keynote

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The Internet-Enabled Supply Chain: From the "First Click" to the "Last Mile"

How is the supply chain changing amidst the evolution of the information age – or, rather, the revolution in the new economy? The Web offers the supply chain enormous potential and entirely new methods for streamlined coordination between business partners, including third- and fourth-party providers. Companies that want to succeed in the new economy need to enhance communications with their partners and providers. The coming years will see an explosion in e-commerce – with a concomitant need for solutions to satisfy ever more demanding customers.

Supply chains in practically every industry are at the beginning of a startling reinvention triggered by the rise of the Internet. The revolution extends beyond performance improvements and efficiencies gained from automation and communication to include entirely new opportunities to create value. This new value is derived from synchronized supply chains that can reach out to a bigger market, perform mass customization to tailor product and services to meet the individual customers' needs and develop new products and services that adapt to the competitive and environmental needs. The Internet changes the way in which supply chains are managed, planned and controlled. The information, decisions and processes that form supply chain management are moving to the Web, breaking old paradigms of inter-company boundaries. This common ground will be where entire supply chains truly can be synchronized. New upstart specialist providers of both virtual and physical activities will carve out their own unique roles in the new infrastructure. In this churning environment, supply chain capabilities will be crucial. But gaining those vital competitive capabilities will not be through the typical supply chain initiatives of today.

Put simply, the Internet enhances supply chain performance and supply chain is crucial to e-commerce. As the supply chain evolves in the information age, the Web's capability to support tight coordination between business partners means that all the information, transactions, and decisions that are the essence of synchronized supply chains will flow through the Web. Using the Internet to connect the systems of supply chain partners will become the medium through which the essential processes of managing and synchronizing supply chains are carried out. As it does so, it will change the nature of supply chain businesses completely. A company that misses this distinction is in grave danger. It may find itself celebrating the squeezing of supplier margins at auction or the reduction in inbound inventory by sharing forecasts while its competitor builds a tightly linked alliance that shuts it out of the channel to the market completely.

Why is this radical change so certain? It is not that the technology is "cool," nor even that there are efficiencies to be gained. At the heart of the matter are customers' ever increasing demands. Customers – whether they are business customers or individual consumers – are looking beyond cost as the sole arbiter of value. They are demanding innovation and personalization of not only the products but of the associated service and delivery. The increased variety and velocity of business increases the complexity of the supply chain issues exponentially and yet at the same time requires even greater flexibility. The competitive power in this environment will lie with a network of business partners who each bring the specific capabilities to bear. But the supply chain activities of these partners must be tightly synchronized with the demands of the market place. That level of coordination requires not only the ability to communicate but also the capability to manage the complexity and immediacy of synchronization.

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More extensive biographies of the authors appear at the completion of this white paper.

Supply chains in all industries are encountering new requirements for competition in the e-business environment, characterized by mass customization, massive scalability, faster and more flexible fulfillment and the ability to develop new channels that attract and serve larger customer bases. Traditional supply chain initiatives alone – such as strategic sourcing, contract manufacturing and joint product development – do not sufficiently prepare organizations for eBusiness competition.

How will the Internet-enabled supply chain be different from the traditional supply chain? Many crucial management decisions and processes will take place on the common ground of the Internet rather than within the physical and technical boundaries of a single company. The exact form, role and indeed name of this common ground will vary widely to suit circumstances. A new electronic supply chain information exchange will encompass hubs, auctions and exchanges containing a wealth of not only information but value to customers and suppliers alike. We believe there are four key areas that distinguish the new Internet-enabled supply chain from the traditional supply chain. The first three areas relate to major management processes shifting to or leveraging the Internet. The last area concerns upgrading the performance of physical processes to match the speed and virtual capabilities of the new supply chain.


