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Dell Computer: Organization of a Global Production Network

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INTRODUCTION

In 2001, Dell Computer became the world's largest personal computer vendor, continuing to gain market share and post profits in an industry struggling with slumping sales and billions of dollars in losses. Dell sells 90% of its PCs directly to the final customer, largely bypassing the reseller channel that accounts for most of the world's PC sales. This direct customer relationship is the key to Dell's business model, and provides distinct advantages over the indirect sales model. Dell's direct relationship with the customer allows it to tailor its offerings to customer needs, offer add-on products and services, and use the Internet to offer a variety of customer services. In addition, Dell's PCs are built to customers' specifications upon receipt of an order, giving Dell additional advantages over indirect PC vendors who must try to forecast demand and ship products based on those forecasts. Dell's direct sales and build-to-order model has achieved superior performance in the PC industry in terms of inventory turnover, reduced overhead, cash conversion, and return on investment (Kraemer, et al., 2000).

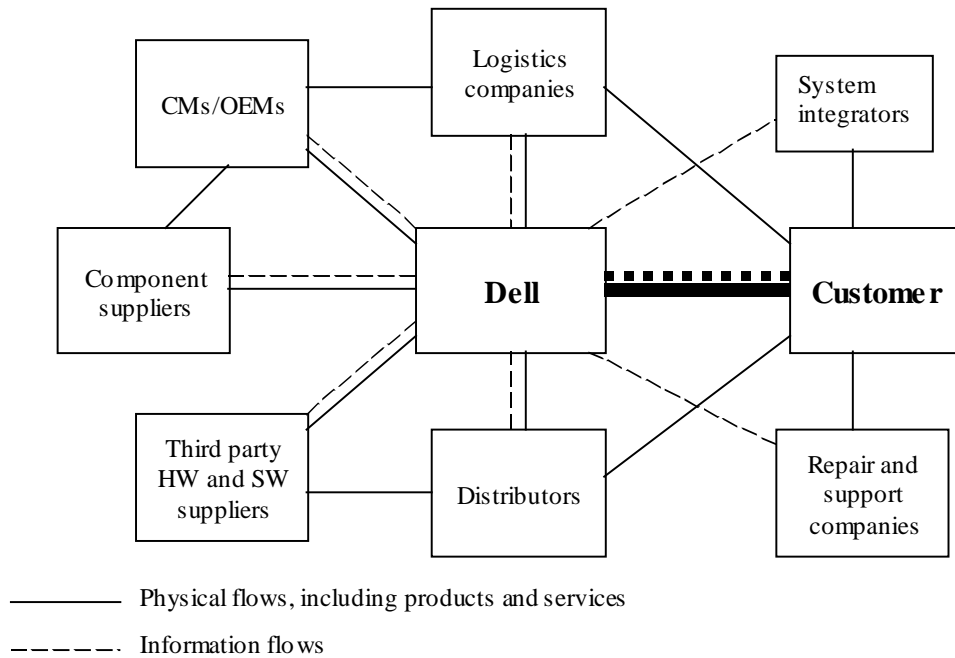
Dell's business model is simple in concept, but very complex in execution. Building PCs to order means that Dell must have parts and components on hand to build a wide array of possible configurations with little advance notice. In order to fill orders quickly, Dell must have excellent manufacturing and logistics capabilities supported by information systems that enable it to substitute information for inventory.

The demands of Dell's model have led it to adopt a new organizational structure referred to as a virtual company or value web (Figure 1). It is marked by a focus on a few key strategic activities, and extensive outsourcing of non-strategic activities. Dell works closely with external partners to produce its PC products and to offer its customers an array of additional products and services that add value and allow Dell to capture a larger share of the customer's IT spending.

To manufacture its products, Dell coordinates a global production network that spans the Americas, Europe and Asia, combining in-house final assembly with heavy reliance on outside suppliers and contract manufacturers. Manufacturing of printed circuit board assemblies (PCBAs), subassemblies (box builds), and some final products (mainly notebook PCs) is handled by contract manufacturers or original design manufacturers such as SCI, Solectron, Celestica, Hon Hai, Quanta and Arima. Like other PC makers, Dell relies on outside suppliers for components and peripherals such as disk drives, CD-ROM drives, semiconductors, add-on cards, monitors, keyboards, mice and speakers. Its PCs can be bundled with standard software such as Microsoft Office or with specialized software requested by corporate customers.

Dell relies on outside partners for services such as system integration, installation, on-site repairs and consulting. Partners include Wang, Unisys, IBM and BancTec. It also works with resellers who support Dell hardware and receive referral fees for recommending Dell to customers.

