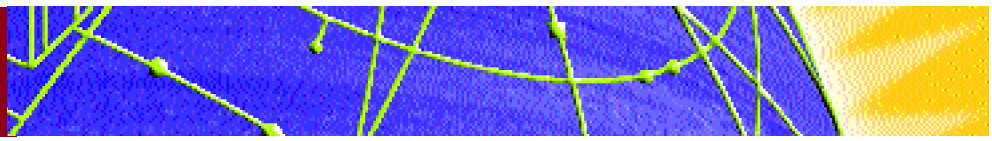

Supply Chain Integration in the Age of e-Business

e-Business has emerged as the most cost-effective model for driving supply chain integration—and deriving the maximum benefits from that effort.

By Hau L. Lee and Seungjin Whang

The increasing complexity of supply networks, the globalization of businesses, the proliferation of product variety, and the shortening of the product life cycles are forcing companies to draft new supply chains strategies. These strategies call for tighter coordination and collaboration of supply chain partners–an approach often called "supply chain integration."

What constitutes supply chain integration? There are really four key dimensions: information, synchronization, workflow coordination, and new business models.

Information integration refers to the sharing of information among supply chain members. This means shared demand information, inventory status, capacity plans, production schedules, promotion plans, demand forecasts, and shipment schedules. Ideally, such information is readily accessible by the appropriate parties on a real-time, online basis.

Synchronization refers to the joint design and execution of plans for forecasting and replenishment. Hence, members in a supply chain can coordinate their order fulfillment so that all replenishments are made to meet the same objective–the ultimate customer demands.

Workflow coordination is the highly streamlined workflow activities among supply chain partners. For example, procurement activities from a manufacturer to a supplier can be tightly coupled to achieve efficiencies in accuracy, time, and cost. Product development activities involving multiple companies also can be integrated to achieve similar efficiencies.

New business models refer to new ways of doing business in a supply chain. A supply chain network may jointly create new products, pursue mass customization, and penetrate new markets and customer segments.

Integration cannot be complete without a tight linkage of the organizational relationships between companies. The channels of communication should be well defined and maintained. The performance measures for members of the supply chain also need to be specified and monitored. In addition, there may be some performance measures for which multiple organizations are jointly held accountable. Such extended performance measures encourage closer collaboration and coordination. Finally, organizations in a supply chain can work together closely for the same goal only if the incentives and risk sharing of the multiple players are aligned.

Electronic Information Integration

To ensure that a supply chain is driven by true consumer demand, information integration is critical. This is the most effective way to counter the problem of demand information distortion–the well-known "bullwhip effect" (see Lee et al., 1997). Information distortion can arise from a number of factors such as partners making use of local information to make demand forecasts and passing them onto upstream partners; partners making ordering decisions based on local economic

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factors, local constraints, or performance measures; and gaming behaviors that exaggerate orders when there are perceived uncertainties in supply conditions. These distortions are amplified from one level to another in a supply chain, and are considered to be one of the biggest causes of inefficiencies in a supply chain. (See Exhibit 1.)

One way to counter the bullwhip effect is to have total transparency of demand information across the supply chain. Indeed, such transparency is considered to be the cornerstone of supply chain integration in the grocery industry, known as Efficient Consumer Response (see Kurt Salmon Associates, 1993).

Companies engaged in information sharing usually share sales data, inventory status, production schedule, promotion plans, demand forecasts, and shipment schedule (see Lee and Whang, 1999). Longs Drug Stores, a major pharmaceutical retail chain, utilizes a state-of-the-art scientific replenishment optimization software provided by Nonstop Solutions to plan the replenishments of their warehouses and stores. The resulting inventory savings of 40 percent enabled Longs to relieve enough capital to purchase 20 new stores.

Availability and accessibility of order status information also is important. Consider the case of a manufacturer who ordered parts from a foreign supplier. Delivery could take an uncertain amount of time and the whole order fulfillment process might involve multiple parties such as ocean carriers, ports, customs clearing agents, warehouses, and land carriers. The inability to track the order or get an update on the delivery time once the order has left the supplier can be frustrating to the manufacturer. To protect against uncertainties in delivery time, the company would have to carry extra safety stock. Timely order tracking across enterprises can enable customers and suppliers to more effectively react to unexpected delays and create contingency plans.

The Internet clearly is a natural platform for information sharing. Many logistics service providers like Federal Express, Fritz, and UPS provide Internet-based systems for partners to track and trace orders at all times—whether those orders are at a warehouse, at sea, at customs service, or on a truck to the customer.