Web-Based Entrants are Making Synchronization and the Associated Benefits Achievable
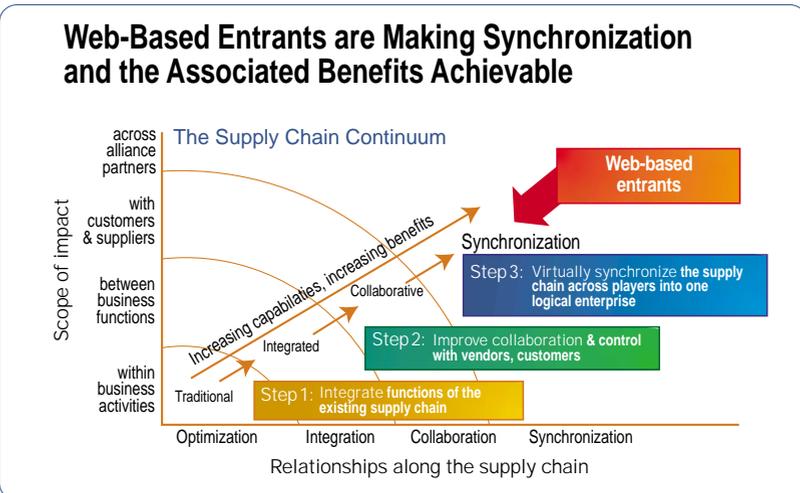
Figure 1.0 | Web-based entrants are making synchronization and the associated benefits achievable.

eDesign – Product Innovation on the Web

Product technologies are evolving more rapidly than ever, placing substantial pressure on a company's ability to consistently release new innovative products. Traditionally, companies have primarily leveraged internal capabilities and perhaps included a few key suppliers to create new products. But using traditional product data management systems and exchanging engineering data with suppliers during design has been difficult and very limited.

The traditional approach will no longer be enough to continue to compete – shrinking product lifecycles requires that companies partner with customers and a broader range of suppliers to better customize product to customer demands in substantially reduced time-to-market periods. Shorter time-to-market, enabled by collaborative design, is of great value to most companies, since the profit margins in the early part of the product life cycle are greatest and the potential sales gains from being the first to market are tremendous. Internet-enabled technology provides real-time linkages between key suppliers, manufacturers, engineers and marketers. The ability to conduct collaborative design means that companies can iterate many more design alternatives with suppliers. Product upgrades can also be achieved more effortlessly and in a timely manner, enabling companies to stay ahead of their competition. The revenue and profit impacts are thus enormous. Internally, enhanced communication and collaborative processes overcome many of the organization silo issues faced in traditional sequentially oriented design activity. Not only can products be rolled out faster, but the risks of customer needs shifting during development are mitigated. Finally, increased collaboration throughout the design process can minimize product complexities that later drive supply chain inefficiencies and costs in production, logistics and service parts.

Hewlett Packard, for example, is an early example of a company that began using eDesign principles. In the design and production of laser printers, they abandoned the traditional design approach of dedicated teams focused on launch dates, features and functionality. Internal and external design teams collaborated to develop a supply chain friendly product, with modular parts and differentiating components that could be assembled at regional distribution centers rather than multiple dedicated production facilities.

Internet technology is replacing traditional product data management systems as the vehicle to enable collaborative design. National Semiconductor, a leader

E- Design Facilitates Real-time, Cross-Company Collaboration and the Design of "Friendly" Products.

Material Supply · Customer · Marketing/Prod. Management · System Design · Procurement · Component Development · Manufacturing · Research · Distribution · Design Tool Development

- **Minimize design complexities that later drive supply chain inefficiencies and costs**
- **Avoid downstream issues in production, logistics and service parts**
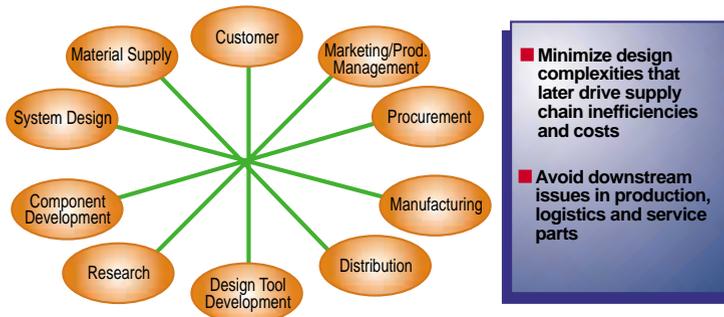
Figure 2.0 eDesign facilitates real-time cross-company collaboration in the design of supply chain friendly products.