FIGURE 1. Dell's Value Web Model



As Dell has moved beyond its home market in the U.S., it has had to adapt its business activities and organizational structure to the different markets in which it operates. In effect, Dell has had to create similar but distinct value webs in each of the major regions, and to further customize its marketing and service functions for individual countries. The process of globalization has shaped Dell's own structure, but Dell's success has conversely helped to reshape the global structure of the PC industry.

This paper looks at how Dell organizes its activities globally, regionally and within regions, and what factors determine its location decisions. The focus is on the PC manufacturing value chain including procurement, manufacturing, distribution and the logistics involved throughout the value chain. This includes Dell's own assembly operations and the location of its suppliers in response to Dell's decisions. We will also briefly discuss the organization and location of marketing, sales and service functions as they relate to Dell's overall global organization.

GLOBAL ORGANIZATION

Dell is a global company operating in 34 countries in three world regions, with about 35,000 employees and \$30 billion in sales. Dell is organized along geographic lines into the Americas, Asia-Pacific and Japan, and Europe/Middle East/Africa (EMEA). Corporate headquarters is in Round Rock, Texas, which is also the regional headquarters for Dell Americas. Each of the regions has its own regional headquarters and its own assembly plants and supply network. Regional headquarters include Bracknell, U.K. for EMEA, Hong Kong for Asia-Pacific and Kawasaki for Japan (Table 1).

Dell's business activities are organized in each region around different customer segments. These vary somewhat, but generally include: (1) relationship (large corporate) customers; (2) home and small business (sometimes called transaction customers); and (3) public sector (government and educational) customers.

Product development is largely centralized in the U.S., and the same base products are sold worldwide. These products are customized for different regional and country markets with appropriate power supplies, keyboards, software and documentation. Other functions such as IT and e-commerce applications usually originate in the U.S., and then are adopted with necessary modifications in the other regions. Manufacturing processes are always being upgraded, and the newest plant is usually the most advanced wherever it is located. Improvements developed for new plants are implemented in existing plants as much as possible.

Table 1
Dell's Worldwide Locations, With Employment and Sales, End of 2000

Country	City	Employees	Sales (FY2000)	HQ	Manufacturing
WORLDWIDE		40,000	\$25.3B		
THE AMERICAS		27,200	\$17.9B		
United States					
	Round Rock and Austin TX	20,800		World and Americas	Yes
	Nashville, TN area	2712			Yes
Brazil	Eldorado do Sul	200			Yes
Canada		n.a.			
Chile		n.a.			
Mexico					
ASIA-PACIFIC		3,200	\$1.8B		
Hong Kong (PRC)		25		A/P	
Australia		n.a.			
China		330			
	Xiamen	200			Yes
India	Bangalore	n.a.			
Malaysia					
	Penang	1600			Yes
New Zealand		n.a.			
Singapore		130			
Taiwan		n.a.			
Japan	Kawasaki	700		Japan	
South Korea		n.a.			
EUROPE, MIDDLE EAST AND AFRICA		9,000	\$5.6B		
United Kingdom					
	Bracknell	500		EMEA	
Ireland	Limerick	3,400			Yes
	Bray	600			

- Dell has subsidiaries in 16 other EMEA countries, not listed here.
- *Source:* Dell web site and various news reports

LOCATION OF MANUFACTURING

While Dell does not manufacture its own components or subassemblies, it does handle final assembly for nearly all of its desktop PCs and servers. Notebook PCs are manufactured by Taiwanese manufacturers Quanta and Compal. In some cases the notebook PCs are shipped complete to the final customer. However, Dell is increasingly ordering base units from its suppliers and doing final configuration of notebooks in order to offer more configuration options to customers.

Dell organizes manufacturing by region, operating one or more assembly plants to serve its major markets. Plants in the Austin, Texas and Nashville, Tennessee areas serve North America; Eldorado do Sul, Brazil serves Brazil and South America; Penang, Malaysia serves the Asia-Pacific region; Xiamen, China serves China and Japan; and Limerick, Ireland serves Europe, the Middle East and Africa (Table 1).

Dell began manufacturing its own brand of PCs in Round Rock, Texas in 1985. It subsequently expanded to new production sites outside the United States as follows (from Dell's web site):

- 1990: Opens manufacturing plant in Ireland
- 1996: Opens manufacturing plant in Malaysia
- 1998: Opens manufacturing plant in China
- 1999: Opens manufacturing plants in Tennessee and Brazil

In addition, Dell has greatly expanded its production capacity in the Austin/Round Rock area over the years, and now operates four facilities there. These plants produce the full line of Dell hardware products. Until the Tennessee plant opened, they supplied the entire North American market. Similarly, Dell has expanded its production capacity in Limerick, Ireland and now operates two plants there.

