An Exploratory Analysis of Competing Supply Chains in the Personal Computer Industry

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Major business trends in supply chain innovations are reviewed. Effects of acceleration principle (also called bullwhip effect) in a manufacturing business environment are explored. The success of three supply chain examples from the personal computer industry are examined with an objective to learn how well they have adapted innovative approaches and mitigated the effects of acceleration principle. The main focus is on Dell Computer, since by the year 2002, its direct-to-customer, build-to-order model had taken the lead in the industry, and was beginning to dominate the market. The analysis provides a brief history of the personal computer industry, and a definition of the narrow focus being examined in this work. The study also explores operations at Dell – its beginnings and a description of its current supply chain model - and then Gateway and the new Hewlett-Packard (HP) shown in comparison and contrast to Dell. A number of research questions arising from the study of three supply chains are addressed. Predictions are made for the future direction of each company (Gateway and HP) versus Dell in market.

The price of PCs is becoming dramatically cheaper because of global competition and advancements in information technologies. A weak economy and fewer sales have also forced computer companies to lower prices. Most firms have struggled in reducing product prices while providing greater level of customer satisfaction.

According to Langlois and Robertson (1995), open modular systems form the backbone of personal computer industry. The open modular product architecture allows customers to purchase standardized PC components from suppliers to be able to build clone products. This market tendency has generated intense price competition (Latour, Hanna, Miller and Pitts, 2002). For example, Dell has developed a business model of selling PCs directly to ultimate customers at reduced prices.

The study introduces readers to changing trends in supply chain innovations and the impact of acceleration principle on a manufacturing operation. It also reviews various supply chains in the personal computer manufacturing industry today that use innovative approaches and mitigate the impact of acceleration principle. The analysis focuses on identifying why Dell’s supply chain is superior, and how competitors (Gateway and Hewlett-Packard) have struggled to compete. Specifically, six questions will be addressed, which are: 1) How do the three firms differ in terms of supplier selection? 2) What are their supply bases and how do they rationalize their supply bases? 3) Where are their assembly facilities located? 4) What were their location criteria that led to their selection? 5) What is the “length” of the total supply chain, in terms of total number of nodes involved and

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order-to-fulfillment time? and 6) Where are the critical suppliers within the supply chain across the three firms?

This paper begins with major trends in supply chain innovations. It then examines the effects of acceleration principle in a manufacturing business environment. Next a brief history of the personal computer industry is presented, and a narrow focus being examined in this work is defined. This is followed by a look at Dell - its beginnings and a description of its current supply chain - and then Gateway and the new Hewlett-Packard shown in comparison and contrast to Dell. Each comparison section concludes with predictions for the future direction of the company versus Dell in market.

**MAJOR TRENDS IN SUPPLY CHAIN INNOVATIONS**

New supply chain initiatives inundated the marketplace in the past decade, starting with just-in-time inventory management to collaborative product commerce (see Table 1). Supply chain programs launched have been successful saving billions of dollars for a large number of companies though for some companies such programs failed to achieve optimal results. Successful supply chain initiatives can make it possible for companies to meet customer needs more quickly, less expensively and through more channels. Better quality and more reliable goods can reach the market sooner. Mass customized products and services can become a reality (Ertek and Griffin, 2002; Iyer and Bergen, 1997).

Essentially five major supply chain management innovations trends are currently taking shape (Poirier and Quinn, 2004):

1. The front end of the supply chain is becoming as important as the back end in maximizing total economic yield. Historically, supply chain management dealt largely with vendors, making companies focus on improving logistics or the back end of the supply chain. Demand now manifests itself in many more ways – through online marketplaces or partnerships – causing companies to increase their emphasis on the supply chain’s front end. As a result, front-end supply chain management – understanding and responding to customer needs – is becoming an inextricable part of supply chain strategy. Companies with front-end capabilities should be better able economically to make the market wants and sell what they have in stock, thus enhancing top-line and margin growth.

   - As companies migrate from internal-only to extended supply chains, collaboration is becoming the most strategic capability. Companies that manage their businesses the old fashioned way – by taking orders, buying supplies, building product and shipping it from the warehouse – may lose out to businesses that focus their energies on design, brand management, sales and marketing, and outsource the rest. Supply chains are becoming complex for any one entity to manage in a competitively dominant way.

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**Table 1**

<table>
<thead>
<tr>
<th>Year / Period</th>
<th>Initiatives</th>
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<tbody>
<tr>
<td>1992</td>
<td>Lean Manufacturing/Just-in-Time; Third Party Logistics; Quality Circles; Manufacturing Resource Planning II; Warehouse Management; Manufacturing Execution Systems</td>
</tr>
<tr>
<td>During 1993-1994</td>
<td>Supplier Integration; Manufacturing Outsourcing; Total Quality Management</td>
</tr>
<tr>
<td>During 1994-1995</td>
<td>Product Data Management</td>
</tr>
<tr>
<td>During 1995-1996</td>
<td>Integrated Product and Process Development; Advanced Planning and Scheduling</td>
</tr>
<tr>
<td>During 1996-1997</td>
<td>Enterprise Resource Planning</td>
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<tr>
<td>1997</td>
<td>Six Sigma</td>
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<tr>
<td>1998</td>
<td>Product Lifecycle Management</td>
</tr>
<tr>
<td>During 1998-1999</td>
<td>Integrated Supply Chain; Collaborative Planning</td>
</tr>
<tr>
<td>1999</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>During 1999-2000</td>
<td>eProcurement; eFulfillment</td>
</tr>
<tr>
<td>2000</td>
<td>Exchanges</td>
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<tr>
<td>2001</td>
<td>Collaborative Product Commerce</td>
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</tbody>
</table>
Leading companies are finding new ways to do business, perhaps through shared-profit arrangements in which suppliers benefit from their success. Companies can substitute new, variable cost outsourcing contracts for owned fixed assets such as trucks and warehouses, thus reducing capital on the books and using only the capacity that is needed rather than owning the excess.