in the design and manufacture of analog and mixed signal semiconductor products, uses product design portals to allow its customers and supply chain partners to collaborate in the early stages of design for a new circuit. Solectron, a worldwide provider of electronics manufacturing services, uses new Internet technologies to efficiently exchange product information and expedite the engineering change process to reach the market faster. Adaptec, a maker of data transfer/communications hardware and software, has substantially reduced design-to-delivery cycle times and saved $10 million in inventory reductions by using Web-based collaborative design processes with key suppliers in Hong Kong, Japan and Taiwan.

The Internet is also enabling innovative ways to leverage knowledge capital critical to the design process. Yet2.com's Web site brings companies such as Boeing, TRW and Monsanto together to trade intellectual property, saving millions on research and development. For example, DuPont's research and development activities produce 400 patents a year, not all of which are commercially valuable to DuPont. The Yet2.com Web site matches patents to appropriate companies, netting the sellers like DuPont millions in licensing fees and helping the buyers to shortcut unnecessary developments costs and lead-times.

The supply chain can operate more efficiently when producing products designed for cross supply chain disciplines. Collaboration sets this foundation – and reduces the number of potential issues that may arise during the life of the product. Synchronizing product design and supply chain requirements in the early stages of the development process will prepare supply chain partners to efficiently produce and deliver the product in the course of its life cycle.

eMediaries and Exchanges – Using Online Markets to Revolutionize Buying and Selling

In the traditional supply chain, buying and selling materials means establishing long-term relationships with vendors, distributors and retailers, with multiple inventory sites, long lead-times and fixed margins. Today, the oldest of all business activities – the marketplace – is being reinvented. Companies can now buy and sell across a wide spectrum of emerging Internet-enabled marketplaces.

New examples are being created almost daily, and like traditional marketplaces, trading networks may take many forms. In the supplier-centric model, like W.W. Grainger, sellers provide their catalogs online for all buyers to access. Global companies like BP Amoco are utilizing the buyer-centric model to display their needs online and allow vendors to make bids. The latest development is online marketplaces – the business-to-business equivalent of eBay. These marketplaces are like online bazaars, where anyone can buy or sell all types of goods and services.

Each of these various exchanges provide companies with unique opportunities to tap into performance and cost benefits unavailable prior to the Internet. Regardless of the type of marketplace, the benefits are many: lower product acquisition costs, lower procurement transaction costs, the ability to tap into almost unlimited supply sources to respond to changing market needs, and a means to profitably dispose of unused excess inventory.

The automotive industry is rapidly embracing the value of exchanges. General Motors, a company with an $87 billion annual spend, partnered with CommerceOne to develop TradeXchange. This online marketplace allows suppliers to use custom-designed, Web-enabled applications to conduct real-time transactions with multiple GM organizations including purchasing, finance, engineering, production control, and logistics. GMC expects to save $400 million annually and gain additional revenue from user transaction fees.

Another example is ChemConnect's World Chemical Exchange, which provides a global-neutral market for chemical and plastic manufacturers and buyers. More than 2,500 members, representing 80 percent of the world's top 25 chemical companies, now can conduct round-the-clock trading of chemicals and plastics of all types. This is already a highly competitive field – there are no less than 16 other chemical exchanges.

In each of these cases, technology replaces the middlemen and becomes the mediator between buyers and sellers. These eMediaries can add tremendous value, particularly in the business-to-business marketplace. In fact, BP Amoco Chairman John Browne predicts that 95

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percent of BPA's chemical supplies will be purchased online by the end of 2000 leading to a 10-15 percent reduction in overall acquisition cost. In some industries – particularly commodity based ones with volatile cost structures or where capacity may go to waste – the advent of an economic method of barter is a great advantage. But the emphasis is less on simply squeezing supplier margins than on providing a free and liquid marketplace.