Employment worldwide is closely correlated with sales (Table 2). The Americas account for 72% of Dell's revenues and 68% of employment; EMEA has 20% of sales and 22% of employment; Asia-Pacific equals 8% of sales and 10% of employment. The only slight surprise is the lack of bias toward the home country, even with the presence of corporate functions in Texas. An explanation could be that the large size and homogeneity of the U.S. market allow Dell to achieve economies of scale in its production sites, call centers and other operations, and thus have a higher revenue per employee than other markets.¹

¹ We heard this explanation several times in interviews with Dell people in the EMEA region. They pointed out that Dell EMEA deals with 13 different languages, 18 different currencies, and 18 different tax rates whereas Dell North America deals has only 3 different languages, currencies, and tax rates.

TABLE 2
Sales and Employment by Region (End of 2001)

	Americas	EMEA	Asia-Pacific
Sales (last 4 quarters)	\$22.2B	\$6.6B	\$3B
% of total sales	70	21	9
Employment	21,600	8,250	4550
% of total employment	63	24	13
Revenue/employee	\$1,027,000	\$800,000	\$659,000

Source: Dell web site

DELL'S LOCATION DECISIONS

Dell's decisions about where to locate are driven by the need to minimize costs while extending the build-to-order, direct sales model around the world. Given the need to have production and support capabilities in the major markets, Dell selects specific locations based on a combination of factors including labor costs, transportation and information infrastructure, market access, proximity to markets and government incentives. The role of these factors can be seen by looking at particular locations of Dell facilities.

The Americas

Texas

Dell's original headquarters was in Austin, Texas, where Michael Dell founded the company in 1984. In 1994, Dell was offered a package of incentives from the neighboring city of Round Rock that Austin did not even try to meet. After collecting the usual 2% tax on Dell sales, the city rebates 31% of those tax collections to Dell for 60 years; property tax abatement of 100% for 5 years; 75% for 5 years; 50% for 50 years (Schnurman, 2000). Dell moved its headquarters to Round Rock, built other facilities there, and eventually had over 12,000 workers in the former bedroom community.

Dell maintains manufacturing facilities in Austin, including its high-volume Metric 12 plant that assembles an estimated 4 million PCs per year. Overall, Dell has about half of its 36,000 employees in central Texas, owing to incentives, a relatively low-cost workforce (compared to other U.S. locations), and a tendency to expand existing capacity rather than look elsewhere as the company grew.

Tennessee

Dell opened its first North American manufacturing facility outside of Texas in 1999, in Nashville, Tennessee. Nashville was chosen for very generous state and local tax incentives, good transport infrastructure, good labor supply and location central to East Coast markets.

Tax and other incentives from the state of Tennessee included:

- Infrastructure assistance (road improvements and utilities to service the facility totaling about \$12 million)

- Job training assistance for Dell employees, which could range from \$12 million to \$20 million over five years based on the employment projects of the company
- Jobs tax credits of \$2,000 per employee

The local Nashville government offered even more lucrative incentives, including:

- The gift of 100 acres of airport-area property valued at \$6.5 million, and the leasing of another 600 acres for 40 years at fair market
- Abatement of all property taxes on the facilities for 40 years
- \$8 million in infrastructure improvements (beyond the state's \$12 million), and \$1.5 million toward demolition of old buildings on the site (Locker, 1999)

Dell now has two manufacturing facilities in Tennessee: one in Lebanon making consumer desktop PCs and one in Nashville making consumer notebook PCs. It also has a sales and support call center in Nashville.

Brazil

In 1999, Dell began manufacturing at a facility in Eldorado do Sul, Brazil. The decision was motivated by the need for production to supply the South American market. Locating in Brazil enabled Dell to avoid tariffs that can nearly double the price of an imported \$1,000 PC, according to Dell. Our own research (Dedrick et al., 2001) shows that tariffs on PCs can reach about 30% of the price, so perhaps Dell is also including transportation or other costs into this estimate. In any case, Brazil is by far the largest market in South America, and it would be impossible to compete there with such a price disadvantage. Also, PCs produced in Brazil can be exported without tariff to other Mercosur countries, which include Argentina, Uruguay and Paraguay.

The specific choice of Rio Grande do Sul state was somewhat surprising, as most of Brazil's computer industry and supplier base is located near Sao Paulo. However, there were reportedly financial concessions offered by the state government, and the southern state is centrally located to supply the other Mercosur countries. Michael Dell said in a statement that the region is a "phenomenal opportunity" for Dell. "Rio Grande do Sul is an excellent base of operations because of its sophisticated labor force, its economic incentives to attract technology-manufacturing companies to the region and its strategic location as an export hub to other South American countries," (Mahoney, 1999).