• The greatest margin potential may occur after a product ships, as service and support become as important as the product itself. With more customers seeking solutions instead of specific products or brands, a growing number of goods are becoming commodities. Responding to this trend, supply chain winners are working harder to bundle great products with strong service offerings, thereby maximizing long-term customer profitability and catering to customers’ increased emphasis on total cost of ownership.

Customers increasingly are purchasing those products that are conduits for content or services that exceed the intrinsic value of the product itself (Dumond, 2000). Further, business customers are changing their focus from procuring a product based on its attributes alone to valuing the total service provided, such as maintenance and operational reliability. As a result, connecting product sales to the service network is becoming a prime value driver for many companies. Supply chain executives are needed to deliver not only the initial product, but also an ongoing stream of products and services to the consumer – often through different channels and even different locations. These changes have added complexity to most companies’ supply chain operations, but they also have become a major source of revenue and profit growth.

• The ability to integrate new and innovative capabilities with corporate business models is driving higher levels of value creation.

A company’s ability to adapt and change itself is becoming even more critical. Part of the reason is collaboration: Companies positioned to work efficiently with multiple partners are getting most of the action, while those that are difficult to work with are being ignored. Rapid and virtual partnering also is the key to new supply chain management strategies, as the best integrators work together to attain the biggest prizes.

INFLUENCING THE MANUFACTURING ENVIRONMENT

The following section describes the effects of acceleration principle on the manufacturing environment.

The Acceleration Principle

Jay Forester at MIT created a management training exercise in the 1950s called “The Beer Game” (Sherman, 1997). It is designed to simulate how product and information flow through multi-echelon supply chains. The result of this simulation is what has been called the “Forester’s Effect”, or the acceleration principle. Simply stated, a ten percent change in the rate of sale at the retail level can result in a forty percent change in demand for the manufacturer. The acceleration principle results in two side effects that are described next.

Lead Time and Inventory Reduction Syndromes

All business organizations involve two flows: material and information. The Beer Game only exposes the top layer of problems manufacturing firms face today with managing these flows. Functional silos within each company affect the flow of information and materials in the same manner, as multi companies do in the supply chain. Batch processing of information creates acceleration principle within the organization. Distorted demand data and delayed information become commonplace, creating several other conditions. The first is a reaction typical of purchasing personnel and production planners. This reaction is referred to as the “Lead Time (or Safety Stock) Syndrome”. This syndrome is illustrated in Figure 1. The effect continues to escalate and soon leads to the fatal mistake of increasing capacity based on this condition. This capacity increase is not without a corresponding cost increase.

Eventually the overload is relieved since increased capacity floods the supply chain causing the second effect from distorted demand data, “The Inventory Reduction Syndrome” as shown in Figure 2. This effect is the result of the organization addressing excess inventory created by the first syndrome. Without process change these two syndromes feed each
other in a continuous loop. Eventually, another silo is established in the organization specifically chartered to run promotions, targeted at reducing excess inventory with the hope of increasing market share. This action is equally as fatal as increasing capacity. The organization has now combined perpetual reductions in sales prices from the Inventory Reduction Syndrome with increasing production costs from the Lead Time Syndrome (Plossl, 1991).

In a growing market, the combination of these two effects is consumed by the growth in demand. Companies can survive and even flourish during this growth period, in spite of the oscillating cycle to focus on reducing inventory during one time period, then expedite product regardless of cost during the next period. When the market experiences a plateau or drops off at this time, the organization can spiral themselves right out of existence.

HISTORICAL NOTES ON PERSONAL COMPUTER INDUSTRY

Many disputes may arise over defining the beginning of when the first personal computer was either manufactured or put on the market for sale. It is beyond the scope of this article to attempt to settle that question. However, in order to proceed, it is necessary to choose a point of embarkation. For this work, the point chosen is the release of the IBM PC, in August of 1981, which became a watershed point that spurred rapid growth in the industry. The reason for this is the “open modular architecture” concept that IBM used in the construction of the PC. This refers to an open box ready for expansion, reconfiguration, and continual upgrading. The IBM PC was not technologically sophisticated though it incorporated most of the basic features users expected.

In PC industry, components chosen by the firms were not proprietary in nature, but rather were readily available from component suppliers. Up to that time, manufacturers had largely relied on their own internal research for the development of components used in computers. Since they were only making components for their own units, the quantities were limited, and corresponding piece-cost was high, resulting in a correspondingly high cost of finished goods. By sourcing components from suppliers who already made a quantity of parts, IBM was able to release a unit that was more affordable to the end user, and its popularity was immediate.

A corresponding result of the release of a successful product based on open architecture was that it became easier for upstarts in the industry to make PC “clones.” Because virtually every component could be purchased from existing suppliers, companies wishing to manufacture personal computers no longer had to make large investments in the research and development of the technology of the components, and no longer had to make large capital investments in manufacturing equipment required to produce those components. For comparatively low starting costs, a person could set up shop and begin making and selling his own personal computers that could run the same software used with the IBM PC.

Within just a few years, many new companies sprang into existence making PC clones. Three of those new companies came to surpass IBM in sales of personal computers (shown in Figures 3a and 3b), but the path they traveled was not always the same. Those three were Compaq (now part of Hewlett Packard), Gateway 2000, and Dell Computer.