Solutions from companies like MRO.com, FreeMarkets, Parts.com and PlasticsNet.com provide buyers of all sizes with pricing benefits by employing reverse auction tolls and electronic request-for-quotes. Buyers can access far more suppliers than ever before, and suppliers gain access to new classes of buyers. Clearly, this is an explosive area – this volume of Achieving Supply Chain Excellence Through Technology contains a number of articles exploring the topic. New insights may be gained from articles by Andersen Consulting experts Christopher Sprague and Brett Kinsella, as well as such leading solution providers as Moai Technologies, CommerceOne and PurchaseSoft.

Web-Based Collaborative Planning – the Virtualization of the Supply Chain

Collaborative planning, forecasting and replenishment – a highly visible consumer products industry initiative – has shown the advantages to be gained from business partners who collaborate on planning supply chain activities. This type of development is crushing old paradigms of "ownership" of key strategic, planning and operational information. Traditionally, companies – and departments within companies – keep such crucial information safely in their own databases, on their own servers, and their own staff manipulated it with applications that they themselves owned. This model often results in multiple and competing forecasts and with little use of supplier and customer data, results in a misalignment with demand.

Planning done in collaboration with suppliers, customers and channel partners through open sharing of relevant consumer sales data and material availability


Gaps in Supply Chain Infrastructure are Resulting in Poor Performance and Disappointed Customers

Andersen Consulting Online Retailer Study

- 480 product orders attempted in a seven day period
- 25% of orders could not be completed online
- Average days receive an order = 5.2
- Only 25% of retailers met their delivery commitment

Legend: Leading e-tailer, Upstart e-tailer, Retailer, Catalog

Categories: stock status provided, delivery date provided, on-time or early delivery
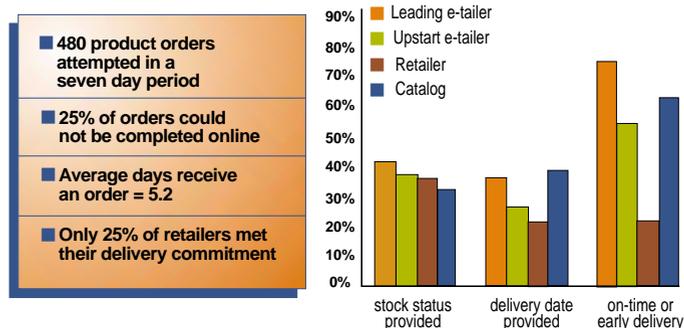
Figure 3.0 Gaps in supply chain infrastructure are resulting in poor performance and disappointed customers.

focuses on a single forecast shared by all supply chain participants. The significant benefits of sharing information with business partners are enticing companies to build trust levels and release key information from their direct control. Sun Microsystems is one company that is taking advantage of the collaborative nature of the Internet. They have developed Web-based collaborative planning tools as a way to strengthen strategic relationships with key customers. These tools allow Sun to exchange forecast and product status information with customers on orders, shipments and promotions, and help Sun to manage their products through the entire life cycle. This capability has resulted in substantial reductions in lead times and forecast availability, improved inventory turns, increased customer satisfaction, and more efficient supply chain operations. Sun is just one of many companies in its industry pursuing the benefits of collaborative planning – indeed, the entire industry will make great strides with the RosettaNet initiative to set standards for collaborative planning processes for electronics industry companies.

As companies increasingly collaborate, innovations will move beyond passing information back and forth, and the concept of a shared repository of data will

make more sense. The Internet is the logical shared repository. This shift in the sense ownership drives two other shifts in conventional wisdom. Why should the applications that manipulate the data necessarily be owned by the business partners? Being able to collaborate with business partners across a common technical platform using common applications will alleviate many of the issues of version control, standards and confusion. This will create direct information technology cost savings and build business flexibility into the information technology infrastructure. The final shift will be the consideration that if the data, technical infrastructure and applications do not necessarily have to be owned, why not also have the staff of specialist third-party assume some of the planning activities?

