell's performance in recent years. This suggests that execution is a key factor in differentiating companies with similar business models. In the end, Dell has succeeded because of both model and execution.

A second question is whether Dell can sustain its performance in the face of new challenges such as the boom in sub-$1000 (or $500) PCs or a possible shift in demand from full-featured PCs to simple information appliances. If customers no longer demand the latest technologies, will Dell still have an advantage? Dell already appears to be implicitly responding to that possibility by recasting itself as a PC outsourcer, emphasizing its service and support capabilities to corporate customers. It also has opened a second Web site called GigaBuys.com that sells a variety of third-party hardware and software. In effect, Dell is already recasting itself as a service and retail company rather than just a PC maker. In this effort, Dell's past investments in IT are particularly important, as it has the infrastructure to support this new extension of its business and is known to customers as an Internet-savvy company.

This leads to a third question: Is Dell an exemplar of the network economy or an anomaly? This can be answered by looking at three key elements of Dell's business—direct sales, build-to-order, and Internet commerce. Direct selling will offer advantages in any industry where clockspeed is critical and where products, services, or information can be delivered more quickly by eliminating intermediaries. Build-to-order production, or mass customization, should also gain footholds in more industries as companies look to differentiate their products and avoid pure price competition. Most important, the use of the Internet for marketing, sales, and supply-chain integration will undoubtedly be embraced by large segments of the economy. The economics of Internet commerce mean that up-front costs may be high, but marginal costs of transactions are negligible. Companies such as Dell that are industry leaders in Internet commerce will be able to expand their customer base

and increase their business with existing companies at a low marginal cost. They also can reduce the cost of coordinating their supply chain through electronic linkages. This will enable them to offer incentives to customers and suppliers to do business electronically and continue to drive their own costs down.

In the long run, Dell might slip up and make mistakes that allow competitors to pass it by, just as many other successful IT companies have done. However, the forces behind Dell's success will continue to apply to companies and industries in which time is a key competitive factor.

NOTES

1. Clockspeed is a term attributed to Fine (1998). In Mendelson and Pillai (1999), clockspeed is determined by three factors: (1) the rate of decline in input prices, (2) product life cycles, and (3) share of total revenues that came from products introduced in the previous 12 months.

2. The growing recognition of the significance of the Dell case is highlighted by a recent *Wall Street Journal* article that describes how academics, consultants, and industry executives outside the computer industry are trying to understand what Dell means for their companies and industries, wondering whether they will be "Dellized" by some company in their industry, and concerned with how to ensure that they are the "Deller" rather than the "Dellee." The article also is the source of the quote by Paul Roemer at the beginning of this article, in which he articulates the broader significance of cases like Wal-Mart, Dell, Amazon.com, and Cisco in the economy. See Wysocki (1999).

3. Silverman (1998). Much of the growth was attributed to Dell and Gateway's success in McWilliams (1997).

4. Dell not only has data on its customers and potential customers, but it uses that data regularly. Dell maintains a special database of its top 50 global customers, which it updates daily and uses to spot emerging trends among large corporate users. It also has a Global Data Repository of data on all of its customers, which is updated daily for the Americas and weekly for Europe and Asia. The respository includes order information, service information, and units/products by company and by location. The databases are analyzed regularly by corporate staff using sophisticated seven-dimension analytical tools in an effort to identify changes in customer patterns and in leading indicators. Dell also maintains a rich database compiled from Dun & Bradstreet and other industry sources on the top 500 global companies that it uses to selectively target sales efforts.

5. There are about 5000 people in Dell call centers around the world talking to customers every day and taking orders for machines, software, and service. Dell's Austin customer service center has around 2500 people. The orders are analyzed frequently to spot trends early and to identify patterns among customer segments.

6. It is important to note that only about 10% of Dell's customers are individual end users, or individual consumers. Most are large corporate or institutional customers. While individual end users within these large corporate and government customers can place orders directly, they do so usually within a framework of certain standard configurations of hardware and software that are predetermined by representatives of IT, procurement, and user departments within the customer organization.

People who are not familiar with the details of the direct model sometimes think it refers only to "direct sales to individual end users or consumers" instead of this more complex and nuanced reality. In other words, the direct notion refers more to the fact that Dell largely (though not completely) bypasses the traditional distribution channels (distributor, value-added reseller, systems integrator, retailer) rather than that it goes directly to the individual end user.

7. Magretta (1998). The information on Dell's relationship with Boeing was confirmed by author interviews with Boeing personnel.

8. Dell interviews; Magretta (1998, pp. 82–83).

9. Dell interviews.

10. Dell installs equipment tags during assembly for some companies and maintains the inventory records for them through on-site staff. For most companies, however, Dell simply has an inventory of what was sold to whom and where; it does not maintain records beyond the initial purchase, for example, when equipment is moved from one location, department, office, or individual to another.

11. Dell web site: http://www.dell.com/corporate/access/factpak/index.htm. Michael Dell in keynote speech at the Networld + Interop show, reported in Smith (1999).

12. *Dell Annual Report* (1997, 1998); Hoover's Online (1999).

13. Barr (1998). Cash conversion is measured as follows: Using the metrics of days of sales outstanding (DSO), days of sales in inventory (DSI), and days of payables outstanding (DPO), Dell adds DSO and DSI, then subtracts DPO, to determine the cash conversion cycle.

14. SG&A data from McKinsey & Co., *Computer Industry Report* (1994, 1998) and from company profiles of Dell, Compaq, and Gateway on Hoover's Online (1999).

15. *Dell Annual Report* (1999). Hoover's Online gives Dell's ROIC for FY ending in 1998 as 56.1%, while Dell reports 185%. According to Hoover's, return on invested capital = net income divided by invested capital (long-term debt + preferred equity + common stock equity). Dell does not define ROIC in its annual report.

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