Indeed, a recent study conducted jointly by Stanford University and Andersen Consulting, based on a survey of 100 manufacturers and 100 retailers in the food and consumer-products industry, found that companies engaged in higher levels of information sharing reported higher-than-average profits.

Electronic Synchronization

Information integration also includes the exchange of knowledge so that the partners can collaborate to create synchronized replenishment plans. Such collaborative efforts up and down the supply chain are best facilitated by the use of the Internet. The Voluntary Industry Commerce Standards Committee is working on formalizing the process models and technology framework for collaborative planning, forecasting, and replenishment for the grocery industry. The initiative will see companies utilizing the Internet, with electronic bulletin boards, to pursue the collaborative efforts.

EXHIBIT 1 **Information Distortion: The Bullwhip Effect**

The joint Stanford University-Andersen Consulting study cited earlier offers again some valuable insight. The survey results show that companies reporting higher-than-average profits are more likely to be engaged in joint logistics replenishment and planning programs with their trading partners. (See Exhibit 2.)

Electronic Workflow Coordination

The Internet has created vast opportunities for cross-enterprise workflow integration, including activities such as procurement, order execution, engineering change, design optimization, and financial exchanges. The result is a much more cost-effective, speedy, reliable and less error-prone supply chain operation. These advantages are reflected in the examples described below.

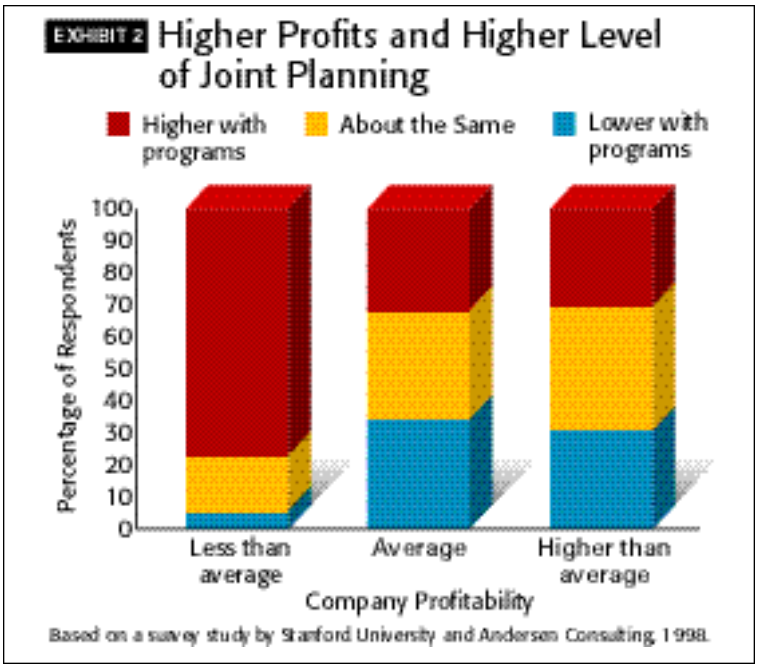
Production Plan Coordination

Adaptec, a fabless semiconductor company relies on advanced Internet-based solutions to exchange information and coordinate production plans with its supply chain partners. Using a software called Alliance developed by Extricity, the company communicates in real time with its

foundry TSMC (Taiwan Semiconductor Manufacturing Company) and its assembly partners (Amkor, ASAT, and Seiko). The information exchanged includes detailed and complex design drawings, prototype plans, test results, and production and shipment schedules. This capability greatly heightens Adaptec's awareness of demand and supply levels and lets the company respond quickly to potential mismatch problems. It also helps to shorten new product development times.

Order Processing and Financial Flow Coordination

Instill, a Silicon Valley start-up, has created an Internet-based service to facilitate and process orders as well as to coordinate rebates, discounts, and other financial exchanges. This solution is designed for operators (such as restaurants), wholesalers, and manufacturers in the foodservice industry. It replaces the traditional time-consuming, error-prone purchasing systems with a secure and user-friendly client program for food operators to order food products on the Web. In addition, the Web site serves as an information hub that links buyers and suppliers. It also offers a purchase tracking service for multi-unit foodservice operators and gives them up-to-the-minute information on purchasing activity for better control. Its user-friendly format gives standardized reports to verify contract pricing, track rebates, and monitor unit-buying compliance. Further, the manufacturers have access to the aggregate demand and tracking data showing how their products move through each distribution channel.