This sort of Web-based outsourcing is a business model and delivery mechanism for a third-party to provide and manage a common business solution over an electronic network to multiple clients. They would provide entire business processes or application solution sets using the Internet as the medium. A Web host would provide the network services and the hardware and software infrastructure while applications service providers would provide applications and content. Business solution

providers will provide the aggregation.

A good example of this model is the partnership between Manugistics Group, Inc. and Freightwise, Inc., a new e-commerce initiative of the Burlington Northern Santa Fe Corporation. Powered by Manugistics' transportation solution, FreightWise offers an online marketplace for buyers and sellers of transportation services and information. FreightWise trading partners will be able to share, view and execute decisions based on real-time information. In effect, the FreightWise Web site will automate transportation and logistics processes by reviewing and selecting the most effective and efficient transportation services across a virtual enterprise. Another example is i2 Technologies' Tradematrix, a dynamic Internet marketplace that provides a one-stop destination for online collaboration and dynamic trading, electronic procurement, spot buying, selling, order fulfillment, logistics services and product design services. TradeMatrix provides an open digital community where customers, partners, suppliers, and service providers gather to conduct business in real-time, enabling companies to make more profitable decisions.

These are just a few examples of an area that is certain to explode with opportunity. Web-based collaborative planning will allow supply chain participants to create a "virtual" store of inventory that each participant can access to satisfy customer needs from any available source. Full knowledge of availability across the supply chain will allow these participants to reduce costs through lower stocks and more efficient shipment planning. By allowing participants to operate supply chains at "eSpeed" through the sharing of production, inventory, product and shipment status, companies can gain competitive advantage by beating others to new customers and markets.

eFulfillment

Matching the Performance of the Physical Activities to the Virtual World
The final capability crucial to success in the Internet-enabled supply chain is not one that will reside on the Web. Rather, the cru-cial capability is upgrading the physical aspects of the supply chain to match the speed of the virtual world. Demonstrations of the speed and sophistication of the latest technology applications are truly impressive but they paint only half the picture. Will a customer be won through real-time information on product availability be lost when delivery is slow and unreliable? Will a customer be as impressed by the chance to configure their product online if it arrives in a different configuration? Will the online experience be as attractive if the delivery times are no more convenient than travelling to the shops? Will collaborative planning with suppliers make sense absent confidence in their ability to consistently deliver against fluctuating demand? The primary goal of eFulfillment is the radical reduction of order-to-delivery time to customers.

This reduction requires exceptional supply chain management, not only for new e-commerce ventures, but also for established players who must raise their performance to continue to compete. As evidence, a recent Andersen Consulting study of online holiday purchases highlights some of the issues of operating in the new economy. The study targeted 100 companies that sell products to consumers online. The group included traditional store based retailers with a Web presence, pure online retailers or "eTailers" and catalogers who provided an online order capability. More than one-quarter of Web sites explored could not take orders because they crashed, were blocked or were otherwise inaccessible. Further, traditional retailers with an online presence were only able to give accurate delivery estimates 25 percent of the time. That kind of disappointing performance demonstrates why e-commerce companies are now recognizing the value of the right investments in supply chain capabilities.

The most obvious impact of eCommerce is the heightened requirement to develop a flexible and reliable channel to reach the end consumer – sometimes for deliveries of just a single item. Robert Mann's article addresses some of the challenges of this environment – the next few years will see many companies stretching to create, buy or outsource eFulfillment capabilities.

Theodore Prince, in an article entitled "E-Commerce and Its Impact on Transportation, Logistics and Supply Chain Management," provides an interesting perspective on who among the third-party logistics providers are best positioned to succeed in this environment. And Beth Enslow's article discusses the ways in which companies may turn their logistics operations into high-speed fulfillment networks by leveraging key technologies.

The increasing demands of order-to-delivery are not limited to the business-to-consumer marketplace. As companies collaborate and synchronize their activities more tightly there will be a ever increasing value in more flexible and customized distribution channels. For example, Mark Hurley's and David Dubose's article describes how Shell Chemicals reviewed its channel strategy and found many different options to deliver the goods and services to its segmented customer base in a differentiated fashion. And the change does not only apply to logistics. Manufacturing has seen the rise of build-to-order manufacturing as customer demand signals are made more visible by various e-commerce systems. The traditional build-to-stock and build-to-forecast models have become obsolete for some product types because of the massive inventories required to support the ever-constant SKU expansion.