HISTORICAL NOTES ON DELL

When it comes to supply chain management in the computer industry today, Dell Computer sets the standard. Dell is the largest PC Company in the world; over $31 billion in annual sales, and it is the most effective company at managing its supply chain. In order to appreciate what Dell has done in this industry, it is important to understand something about where things were prior to Dell’s existence (Information Technology Association of Canada, 2001-2003). Dell was founded in 1984, when Michael Dell hit on the idea of selling PC’s over the phone from his dorm room. The simple difference this entailed was not having a sales team, and not having a middleman or distributor to whom a share of the profits would go. Dell focused on cutting costs and delivering quickly, and sales soared. Within three years, Dell was offering next-day, on-site service for its products, and it made its first foray into international markets by opening a subsidiary in the United Kingdom. The company continued to strive to cut its gross margin. On the face of it, this seems counter-intuitive, since that step should decrease profits. But with no other
companies in the chain taking a cut, Dell could reduce its margins and under-price the competition while still making a profit, and therefore began to take sales away from them. During this time, large companies had infrastructures consisting of multiple enterprise resource planning (ERP) systems that could not communicate effectively amongst themselves or with external systems. They were slow and unable to respond proactively to business changes as they occurred. As PC manufacturing companies began to increase their outsourcing from outside suppliers, the need for visibility across the extended supply chain grew tremendously and the ERP structures of the large computer companies proved to be ineffective at delivering on that need. This supply chain communication problem persisted for many years. While costs slowly came down through focusing on reducing operating expenses, inefficiencies continued to exist from the communication challenges that resulted from the high level of outsourcing (Harrington, 2002).

During this time, Dell wasn’t much different from the rest. As late as 1994 it was considered a second-tier PC maker. This didn’t stop Michael Dell from making rash predictions about increasing Dell’s market share. In 1993 Dell held 41% of the market, and Michael Dell proclaimed that it would reach 18%. The company reached this mark in 1999, and continues to grow (Pletz, 2002). At this time Dell still faced the inefficiencies created from ordering component parts from its suppliers in advance and then building inventories for sales. Dell was at a disadvantage as the larger PC companies benefited from their size, i.e., lower fixed costs per unit. This forced Dell to completely reevaluate its supply chain. It needed to do something radically different if it was going to survive in the PC industry.

**DELL’S SUPPLY CHAIN MODEL**

This is when Dell began to introduce a new business model (Court, 1998). It converted its operations to a built-to-order process, eliminated its inventories through a just-in-time system, and sold its products directly to consumers as shown in Figure 4.

Dell attempted to develop a supply chain model that went beyond the pursuit of efficiency and asset productivity. It was attempting to displace the current model with one that made the supply chain more efficient and delivered more value to consumers (Copacino and Byrnes, 2002; Lawton and Michaels, 2001). As we all know, Dell was successful in this endeavor. It achieved a high level of success by making supply chain capabilities the core of its business model, which can be explained through these five key steps as shown in Figure 5 (Wasserman, 2002; Magretta, 2002; Copacino and Byrnes, 2002):

**Account Selection**

Dell started by establishing targeted accounts. It carefully defined both target accounts and accounts that did not fit with its supply chain strategy. Specifically, Dell targeted corporate relationship customers that had predictable, budgeted needs and that wanted a predetermined set of product models (Briody and Moskowitz, 2001). It also selected individual customers that were high-end, repeat purchasers with a preference for early technology adoption. Both account segments had the stable, predictable purchase patterns that
Dell needed to make its built-to-order system work.

In-Customer Operations

Dell determined that it was crucial to operate within its customers’ organizations. This requires powerful technical capabilities, deep customer knowledge, and the ability to fit into the customer’s organization and work processes. What ultimately differentiated it from the competition was its ability to blend into its customers’ day-to-day operations and culture. This unique customer knowledge has helped Dell create barriers to entry that others have not yet been able to penetrate.

An example of this is how Dell developed a set of effective customer-specific intranet Web sites. Each Web site is highly tailored to the customer’s individual station. Dell works with each customer to specify a particular set of product configurations that work best in the customer’s network. Tailored offerings are specific and developed for each customer (Bearden, 1999). At the same time, Dell uses its direct links with both corporate and individual customers to get immediate, real-time insights about uncovered customer needs and identifies new generations of products and services. This enables Dell to deliver reliable customer service and innovation at the same time! (McSpadden, 2001)

Channel Strategy

There are many different ways in which a company can approach strategy. Some move along the Porter line, pursuing either low cost of production or highly specialized products. Others pursue a “solutions” approach, integrating their business systems with those of their customers’, enabling them to “co-create” value and share in the gains (Kucharvy, 1997; Ojo, 2002). While others attempt to become the de-facto standard in the industry, effectively “owning” their link in the value chain. By developing its direct-to-consumer strategy, Dell created a channel that had never existed before (Burke, 2002). It combined its deep integration of its customers’ businesses with its unique position in this new direct-to-consumer channel as shown in Figure 6 p. 22.

By distinguishing a set of high-end customers that were ready for direct distribution and customer support from help lines, Dell became the only viable alternative for PC sales through its new channel (Fisher, 2002). As a result of this, Dell now has access to several crucial elements that help propel its business model (Teresko, 2001):

• Real-time customer feedback and market insights
• The ability to sell what they had, i.e., using day-to-day pricing and sales incentives to shift demand toward products that are currently marketable
• Crisp product life cycle transitions
• Elimination of the obsolete and excess dealer stock that plagues the non-direct competitors
• The ability to control pricing on a real-time basis

Core Operations Capabilities

Before a company can be great at anything, it must be good at many things. It is necessary for companies to develop a set of core capabilities they can leverage to accomplish truly outstanding things. Early in Dell’s rise to success, it developed a set of operations capabilities in five key areas:

1. It created the flawless make-to-order system mentioned before
2. It worked at length to build an effective supplier management function in order to shorten component lead times and maintain the absolute quality standards required by the just-in-time operation
3. It developed the system needed to be able to sell what it has that is needed to match consumer demand
4. It instituted an extraordinarily crisp set of product life cycle management capabilities that yield great cost reductions and strategic advantages
5. It worked with its suppliers to shorten their product life cycles, extending its business model to the whole channel

Figure 4
The Dell Model

Figure 5
Dell’s Five Steps Approach to Attain Supply Chain Excellence
Dell had to find a way to operate with no inventories in order to raise the cash needed to continue investing and developing this model. This required a complete change in management style and its success depended upon total commitment from the management team (McAfee, Glassman and Honeycutt, 2002). There were many issues that surfaced and most of them revolved around two philosophical changes to the old way of conducting business operations:

- **Built-to-order vs. Built-to-stock.** Integrated with direct-to-consumer, Dell introduced a way for consumers to decide what features they want in their computer before manufacturing of the product was complete. This way, products were never built for stock; rather, they were built for the individual consumer and never gathered dust as inventory. This significantly lowered financing costs and increased customer satisfaction for Dell’s chosen market segments (Economist, 2001a).