Europe/Middle East/Africa (EMEA)

Dell's EMEA headquarters are in Bracknell, United Kingdom. It also operates a sales and support call center there for consumer and small business (transaction) customers in Europe.

Dell opened an assembly plant in Limerick, Ireland in 1990 to serve the European market, and subsequently opened a second plant and administrative center there as well. It also operates a sales and customer support center in Bray, Ireland to support larger corporate and other institutional (relationship) customers. Dell located in Limerick initially because of the low cost and high quality of labor. Today labor costs are much higher, but the work force is still highly

skilled and non-union. Dell has received good cooperation from technical schools and universities in the area to develop the skills Dell needs. Now 50% of the people working for Dell in Limerick have at least a bachelor's degree.

Another advantage of Ireland is its low corporate tax rates. In addition, Ireland is part of the European Community, so products made in Ireland can be shipped to Europe without paying the value-added tax. Also, because Ireland is now adopting the Euro, Ireland will have currency stability with the rest of Europe, eliminating the exchange rate risk within Europe. This is a major factor in Dell's decisions to expand production in Limerick (Loughran, 2000).

Another factor was the tax incentives and other support offered by the Irish Development Agency. The agency helped Dell find land, set up its facilities, and assisted with job training. More recently support has been provided in the form of per capita grants for each Dell employee (Kennedy, 2000a). Finally, Ireland is attractive due to the presence of suppliers such as Intel and Microsoft, the presence of contract manufacturers such as SCI, and the quality of its freight and transportation infrastructure (Kiely, 2000).

In addition to Ireland and the U.K., Dell operates subsidiaries in 16 other countries around EMEA, mostly for sales and local technical support. It also operates five logistics hubs where PC units are brought together with monitors, peripherals and other add-ons for distribution to end customers. Furthermore, these hubs also provide repair services.

Asia-Pacific

Dell opened its first manufacturing center in the Asia-Pacific region in 1996 in Penang Malaysia. Malaysia was chosen for its central location in the region, proximity to suppliers, reasonable wage rates and attractive incentives. When Dell built its factory in Penang, it received a five-year tax holiday. High-tech companies investing in Malaysia are entitled to five years without having to pay the country's 30% corporate income tax. Projects that the government thinks will have a significant impact on the economy can qualify for strategic-project status, which provides for a 10-year tax exemption, so Dell began working to get a better deal according to Phil Kelly, Dell's president for Asia-Pacific operations at the time (Arnold, 1997). Evidently, Dell got what it was looking for. In 2000, the company announced it would more than double its capacity in Penang by opening a new facility that will produce notebook PCs for the Asia-Pacific and U.S. markets.

In 1998, Dell opened a new manufacturing facility in Xiamen, China. The plant is directly across the straits from Taiwan, and is home to a number of Taiwanese computer and components makers. This provided Dell with a base of suppliers and other support services. Having a plant in China was necessary to sell in the main land China market. With China's tariffs and taxes, importing is not a viable strategy, and if Dell hopes to sell to government agencies and state enterprises, it needs to have production in China. In 2001, Dell announced it would begin producing desktop PCs for the Japanese market in Xiamen, shifting production from Penang.

General Location Factors

Looking across the regions and sites, the following are the major factors affecting Dell location decisions. As was suggested by each of the vignettes above, no one of these factors is sufficient

by itself to determine a location decision. Rather they seem to operate in a nested hierarchy with market considerations first, followed by labor and infrastructure, and then by government incentives.

- **Market access:** Texas is central to all of the U.S; Tennessee to the East Coast. Malaysia is central to the huge Asia-Pacific region. Ireland is offshore but close to the big markets of the UK, Germany, and France. Also, as part of the European Union (EU), Ireland provides tariff-free access to EU markets. Brazil and China plants are set up for market access and to get around tariffs and taxes that would make PC prices uncompetitive if imported.
- **Labor costs and quality:** Texas and Tennessee are cheaper than Silicon Valley. Malaysia is cheaper than Singapore (although more expensive than Thailand or Indonesia). Ireland is still cheaper than most other EU countries (although more expensive than Portugal or Greece). Eastern Europe is cheaper than Ireland and more centrally located within Europe and, as a result, many of Dell's contract manufacturers and suppliers are locating there and creating speculation that Dell will follow (Kennedy, 2000b). The quality of labor is high in each of these locations as well. Besides having well-educated workers, engineers and technicians, each location has little or no labor union activity.
- **Transportation and telecommunications infrastructure:** Logistics is a bigger cost than manufacturing labor according to Michael Dell, so transport infrastructure is very important. The Tennessee locations, for instance, are in close proximity to major highways and to a major Federal Express distribution center. Telecommunications bandwidth, cost, and quality are also factors, especially for call centers and data centers.
- **Government incentives:** Major incentives were offered by Round Rock to get headquarters and call center operations. Dell also received valuable incentives in Tennessee. Apparently financial incentives were offered in Brazil by the state government, and also in Malaysia in the form of tax holidays. It is unclear what was offered in Xiamen, China, but it is common for local governments to offer incentives in China. Ireland's low corporate tax rate was a major incentive, but Dell also received support in finding land, building facilities and training employees; today it received per capita grants for each employee.
- **Industry clusters:** Dell generally avoids existing industry clusters, preferring to locate production where labor markets are not as tight. For instance, it avoided industry clusters in Sao Paulo (Brazil) and Shenzhen (China). Its locations in Penang and Ireland were decided before those locations had developed into IT industry clusters. Most of Dell's operations do not rely on access to research universities and high concentrations of specialized engineering talent, so it can avoid the higher costs associated with such locations. It also does not need to be very close to suppliers' manufacturing facilities; rather it requires that suppliers simply ship to supply hubs close to Dell's assembly plants.