Taking such techniques one step further will lead companies to the assemble-to-order or configure-to-order model where each SKU is produced to the specific configuration of an individual customer. Making this change represents an enormous increase in the complexity of operations, requiring each piece of inventory to be tracked and planned to its eventual customer. But the value proposition to the customer of this mass customization can be significant enough to force this change, especially now that e-commerce can easily capture the customers requirements.

Just as the restructuring of the business models is creating opportunities for new entrants to provide "virtual" services

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such as marketplaces and exchanges there is also an increased scope for other companies to fulfill new specialized roles in the "physical" execution arena. The advent of the e-economy is pressuring the fulfillment operations of many companies, whether they are shipping small packages to individual consumers or operating tightly synchronized business-to-business transportation. New partnerships are evolving to alleviate these pressures. No matter what industry, or what product, companies will look for innovative ways to continue to reduce order-to-delivery times.

Making it Happen

The message of the Internet-enabled supply chain is that the Internet will not replace supply chain management. Rather, it is an incredible medium that allows supply chain activities to be carried out in a truly synchronized fashion. Internet-enabled tools and solutions will allow development of cost efficient, service effective supply chains. However, speed is the key capability that defines the new supply chain in the Internet age. Speed, cost reductions, and customer service are all impacted by availability. This will be accomplished through better information to manage product flows and reduce inventory. Benefits are further enhanced by greater collaboration between supply chain partners to increase speed and flexibility, and the ability to create entirely new supply chain operations in conjunction with e-mediary deals.

Yet challenges remain. If the new supply chain rule is no longer operating independently, choosing the right partners becomes critical. Integrating supply chain processes and technology across supply chain partners will replace trucks and warehouses as the keys to ongoing competitive advantage. But sharing data and resouces successfully is contingent on trust and openness, issues that still plague many companies. Finally, remember that economics count in overall supply chain design. Electronic commerce will allow competitors to quickly access cheaper products and delivery methods. Consequently, low cost supply chain oper-

ations remain critical.

Many companies continue to focus on improving supply chain performance by reducing costs and/or improving customer service. While effective for certain traditional channels and markets, the Internet-enabled supply chain requires a whole new approach to gaining and sustaining competitive advantage. Third-party providers may be used in such areas as call centers, manufacturing and logistics to set up new channels to reach customers who may disdain traditional channels. Sharing data with supply chain partners provides the information needed to be successful in supply chain management. Without the right data, companies will fail in the new economy. Most importantly, spending time gaining a better understanding of customer needs and focusing on creating experiences that make doing business simpler and easier for them will have tremendous results. The winners in the emerging Internet-enabled supply chain competition will be those companies that discard the traditional rules of doing business while working collaboratively with their customers and supply chain partners to create the future.

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Dr. Lee has published widely in journals such as Management Science, Operations Research, Harvard Business Review, Sloan Management Review, Supply Chain Management Review, IIE Transactions, Interfaces, European J. of Operational Research, and Naval Research Logistics, etc. He has served on the editorial boards of many international journals, and is the current Editor-in-Chief of Management Science.

Dr. Lee has consulted extensively for companies such as Hewlett-Packard Company, BayNetworks, SUN Microsystems, Apple Computer, IBM, General Motors, Xilinx Corp., Andersen Consulting, Eli Lilly and Company, Booz-Allen and Hamilton, Raychem Corp., McKesson, Motorola, and NON-STOP Logistics Company. He has also given executive training workshops on Supply Chain Management and global logistics in Asia, Europe and America. Professor Lee obtained his B.S. degree in Economics and Statistics from the University of Hong Kong, his M.S. degree in Operational Research from the London School of Economics, and his M.S. and Ph.D. degrees in Operations Research from the Wharton School of the University of Pennsylvania.