- **Configured-to-order vs. Built-to-forecast.** To manage its built-to-order system effectively, Dell pioneered the concept of configured-to-order (Bearden, 1999). It began using real-time information to make adjustments in the production cycle. Products were started based on what the market was saying it would need. In the past decisions about when and how much to produce had always been made using demand forecasting and planning. This was the answer the Just-in-time concept was looking for in this industry, but it was the most difficult for management to get comfortable with.

Due to the complexity of the built-to-forecast concept, it is necessary to break it down to effectively explain how it works (Harrison, 2002). There are four key points that must be understood:

1. **Demand is managed at the supplier level.** With no inventories to manage demand from, this model requires demand to be managed through capacity at the production facilities. Dell’s supply chain depends upon the number of PCs produced being equal to PC’s sold. Therefore, the supplier must know how many parts to produce and ship to the assembly line so that inventories will not be created.

2. **Demand forecasts determine capacity, not production.** For suppliers to be able to produce only the number of components needed for actual sales, they need to know in real-time what the demand is for their products. The traditional method of forecasting what demand will be and then producing that number of products is far too inefficient to be used in this type of supply chain. That is not to say, however, that there is no value in forecasting. Forecasting is used to determine the capacity of components needed so that supplies are available as demand calls for them. This allows suppliers to prepare for anticipated changes in demand by increasing capacity or selling a certain percent of their products through another channel.

3. **Operations are started based on expected rates of demand vs. manufacturing orders.** Under the conventional method, manufacturing orders are released to produce specific items due on specific dates. When this is for make-to-stock, where finished products are sent to inventory, this works just fine. However, when this is for a specific customer order, which is needed to satisfy customers in the PC industry, problems often arise (Souza, 2000):
   - Missing components delay the entire process
   - Changes in customer requests require changes in the timing of the entire process
   - Swapping of parts to satisfy orders complicates the entire process

Rate-based planning establishes a rate of demand for finished products and the component suppliers build and assemble to match that rate. By doing this, Dell has computers half made when customer orders are taken, and it can deliver the final product very quickly: The average amount of time a customer has to wait for a Dell PC is only 5 days (McSpadden, 2001).

4. **Rates are determined through real-time demand information.** This method of production is extremely risky. If rates are not accurately estimated, Dell could find itself short of needed inventories or full of unneeded supplies. To ensure that rate planning is done effectively, Dell relies on real-time demand information and communicates that back through the supply chain. Every two hours new information is passed through the system that can alter the manufacturing schedule, as needed, to adapt to changes in demand.
To accomplish this complicated real-time demand information, Dell’s Texas factory takes six to eight hours to make a computer from its inception to the finished good. Dell compares all of its six factories (Texas, Tennessee, Brazil, Malaysia, Ireland, and China) performance with an index which determines production efficiency and payment by the hour in each of these factories (Holmberg, 2000). For instance, a notebook computer goes through fifty-seven nodes in Dell’s factories where time spent in each node is closely monitored (Nikkel, 2004).

Many firms through effective supply chain management are able to reduce inventory and lead time. However, in a Dell’s supply chain another important factor is also controlled. It is called “demand shaping”. Typically, with higher product demand, the price goes up. In the event of increased demand for a computer model causing strain in supply chain, Dell responds by reducing the price of different model in the same product line. Consequently, a customer who wished to purchase specific computer model changes its intention and decides to buy different computer model in the same product family. In this way Dell manages to prevent product shortage and shows how Dell is able to control prices of its product lines (Nikkel, 2004).

DELL’S Suppliers

Although Dell has excellent internal management, it also maintains closer cooperation with its suppliers. Dell’s approach to global supplier management is built around four key areas:

1. Corporate philosophy based on global responsibilities to their stakeholders;
2. Company’s obligation to supporting environment, human rights, employees' health and safety;
3. High ethical standards expected from its suppliers who are to ensure their employees’ rights, safety and environment; and
4. Dell’s global supplier management program closely tied to market demand which supports number of core requirements such as certification and standards, training and communication, review and compliance, correction and enforcement. (Supplier Selection and Management Report, 2002).

Technology greatly enables mass customization for Dell. For instance, Dell has completely automated its ability to take thousands of orders, translate them into millions of component requirements, and work directly with its suppliers to build and deliver products to meet individual customer requirements. In fact, more than 90 percent of Dell’s component purchases now are handled online. Suppliers use an Internet portal to view Dell’s requirements and changes to forecasts based on marketplace activity, and to confirm their ability to meet Dell’s delivery requirements. Then, as Dell factories receive orders and schedule assembly, a “pull” signal to the supplier triggers the shipment of only the materials required to build current orders. Dell also provides its customers with accurate delivery dates. Flexible and cost-efficient supply chains begin with improvements to supply-management processes. This, in turn, starts with consolidating suppliers. Dell consolidated its supply base, investing heavily in the R&D and make-to-order manufacturing capability of a select group of suppliers. It then implemented a demand-fulfillment system that allows it to schedule assembly operations with real-time order data, and to pull components from supplier hubs to meet assembly needs with only a two-hour lead time. Although private exchanges are visible in every industry, Dell has been particularly successful, because of its acute need for connectivity and demand propagation through a vertically disintegrated supply chain. A private exchange is a technology-based network that enables a company to electronically synchronize its supply chain with those of its strategic trading partners to buy, sell, and move goods more efficiently. Dell has created a fully functional, online trading community, where it and its key suppliers meet to transact business; and where $16 billion in transactions move annually. Two levels of collaboration actually are involved in the Dell exchange. One involves the suppliers that schedule Dell’s inbound materials. In this context, Dell sends suppliers a mandatory delivery schedule, and then closely manages that schedule. The second exchange is between Dell and its suppliers’ third-party warehouses (Fugate and Mentzer, 2004).