SOURCING

Unlike other PC makers, Dell has avoided outsourcing final assembly of its products. It outsources subassemblies, such as motherboards and bare-bones PCs, and outsources nearly complete assembly of notebook PCs, doing only limited final configuration in its own assembly plants. Also, in 2001, Dell outsourced production of a standard, non-configurable PC called the SmartStep to Taiwan's Mitac, which is manufacturing the product in its plants in China (Commercial Times, 2001). But in general, Dell prefers to keep control over the key final

assembly and configuration processes for the bulk of its products. One reason is a concern that by outsourcing its manufacturing completely, Dell might be creating its own competitors, as U.S. television makers did when they outsourced to Japanese suppliers. Also, unlike some of its major competitors (IBM, HP, Compaq), Dell's main business is PCs, and it feels it cannot afford to give up its capabilities in PC production (Louise O'Brien, 2001).

A network of suppliers and contract manufacturers supports each production facility. Sourcing decisions are made by worldwide procurement and product development in Austin with input from the regions. Most sourcing is global, which means that Dell sources major components for all locations from their headquarters. This allows Dell to consolidate its buying power and get better terms from suppliers.

While sourcing of materials for PCs (major components and systems) is done centrally, sourcing of consumables is local (box and shipping material, printing of keyboards, printing of manuals, etc.). The majority of sourcing is from low cost suppliers in Asia, but some sourcing is from local producers. For example, monitors for the EMEA region are purchased from Sony, Samsung and Acer, and shipped by sea from Asia, but monitors are also purchased locally from Phillips and Nokia. This might be due to product specifications, need for backup supply or price.

For major components, Dell looks for suppliers with global capabilities such as Intel, SCI, IBM, Samsung, Toshiba, Sony and Seagate. For each major component, it usually works with only a few suppliers, e.g., with Seagate, Maxtor, Western Digital and IBM for disk drives. Local suppliers in each region provide other parts.

Suppliers are required to maintain inventory near or in Dell plants to support Dell's build-to-order production. They can produce elsewhere and ship to supply hubs, or they can set up production nearby. For EMEA and the Americas, Asian suppliers increasingly do both. In some plants, components are actually kept in trucks backed up to shipping docks, and are pulled off as needed. Suppliers are required to maintain ownership of that inventory until it is actually pulled off the truck and onto the assembly line (Intel is the exception; its market power allows it to set its own terms, which require PC makers to take ownership as soon as the product leaves Intel's facilities).

Impacts of Dell's Location on Supplier/Partner Location

With so many different suppliers and partners involved, the location decisions of these companies naturally vary by company and location. Many parts and components are manufactured in Asia and shipped to distribution centers near Dell facilities. This is usually the case for hard disk drives, floppy drives, power supplies, CD-ROM drives, cables and connectors, and many add-on cards such as modems, sound cards and video cards. On the other hand, a larger share of motherboard production is located regionally. For instance, Solectron and SCI supply Dell's U.S. plants from their plants in Guadalajara, Mexico, and from plants in the U.S.