Procurement Coordination for New Product Introduction

Over the Internet, buyers can accomplish complex purchasing tasks—such as parts list management, quoting, ordering, order change, and order confirmation—in hours, instead of days. The Internet also can enable companies to tap into a bigger supply base to ensure reliable supply of essential products. Timeliness in supplier selection, order quote generation and receipt, and the integration of purchasing decisions with internal ERP systems are particularly valuable capabilities in new product introduction. Solectron, for example, makes effective use of Digital Buyer, an Internet-based procurement software provided by Digital Market. This product allows Solectron to reach multiple suppliers and obtain price and availability quotes within a day or two.

Engineering Design for Supply Chain Management

Product rollover, defined as the transition from one version of a product to its successor, can be a vulnerable period for companies. In fact, a successful company can lose significant market share by mismanaging a product rollover (see Billington et al., 1998). One of the major risks in product rollover is the time taken to ready all the new parts for the rollover. Engineering changes involved in rollovers may require both new suppliers, new bills of materials, and new requirements for existing parts. Agile Software, for example, has been able to help companies like Lucent Technologies and Flextronics with its Internet-based software systems that allow engineering changes to be made effortlessly.

New Business Models

New Internet-based business models are becoming increasingly evident in the supply chain. A few of the more noteworthy examples are outlined below.

Virtual Resources

The Internet facilitates information searches so that multiple resources in a supply chain that formerly acted as independent resources can be tapped simultaneously to satisfy special needs. Resources such as inventory stockpiles and capacity can thus be pooled to create "virtual resources." Hewlett-Packard just launched a Web site known as TradingHubs.com that lets resellers auction excess inventory of computer products, thereby allowing the resellers to pool their inventory stockpiles. Resellers now have an open market to trade their excess inventory and excess needs. The costs of holding extra inventory as well as demand

shortages thus are reduced simultaneously.

Logistics Restructuring

With the advances of information technology, companies also can restructure the logistics flows of their products to gain efficiencies. The physical flows no longer have to follow the information flow. The Internet allows information flows to take the place of some of the inefficient physical flows. Cisco has been one of the most successful companies in using the Web for selling products. The company's annual sales of more than $8 billion over the Web constitute about 74 percent of all sales. While outsourcing most of its manufacturing, Cisco continues to use its sales force to sell to customers. The elaborate Web-based information system links Cisco and its supply chain partners and takes care of all the necessary information flows.

Product Upgrades and Service Support

The latest innovation by Xilinx, a semiconductor company producing field-programmable logic devices, is Internet-Reconfigurable-Logic (IRL). Some of the products in which Xilinx integrated circuits reside go through constant product- generation changes that would require the updating of the functionalities of the Xilinx chips. With IRL, the field-programming logic can be modified or updated after the installation at the end-user's premises over networks and the Internet. These online field- upgradable systems can range from multi-use set-top boxes and wireless telephone cellular base stations to communications satellites and network management systems. In the most recent quarter of 1999, Xilinx surpassed its competitors and became the market leader for field-programmable logic.

Mass Customization and New Products

The Internet enables many companies to use the Web to let customers configure specific order options tailored to their tastes and preferences. In this way, the Internet facilitates mass customization. At the same time, the Internet can be used as a means to test new products and services.

As these new business models suggest, the next few years will see an explosion of business-to-business Internet applications as visionary companies develop new paradigms of e-Business. This advantage will be manifested in better asset utilization, faster time to market, reduction in total order-fulfillment times, enhanced customer service and responsiveness, new market penetration, higher return on assets, and ultimately, enhanced shareholder value.

With these kinds of advancements, the promise of supply chain integration becomes a closer reality. And those companies that most effectively use e-Business to enhance their integration efforts will have a tremendous competitive edge over their competitors.

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The Information Hub

In an integrated supply chain, information flows can be thought of in the same terms as a cross-docking operation in physical logistics. In this case, the cross-docking facility is called the "information hub" where information is instantaneously processed and forwarded to partners upon arrival. The information hub is a node in the data network where multiple organizations interact in pursuit of supply chain integration. It has the capabilities of data storage, information processing, and push/pull publishing. The overall network forms a hub-and-spoke system with the participants' internal information systems–that is, an ERP or other enterprise system–being the spokes. A most natural setting of the information hub would be a Web site running an ERP system for the supply chain.