The analysis above shows Dell’s direct-to-consumer supply chain design provides safeguards to inhibit acceleration principle. The two side effects of this principle (that is, Lead time and Inventory reduction syndromes) that are caused by distorted demand data and delayed information across the value chain do not occur.

HISTORICAL NOTES ON GATEWAY

Having closely examined Dell, its history and its supply chain, we turn first to looking at a company that perhaps may have started out looking the most similar to Dell of all the PC manufacturers, but ended taking a very different path. That company is Gateway, Inc.

Gateway began its existence as the Texas Instruments Personal Computers Network in a barn near the Iowa/South Dakota border in 1985, with founder Ted Waitt, another college dropout like Michael Dell, selling add-on parts by phone for Texas Instruments’ computers. In 1987, he and his friends built and sold their first fully configured computer system at a price that matched what other companies charged for a bare-bones personal computer. Sales began to take off and they changed the name to Gateway 2000.

Through a creative use of advertising, catalog placement, and phone sales, Gateway quickly established itself as a successful new supplier in the personal computer industry. It bore a similarity to Dell as a low-cost direct-to-customer manufacturer, but this characteristic was not sufficient to put Gateway into a
class with Dell. Strategic decisions regarding Gateway’s direction kept it as a smaller provider.

A primary difference between the two relates to the target customer base. Dell went aggressively after corporate sales (only 20% of its current sales come from consumers rather than corporations). Gateway focused more on the consumer, rather than business-to-business sales. And though it was successful in this market, providing good value and excellent customer service, it found that the potential volumes in the B2B market were simply far greater than the consumer market. By the time Gateway realized this fact it was a latecomer. It had established itself as a consumer brand with its Holstein patterned black and white boxes. This consumer focus actually hampered its entry into the corporate world. The reverse is not true for Dell, as Dell is now beginning to take market share in the consumer market (Chambliss, 2002; Shah and Serant, 2002).

Gateway went both public and international in 1993, as it opened a manufacturing facility in Ireland, followed by retail showrooms in England in 1994, and an 80% acquisition of the largest Australian computer maker in 1995. Further expansion entailed its own Internet service, online software, and peripheral store. 1997 marked another diverging of paths for Dell and Gateway. Gateway rejected a takeover offer from Compaq that year, in the amount of $7 billion. This was the year that Dell launched dell.com, its goal to sell PC’s through the web site. This would be a huge boom for Dell, and now accounts for 50% of its $31 billion in revenue (Shah and Serant, 2002). At the same time, Gateway launched its Gateway Country stores. These were not traditional retail stores, but were rather designed for consumers to visit the store to try out different types of computers and configurations, and then to place their order for delivery to their home. The unfortunate realities of these stores, is this they require overhead and salespeople to staff them, along with on-site equipment, which is subject to deterioration.

Gateway continued to increase its revenue until the year 2001, which may prove to be an extremely critical year for the company. The entire personal computer market experienced a downturn for the first time in its history, and Gateway was hit particularly hard, with a drop in revenue of more than 30% (Swartz, 2002). The company decided to close all of its international operations, pulling out of Europe (Client Server News, 2001) and Asia (Asia Pulse, 2001) completely. They are, in effect, giving up on international competition. However, in 2002 PC vendors with strong indirect channels exceeded the sales growth trend in Europe, the Middle East, and Africa as this region recorded modest growth (Fliniders, 2002). Even though the U.S. market is in recession, Asia continues to be one of the few bright spots for the computer industry. Dell is growing much faster in Asia than its competitors (Pietz, 2001).

According to Ted Waitt, founding CEO of Gateway, their model is the same as Dell’s model, including using expertise of the same consulting firm that had worked with Dell in earlier years. This retrenchment includes a boosting of effort in the more than 270 Gateway Country stores, with more cash-and-carry options being offered to customers. The company ended 2001 with over $1 billion in cash and marketable securities, which served to sustain it as it sought to compete once again with Dell domestically. The strategy focused now on selling PC’s that would lead customers to purchase additional services, such as setting up a home network. They all but declared in the spring of 2002 that they would match Dell on price, but backed away from that after a couple of months (Mainelli, 2002).

**GATEWAY’S SUPPLY CHAIN MODEL**

Gateway may be on the ropes if they do not turn things around in the next year or two. They are following Dell’s model by continuing to assemble themselves, with manufacturing now being limited to their North Sioux City facility in South Dakota, and their Hampton, Virginia, plant. Their sales occur through the web (with customized extra-net sites being offered similar to Dell’s), through the phone, and through its Gateway Country stores (both as orders and as cash-and-carry). The supply chain for Gateway Computers is shown in Figure 7.

Gateway will continue to rely on these stores as a focus of its efforts. They hope to bring customers in by offering innovative products at good prices, but whether it is enough is yet to be seen (Mainelli, 2002). In the meantime, they are looking into a means of generating revenue from the computers on display in its stores through a concept called “grid computing.” The principle is to link all the machines together and use the combined processing power as one would use a supercomputer for number crunching. Corporate customers could then purchase access to this power. Other companies are experimenting with this concept, which resembles selling computing power as a utility, on a time basis. Innovative ideas such as these, which can generate revenue from otherwise idle and depreciating resources, will be necessary for the survival of the company (Musgrove, 2002).

**GATEWAY’S Suppliers**

Gateway’s goal is “reducing its procurement and manufacturing cost, monitoring supplier much more closely, and create a mechanism to shorten response time among all constituents of its supply chain” (Ojo, 2003). Gateway has eight key suppliers, among them include: Western Digital, Microsoft, and Intel (Carbone, 1996).