In Europe, Dell's Ireland plants are supplied from Asia and from local plants. Many of Dell's suppliers came to Ireland at Dell's insistence. After opening the first Limerick plant, Dell gave

Irish suppliers eight months to show they could meet Dell's demands. When local suppliers could not do so, Dell brought in outside suppliers (Kennedy, 2000a). The outsiders bought some Irish companies, consolidated others, and took over much of the supply industry. The companies that came in were global companies that were already serving the PC industry. They included, for example: Fullerton -- a Scottish company from Glenrothes that does work for Dell and for IBM in Raleigh, NC; Lightning Beech -- a U.S. company that supplies sheet metal; Trend Tec-- a company that does metal and plastics in the U.S. and serves Dell and Compaq; and APW, which bought two Irish companies and does chassis, plastics, and metal. In addition, contract manufacturers already in the UK or Ireland supply Dell: Jabil supplies Dell with PCBAs from Scotland, SMS from Wales, and SCI from Fermoy, Ireland (Kennedy, 2000a). One Irish supplier, Keytech, did make the grade. Keytech is located in Shannon near Dell's Limerick plants, and made cases, chassis and subassemblies (Kennedy, 2000a,b).²

For the Ireland plant, the breakdown of supplies by region is as follows:

Asia	65%
Europe	25%
US	10%

For some specific components and peripherals, the locations are as follows:

Monitors	Europe and Asia (Phillips, Nokia, Samsung, Sony, Acer)
PCBs	Asia, Scotland, and Eastern Europe (SCI, Celestica)
Drives	Asia, mainly Singapore (Seagate, Maxtor, Western Digital)
Printers	Europe (Barcelona)
Box builds	Asia and Eastern Europe (Hon Hai/Foxteq)
Chassis	Asia and Ireland (Hon Hai/Foxteq)

SCI (now owned by Sanmina) makes 90% of the motherboards used by Dell in Cork. However, a new deal with Hon Hai to supply motherboards globally may change that. Three different suppliers provide the chassis. The suppliers' truck, located on the inbound side of the plant, is the local warehouse, and the suppliers' people deliver chassis to the production cells as needed.

Overall, not much actual manufacturing is located very close to Dell's plants, except in Malaysia, and much of that was already there. But more components are produced regionally as suppliers and CMs organize their own production regionally. For instance, PCB assembly and box builds are done in Mexico and Europe as well as in Asia to supply much of Dell's demand in the U.S. and EMEA. It is hard to attribute any of this to Dell alone, as Compaq, Apple and Gateway are all in either Ireland or Scotland and in either Malaysia or Singapore, so CMs can supply multiple PC customers from one location. Dell's BTO model clearly does not require higher value components to move closer, nor do very low value components such as power supplies and keyboards need to move closer. It's the mid-level components such as box builds, motherboards and other PCB assemblies that seem to be moving closer to Dell's assembly plants. This is particularly the case for large, bulky items such as box builds (nearly complete systems) that would be expensive to ship by air to meet volatility in demand, and at the same

² While Key Tech was successful in surviving the initial shakeout, it is no longer a supplier to Dell. Key Tech indicated that it stopped bidding on Dell procurements because Dell kept driving down prices. Key Tech has focused on building higher value-added storage products that better fit its cost structure.

time are too expensive to risk holding in inventory. Although light in weight, motherboards tend to be assembled locally because the build-to-order model does not allow sufficient time for them to be assembled in Asia and then shipped. However, baseboards for PCB assemblies are manufactured in Asia and shipped in by air.

DELL'S OTHER OPERATIONS

Dell's other operations tend to follow the location of its production facilities, but they do not follow in a simple pattern, as each operation seems to have its own organizational logic and location considerations. This is illustrated by looking at a few of Dell's other operations: logistics, call centers, marketing and sales and data centers.

Logistics

Dell's organization of logistics in EMEA provides a good illustration of the general logic for logistics. All of Dell's inbound logistics for material needed in assembly of PCs are handled by suppliers who must have supply hubs or production facilities located within 30-minutes' travel time of the Limerick plants. Third parties operate some hubs for a number of suppliers.

On the outbound side, Dell has five distribution hubs in EMEA to take advantage of location close to major markets, transportation networks and logistics expertise. These distribution hubs are as follows in EMEA:

- Limerick for Ireland, Eastern Europe, Middle East and Africa (except South Africa);
- Liverpool for UK;
- Tillberg, Netherlands for middle Europe;
- Gottenberg, Sweden for Nordic countries; and
- Johannesburg for South Africa

A different logistics partner operates each hub. Similar outbound staging areas and arrangements with logistics partners exist in the Americas and Asia-Pacific.

Call Centers

Dell makes extensive use of call centers, both for sales and for technical support. Dell generally organizes its call centers around its major customer segments with different call centers for relationship and transaction customers. It tends to locate call centers regionally to optimize telecommunications and language considerations, but customers may at different times be routed to call centers in different locations. Regional call centers are located as shown below. The EMEA call centers illustrate the complexity within any one region.

- U.S.: Round Rock and Nashville. A new call center is planned in Fort Worth, Texas.
- EMEA: Limerick, Ireland; Bracknell and Bray, U.K. Relationship customers are handled through Bracknell, whereas HSB customers are handled through regional centers in Montpellier, France for France, Spain, Italy and the southern countries; Amsterdam for the middle and central countries; Copenhagen for the Nordic countries; and Bray, Ireland for the UK, Ireland and other English speaking countries. The Limerick call center specializes in

higher-level technical issues, and also operates as a backup call center when telecommunication problems occur or call volume is exceptionally high.

- Asia-Pacific: Bangalore, India.

Marketing, Sales and Support

Dell's marketing function is directed from global and regional headquarters with special messages targeted for the different country markets. However, the sales, service and support functions are located in the individual countries because these activities must be close to end customers. To compete for large contracts from corporate and public sector customers, Dell's direct sales force must be on the ground in each country in order to be aware of sales opportunities, interact with procurement personnel and negotiate through the competitive bidding process. Moreover, since many Dell contracts are large and Dell hopes to expand its business with every customer, the account executives assigned to each large customer must be within easy reach. Similarly, although telephone technical support is centralized in regional call centers, field service and support require location close to the customer. As a result, Dell has sales and service offices in 34 countries around the world, usually in a large urban area and with multiple offices in some countries.

IT and Data Centers

A network of data centers supports Dell's sales, manufacturing, logistics and other operations. The data centers are regionalized and have their own development as well as operations staffs. Global applications such as online sales tools, order management, and supply chain management generally are developed or first implemented in Austin. The regional data centers are then responsible for transferring these applications and adapting them to the local markets. Data centers are as follows:

- Americas IT and data center is in Austin/Round Rock
- The EMEA data center, located in Bracknell, England, is the Internet hub for Europe, including intranets, extranets and Internet. It was located there despite the fact that Limerick is Dell's production hub because Ireland did not have adequate telecommunications facilities for these functions whereas England did. There are also major data centers in Limerick serving the two production facilities and an administrative center, which includes finance, administration, tech support, customer service, and Dell online.
- Asia-Pacific data center and IT operations are in Singapore, which has the best telecommunications infrastructure in the region.

Dell's Service Partners

Rather than do everything itself, Dell has made extensive use of business partners to help serve its customers, especially as it has moved into producing servers and targeting the small and medium business market. Three functions - systems integration, service and repair, and consulting - all have to be located very close to the customer, as they involve direct contact with the customer. Dell partners with companies that can deliver these services globally - or at least regionally.

- System integration: Dell partners for procurements with integrators like Electronic Data Systems (EDS) who will install Dell servers and link them up with end user devices.
- Service and repair: Dell also partners with firms like IBM, Unisys, Wang and Banctec for field service and repair. While 90% of service incidents are handled by telephone in Dell's call centers, about 10% involve field calls, which Dell has outsourced to these partners. Their field service units are tied to Dell electronically, and get the orders for field service within an hour or two of a call coming in to Dell.
- Consulting: Dell partners with Arthur Andersen and Gen 3 in the U.S. to provide consulting services to companies that seek to emulate Dell's success with the direct model and Internet-based IT.

Reaction to Market Slowdown in 2001

Like all PC makers, Dell's sales were affected by the decline in PC demand that started in late 2000 and continued throughout 2001. Dell was the only PC maker to show any growth in sales in 2001, as it made major gains in market share, but it still saw much slower growth than the 30-50% annual gains it was used to. It also saw its margins reduced by the price war that it launched to gain market share.

In order to cut costs, Dell laid off about 5,000 workers, mostly in the Austin, Texas area. These included cuts in headquarters staff and some other functions. Smaller cuts of a few hundred employees were made in Tennessee. About 600 workers were laid off in Europe. The concentration of layoffs in the U.S. appears to be due to the focus on cutting corporate staff more than a shift of production or other activities away from the U.S.

CONCLUSIONS

Although Dell only entered the PC business in 1985, it has become a global company with global production networks spanning the three major world regions: Americas, EMEA and Asia-Pacific. These networks, which are complex and multi-level, are able to take advantage of capabilities that serve the entire PC industry. In many cases, the capabilities were first created by with the introduction of the IBM PC when IBM sourced parts and components globally in order to break into the PC market fast (Dedrick and Kraemer, 1998). The networks were subsequently expanded and enriched by both traditional computer makers such as IBM, Hewlett-Packard and DEC, and by newer PC companies such as Compaq, Gateway and Acer.

Broadly speaking, market potential is the driving force behind Dell's general location decisions, while costs and capabilities are the driving forces behind the specific location of Dell's activities. In other words, Dell targets markets that appear receptive to its business model. To serve those markets, Dell sources from locations that have the production capabilities and cost structure it needs to be competitive in the targeted markets.