Compared to Dell, Gateway’s fulfillment time is longer. It takes six days. It may be due to geographical and infrastructure factors which Gateway has disadvantage over with other companies. The key to the success is for Gateway to absolutely finding out potential suppliers and how they make a partnership earlier than other competitors with fulfillment of its direct business model. Gateway
requires a high volume of quality products and components for their PC and Consumer Electronics / non-PC offerings, substantially all of which it obtains from outside suppliers. In some circumstances, Gateway maintains single-source supplier relationships, such as with Microsoft for operating system products and Intel for PC microprocessors. If the supply of a key material product or component is delayed or curtailed, Gateway’s ability to ship the related product or service in desired quantities and in a timely and cost-effective manner could be adversely affected. Gateway seeks to mitigate a portion of these risks by maintaining insurance to protect themselves against loss of profits due to a supplier’s inability to perform due to an insurable property loss. In addition, they seek to mitigate such risks by having dual sources of supply where appropriate and by using reputable and reliable suppliers. However, even where multiple suppliers are available, certain key components are at times subject to industry-wide availability and pricing pressures. In cases where Gateway needs to switch to another supplier and alternative sources of supply are available, qualification of the sources and establishment of reliable supplies could result in delays and possible reduction in net sales.

Gateway has been increasingly dependent upon third-party providers of products and services. During 2003, Gateway outsourced a substantial portion of its manufacturing operations, service and support operations together with the implementation of new IT systems and a number of administrative services to third-party providers under contract (Olenick, 2003). While such outsourcing arrangements, including the outsourcing of a substantial portion of manufacturing, may lower the fixed cost of operations, they also reduce Gateway’s direct control over production and distribution. In many instances, Gateway relies on offshore suppliers, particularly from Asia, for product assembly and manufacturing, and risks associated with transportation and other natural or human factors may disrupt the flow of product. Gateway’s supply chain is similar in many respects to Dell’s especially as it relates to configure to order. It is more vulnerable to outsourcing which is a significant part of its manufacturing operations unlike Dell. Acceleration principle is largely minimized in Gateway’s supply chain though lead time is longer compared to Dell.

HISTORICAL NOTES ON HEWLETT-PACKARD (HP)

Hewlett Packard is a leading global provider of computing and imaging solutions and services (www.hp.com). Its mission is to make technology and its benefits accessible to everyone around the world. In early 2002, HP completed its acquisition of Compaq, making it the largest PC manufacturer in the world at the time; Dell for the past two years has surpassed HP in total global market share - the figures at the end of first quarter of 2004 are shown in Table 2 p 26.

HP now finds itself struggling to keep pace with Dell, and given its worldwide position in the PC market, it has a lot to lose (Economist, 2001b; Economist, 2001c). In an effort to remain competitive and protect its market position, HP is also making significant efforts to take costs out of its supply chain while maintaining or improving customer service (Vijayan, 2002). In some ways HP is trying to mimic or outdo Dell. In other ways HP is trying to do things differently than Dell (Lohr, 2002). To isolate these differences, we will look at HP’s supply chain in two ways: the Back End and the Front End. By Back End we mean all steps in the supply chain from component production until computer assembly and by Front End we mean from the sale to the customer to delivery.

HP SUPPLY CHAIN MODEL

This section reviews both the back end and the front end of HP’s supply chain prior to looking at its total supply chain.

HP Back End Supply Chain

On the back end HP appears to be conceding that Dell’s model is the way to go. HP is making investments to develop the kind of infrastructure that Dell has. It is converting to a build-to-forecast system, using technology to communicate needed production throughout its chain (Canadian Corporate News, 2001). It is having trouble, however, as the Compaq acquisition is slowing the process considerably (Park, 2001; Silverman, 1998). Instead of focusing 100% on reengineering its supply chain, it has had to focus on integrating the two companies. This is a very complex process as issues such as asset rationalization, personnel positioning and cultural integration have had to be dealt with. It will be a while before HP can get the majority of its production to the level of efficiency
Dell is today, and once it does, Dell will be even farther ahead as it continues to become more efficient.

**HP Front End Supply Chain**

While HP is essentially trying to mirror what Dell does on the back end, it is pursuing a very different strategy on the front end. Specifically, HP is focused on selling through resellers vs. only direct-to-consumer. Prior to being acquired by HP, Compaq had established itself as the number one PC sold via retail channels (Silverman, 1998). It had established a broad network of relationships and outlets worldwide. HP is trying to maximize the value of the network that Compaq built. Instead of focusing only on selling direct-to-consumers, which it is still trying to do with part of its sales, it has set up extranet sites for its resellers to be able to order HP PC’s and other products in the same way that consumers do. By doing this, HP is passing the inventory management burden on to the reseller, whom HP believes is better equipped to do so since the resellers are closer to the end users. In short, this makes resellers much like a corporate customer, ordering online and enabling HP to sell direct without having to create any inventories (Cirillo, 2002; Davis, 1998; Lee, Billington and Carter, 1993; Lee and Billington, 1995).

The criticism of this strategy is that there are costs added to the entire supply chain by having the retail link: the retailer needs its margin and the consumer is forced to pay more than if he/she were to buy direct. HP believes this will be offset by the services offered by the reseller. If the reseller wants to move product in large volume, it will have to remain aggressive on product prices and it will more than likely have to earn its margins by selling services. To assist in its overall success, HP has strategically chosen which resellers it works with. It wants to be sure that resellers representing HP brands have the capacity to deliver services that consumers are looking for. If not, product won’t move and HP would risk developing a poor image. HP has now larger economy of scale since it acquired Compaq. It has same capability as Dell to configure to specification and deliver its product in five days. Although HP and Compaq acquisition has done better than most people has expected, HP’s greatest challenge still remains to be in improving its supply chains, not leveraging its size (Gifford, 2004). One of the examples would be figuring out how HP is eliminating redundancies in its supply chain, customer relationship management, and logistics in local area. HP has created an integrated supply chain model with five major business building blocks. This model is shown in Figure 8 below (Asia Computer Weekly, 2003).

The HP supply chain shown in Figure 8 consists of following critical business elements:

**No or low touch contract manufacturing** - delivers goods directly from the manufacturer to customers, with no intervention from the distribution channel.

**Vertically integrated, high volume supply chain** - requires only minor localization in certain regions. For example, a printer may need a locally appropriate power cord to be added from suppliers to the configuration before shipment (Van Hoek, Commandeur and Vos, 1998).

**Direct configure-to-order** - allows organizations to accept sales orders directly from customers, creating the product to meet the customer’s specifications as it is assembled.

**Value added system solution** - supports complex, highly configurable products - the types of goods that businesses expect to have configured expressly for their needs, such as infrastructure solutions, servers, and high-end printer products.

**Service logistics** - provides spare parts for service organizations; they require an understanding of the demand for parts and their stocking requirements, such as location and frequency (HP’s Annual Report).

<table>
<thead>
<tr>
<th></th>
<th>Global Sales</th>
<th>US Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell</td>
<td>18.60%</td>
<td>33.50%</td>
</tr>
<tr>
<td>HP</td>
<td>15.60%</td>
<td>18.60%</td>
</tr>
</tbody>
</table>

**Table 2**

**Global and US market share – Dell versus HP**

(Daoud, Loverde, Promisel and Kay, September 2004)

**Figure 8**

HP Supply Chain

[Diagram showing HP Supply Chain with various components and relationships labeled: Vertically integrated, high volume supply chain, Configure-to-order, No or Low Touch Contract Manufacturing, Retail Store, Internet, Customers, System Solution, Service Logistics, Manufacturing, and Company Overview.]

HP'S Suppliers

In order to cut its costs, it is crucial for HP to create a strong long-term relationship with its suppliers. Such relationship with fewer suppliers creates greater purchasing efficiency; nevertheless, working with more than one supplier per component area can enhance competitive pricing and with scale comes influence (Crista Souza, 2003). Furthermore, in order to maintain a long-term relationship, HP looks at its suppliers from six perspectives: price, quality, security, service, capacity and technology. HP spends a large amount, an average (based on past 3 years) of $43 billion per year on production materials. It therefore wants to make sure it is getting the best price, the highest quality and the best support possible from suppliers. Over the last three years, the company has launched initiatives to exercise greater control of its spend, consolidate its purchases where possible and develop emerging sources of supply in China, Eastern Europe and India. Its business units usually have different supply requirements. The company believes it has found a way to satisfy all of its business units’ supply and procurement requirements while still reducing cost and taking advantage of emerging markets. Having revamped its approach to supplier management since its 2001 merger with Compaq Computer Corporation, HP has centralized purchasing of key commodities, such as, microprocessors, memory ICs and disk drives that are used by many of HP’s four business units to leverage its spend with suppliers. For commodities that are unique to business units, such as chassis and power cords, it has a decentralized approach. To support both corporate purchasing and purchasing at business units, HP has its Global Procurement Services group, which serves as an international procurement organization and a buying arm for the company. HP uses its Purchasing Council to help develop purchasing strategies used throughout the company. It also has core teams which work in new product development and commodity teams which manage parts purchased for multiple HP business units. Reliance on suppliers for technology development is one reason HP has centralized its purchasing with a small group of suppliers. 80-85% of HP’s production spend is with just 35 suppliers. Another way HP has reduced cost from suppliers is through its Absolute Best Cost (ABC) process. With ABC the company identifies what is the best cost it can find for a part. The company determines what are the feature sets it may want to add to the part, what are the costs for the features and if the customer will pay for them. HP also does risk assessment on parts. The company then agrees to a price ceiling in return for a volume commitment to the supplier. Another way HP has helped control cost is through e-sourcing. The company does electronic requests for quotations (RFQs) and private offers. A private offer is a form of an electronic RFQ, but it is sent to an individual supplier. No data on RFQs is shared among the suppliers. The company also does reverse auctions with some suppliers.

Reducing the cost of purchased goods, either through consolidating purchases or using e-commerce tools is important to HP because 70% of HP's revenue is used to buy parts for production. Any savings in material goes to HP's bottom line. That is one reason why HP keeps control of its strategic purchases of components used by its electronics manufacturing services (EMS) and original design manufacturing (ODM) providers. Like most OEMs, HP outsources much of its manufacturing to reduce its total cost and uses EMS providers and ODMs in various ways to support its different business models. In each of these models, HP maintains control of sourcing for strategic components such as DRAMs, drives and software. For such parts, HP corporate purchasing negotiates contracts with suppliers. HP’s Global Procurement Services (GPS) buys the parts and sells them to the company's manufacturing partners in what HP calls its buy/sell process. Parts are sold to the EMS provider at a higher price than what HP paid to the supplier. The analysis of HP's supply chain indicates many similarities and differences between HP and Dell's supply chains. The company is working to eliminate inefficiencies in its supply chain. However, when it comes to acceleration principle and its side effects - lead time and inventory reduction syndromes; HP has been managing its supply chain very effectively through proactive management of information and material flow with all its trading partners.

GLOBAL COMPETITION

When we look at the PC global landscape, it is clear that the battle is between Dell and HP. Figure 9 shows both Dell and HP have global coverage, however, due to the breadth and complexity of HP's product mix, it has far more manufacturing presence worldwide.