The markets in which Dell operates vary by global region and by countries within these regions, and so Dell has organized its operations by region and by country. Headquarters offices, assembly production and call centers are centralized within each region (although not all in the same country), whereas sales, service and support are decentralized to individual countries.

Supply/logistics hubs are organized by sub-regions covering several countries. The choice of specific sites for production within a region is discussed below.

Dell's location decisions are not based upon any single factor, but rather upon an array of factors. The best way to understand how these factors come into play is to view them as multi-tiered. The first tier involves market considerations. These include the character and potential growth of prospective markets and country requirements for market access. For example, when Dell went into Europe, it went into the English speaking markets of Ireland, UK, and Sweden, which were similar to the U.S. in language and business culture, before venturing into the large German and French speaking markets. Likewise in Asia-Pacific, Dell concentrated on English-speaking markets such as Australia, Singapore and Malaysia first, followed by Japan, the second largest PC market in the world. Having built a regional infrastructure, it later entered China to gain access to its rapidly growing and potentially very large market.

Once a decision has been made to enter a market, then second tier considerations of labor and infrastructure come into play when deciding where to locate production activities. These are used to narrow location choices to several countries. The primary consideration with regard to labor is cost or wages, but skill levels, quality and availability also enter into decisions. Theoretically, the ultimate factor should be cost relative to productivity, and it appears that this is the case, as Dell has located facilities in places with a combination of low (but not the absolute lowest) cost and high quality workers. Infrastructure considerations include transportation, logistics expertise and telecommunications quality and cost.

At the third tier, factors such as government incentives come into play and affect the choice of one country, state, or even city, over another. Such incentives usually include land, facilities, export processing flexibility, and/or employee per capita grants.

Dell has a major impact on its supplier location decisions in three ways. First, Dell requires that suppliers locate material within a specified delivery time from its assembly plants. Asian suppliers (and U.S. suppliers producing in Asia, such as disk drive makers) maintain supply hubs near Dell assembly plants worldwide, where material is pulled as it is needed for production. Second, Dell requires that its suppliers continually reduce the price they are charging Dell; in exchange it agrees to reward these suppliers with larger orders and longer-term contracts. This requirement causes suppliers to continually seek lower wage production sites in order to meet price pressure from Dell (and other PC makers as well). Third, Dell requires that suppliers have adequate inventory to supply the needs of its direct, build-to-order production model. Demand is highly volatile, and consequently suppliers cannot meet Dell's fluctuating demand totally from Asia. Material must be produced regionally, so suppliers and contract manufacturers must also organize regionally. Thus, within the EMEA region, some Asian suppliers have built local manufacturing capability, initially close to production hubs in Ireland, Scotland and Wales but increasingly in lower cost sites in Eastern Europe.

Both the American CMs and Asian suppliers are moving to lower cost production sites: Eastern Europe for EMEA, Mexico for the Americas, and China for the Asia-Pacific region. It is said that they are often moving at the insistence of the computer makers. It is unclear whether Dell will follow its suppliers to low cost production sites or outsource final assembly to its contract

manufacturers. Dell has already gone to China, mainly for market access, but is now producing a line of non-configurable PCs in China for sale in other markets (including the U.S.).

Dell makes extensive use of outsourcing, but claims it will never outsource the final assembly of configure-to-order products. Dell insiders argue that execution of the build-to-order model is strategic to the company; therefore, final assembly/configuration for different markets and customers will not be outsourced. "Dell doesn't want to pass on the secrets of the direct model to subcontractors. Dell is bringing in more of the box with more stuff in it from suppliers, but keeps control of the complex and proprietary parts of the process. Dell's model is very good and very unique in the industry. The focus is on execution. There will always be boxes needed in the market. Dell doesn't have to move away from making boxes. It simply needs to keep focused on quality, price, and delivery" (Corkery, 2000). They further argue that Dell plants are major showcases that help sell large corporate customers on Dell as their supplier (Freake, 2000). They leave open the question of whether they will eventually move to lower cost sites for final assembly.

In summary, the organization of Dell's production network is changing. Whereas the network was previously located mainly in Asia, today it is increasingly being regionalized in order to better target markets with the direct model and to respond to rapid changes in markets. These regional production networks involve a combination of Asian suppliers and U.S. contract manufacturers. Regional suppliers are also playing a role. Sales and employment across world regions are generally in line with one another, with the Americas showing somewhat greater productivity. More than two-thirds of Dell's employees are in the Americas, and mainly the United States, where Dell continues to expand its operations through new plants and call centers. Dell maintains control over its value network by a new model of organization--the virtual organization--wherein Dell's ownership of the customer relationship gives it the power and leverage to coordinate the entire network.

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