At 18.6 and 15.6% of the global market, respectively, these two sit far ahead of the rest of the pack. Prior to hypothesizing about which strategy we think will win, we wanted to make some comments about the industry at large. Specifically, we wanted to identify where the industry is headed and what the key success factors are today. We do this through four main points:

1. Maturity in the industry. The PC has gone through many metamorphoses. Its evolution has taken it from being the size of a bedroom, to a desktop utility, to a portable brain trust that can be used all over the world; increasing its speed and capacity the entire time. During this period there have been significant R&D investments in the design of the PC itself, making it more desirable for the consumer. That evolution, however, appears to be reaching its end (see the “S” curve chart shown in Figure 10) (Roberts and Wenyun, 2003; Christensen, 1997). Now, there isn’t much that differentiates one PC from...
another. Consumers are able to get virtually the same product from any PC manufacturing company. Software and processors are proprietary to third party companies and can be found in just about any PC. The difference, then, comes down to two things: Price and Service.

2. R&D is going towards supply chain improvements. As a reaction to the maturity of the industry, PC manufacturing companies have invested nearly their entire R&D, with the exception of a few (e.g. Apple), on improving the cost and efficiency of their supply chains. Since they are competing mainly on price and service, lowering the price is their goal. While providing service is typically a labor cost, supply chain efficiency is the only place for R&D to go. That leaves the software and microprocessor companies (e.g. Microsoft & Intel) to invest in products that will entice consumers based on their product attributes.

3. The battle is being fought at the retailer vs. direct-to-consumer level. Direct-to-consumer evolved as a way to lower supply chain costs and get to the consumer at the cheapest price possible. Its evolution has included faster product delivery, better customer service, and its benefits/competitive advantages are obvious. Nevertheless, there are still issues about that model that some consumers don’t like. Some want to physically visit with a sales person to discuss their various options. In addition, some prefer to have somewhere to go when there are problems post-purchase. In many cases, the direct-to-consumer model only offers a help line, and that doesn’t work for all consumers. There is value in having a retail outlet for some people, hence the ongoing competition between retailers and direct-to-consumer companies.

4. Most of the diversified PC makers are losing focus on the PC. As PC competition has revolved around price and service, margins have come down and the industry has become far less attractive. As a result, the PC companies that have established businesses in other areas have chosen to invest where they can realize a better financial return. Since the emergence of Dell, many found themselves at a competitive disadvantage. Investing to become more competitive simply didn’t seem like a good investment, especially where there were other markets in which they could realize significant profits. IBM, for example, has let its PC market share slide significantly over the last five years. Instead, it has invested in service businesses and other technology (Popovich, 2002). Now we are left with two world powers while the others struggle. The significant drop in sales from Gateway evidences this. What we have left is the comparison of Dell and HP. Since service is mainly outsourced through resellers, these two can’t avoid competing on price.

To determine which is better positioned for this, we looked at a variety of ratios that spoke to each company’s overall efficiency (see financial ratios for 2003 in Table 3).

Aside from Gross margin percent, Dell is beating HP on every front. With price such a key issue, Dell clearly has the advantage today. This leaves two options for HP if it wants to compete with Dell long-term in the PC industry: 1) Make investments in...
its supply chain to be able to compete on price, or 2) Develop such a strong position through service via resellers that customers prefer this channel for purchasing (Park and Burrows, 2001).

CONCLUSION

The analysis presents major business trends in supply chain innovations including detailed description of the supply chain models that have been implemented by the three major PC manufacturers – Dell, HP and Gateway. It describes how their innovative business practices have helped mitigate the impact of acceleration principle and also associated side effects – lead time and inventory reduction syndromes. Specifically, the supply chain strategies used by all three PC manufacturers to minimize the acceleration principle include: managing inventory investment in the value chain; establishing supplier relationships; increasing customer responsiveness; building a competitive advantage for the channel; and introducing enabling information technologies. The research study also explores answers to a number of questions which formed the basis of the study.

It may be viable to assume that in the end this battle will be won and lost over price, and HP must improve its supply chain if it wishes to compete. While service is an issue, we believe that over time consumers will become more comfortable with the help line and as the processors and software improves, there will be less problems for consumers to worry about. Given Dell’s position, we think the battle HP is up against will be too big for it to win. Our assessment: Dell will win the war and HP, if it continues to produce PC’s, will eventually become a niche player in that market.

Table 3
Dell versus HP Financial Ratios Comparison (Annual Reports, 2003)

<table>
<thead>
<tr>
<th>Ratios</th>
<th>Dell</th>
<th>HP</th>
<th>Gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net income as a % of sales</td>
<td>6.00%</td>
<td>4.31%</td>
<td>-15.13%</td>
</tr>
<tr>
<td>Asset utilization</td>
<td>2.29</td>
<td>0.79</td>
<td>1.68</td>
</tr>
<tr>
<td>Return on assets</td>
<td>13.72%</td>
<td>3.98%</td>
<td>-22.50%</td>
</tr>
<tr>
<td>Gross margin as a % of sales</td>
<td>17.93%</td>
<td>4.91%</td>
<td>13.62%</td>
</tr>
<tr>
<td>SG &amp; A as a % of sales</td>
<td>8.61%</td>
<td>18.68%</td>
<td>28.63%</td>
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<tr>
<td>R&amp;D as a % of sales</td>
<td>1.29%</td>
<td>6.20%</td>
<td>N/A</td>
</tr>
<tr>
<td>Operating margin as a % of sales (before tax)</td>
<td>8.00%</td>
<td>4.90%</td>
<td>-15.01%</td>
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<tr>
<td>Fixed asset efficiency (sales/average PPE)</td>
<td>40.72</td>
<td>1.72</td>
<td>7.4</td>
</tr>
<tr>
<td>Inventory efficiency (cost of sales/average inventory)</td>
<td>99.5</td>
<td>11.83</td>
<td>28.97</td>
</tr>
<tr>
<td>Receivable efficiency (sales/average receivables)</td>
<td>14.58</td>
<td>6.78</td>
<td>16.69</td>
</tr>
<tr>
<td>Gross margin ROI (achieved gross margin/average inventory invested)</td>
<td>2174.32%</td>
<td>320.76%</td>
<td>456.94%</td>
</tr>
</tbody>
</table>
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Dell Computers Website, Available: http://www.dell.com


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