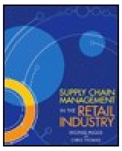

Supply Chain Management in the Retail Industry

by Michael Hugos and Chris Thomas

Chapter 6: Technology and Supply Chain Coordination

Overview

Some people insist that the “human touch” will always be necessary in retail—that most customers are more comfortable dealing with a person than a computer screen or an automated telephone line. Still, technology has its benefits, notably speed and consistency. A computer system may get a virus now and then, but it never plays favorites, talks on its cell phone while it’s supposed to be working, or is intentionally rude to a customer.

Technology has meant good things for supply chains as well. The spread of high-speed data communications networks and computer technology has made it possible to manage a supply chain with a level of precision that was not feasible 20 years ago. The organizations that learn to use the latest techniques and technologies can create customer service throughout their supply chains— from their suppliers to the consumers—that give them a competitive advantage in their markets.

After reading this chapter, you will be able to

- Explain the bullwhip effect on retailers and supply chains
- Explain the benefits of collaborative planning, forecasting, and replenishment (CPFR).
- Describe the types and uses of information systems in a supply chain.
- Assess the technology that supports and enables effective supply chain coordination.

The widespread availability and use of the Internet offers companies opportunities that did not exist before. These opportunities are made possible because it is now so easy and relatively inexpensive for companies to connect to the Internet. Once connected, companies can send data to and receive data from other companies with which they do business, regardless of the computers or software that each company uses to run its internal operations. Data sharing allows companies to work together to achieve tremendous supply chain efficiencies and significant increases in customer service and responsiveness. The term for this type of coordination is known as **supply chain integration**. It allows companies to react much more quickly to changes in market demand, and business competition based on supply chain efficiency is becoming a central fact in many markets.

To develop this capability, individual companies and entire supply chains need to first learn new behaviors and then enable these new behaviors with the use of appropriate technology. Before you learn about the technology, however, let’s examine one of the reasons coordination of these efforts is so important.

The “Bullwhip Effect”

One of the most common dynamics in supply chains is a phenomena known as the **bullwhip effect**. Small changes in product demand by the consumer at the “front end” of the supply chain translate into wider and wider swings in demand as they are experienced by companies “further back” in the supply chain. As a result, companies at different stages in the supply chain come to have very different pictures of market demand, and there is a breakdown in supply chain coordination. Companies behave in ways that at first create product shortages and then lead to an excess supply of products. It’s a ripple effect, except that for every member of the supply chain, the economic reality is more like the lash of a real bullwhip!

This dynamic plays out on a larger scale in certain industries in what is called a **boom-to-bust business cycle**. In particular, this affects industries that serve developing and growth markets—cell phone equipment, computer components, and the like—where demand can spike suddenly. The cycle begins with the “boom,” when a hot new product sells out, creating shortages in the market. Distributors and manufacturers steadily increase their inventories and production rates in response to the demand. But at some point, either the demand changes or the supply of product exceeds the demand level. Distributors and manufacturers seem to be the last to realize this—they’re going allout, continuing to build the supply.

Finally, the glut of product is so large that everyone realizes there is too much. Manufacturers shut down plants and lay off workers. Distributors are stuck with inventories that decrease in value and can take years to work down. The cycle ends with a “bust.”

This dynamic can be modeled in a simple supply chain that contains a retailer, a distributor, and a manufacturer. In the 1960s, a simulation game was developed by the Massachusetts Institute of Technology’s Sloan School of Management that illustrates how the bullwhip effect develops. The “Beer Game” shows what happens in a hypothetical supply chain that supports a group of retail stores that sell beer, snacks, and other convenience items. The results of this simulation teach a lot about how to coordinate the actions of different companies in a supply chain—how the bullwhip gains its momentum, and how to avoid its dangerous boom-and-bust consequences.

The Beer Game starts with retailers experiencing a sudden but small increase in customer demand for a certain brand of beer, called “Lover’s Beer.” Orders are batched up by retailers and passed on to the distributors who deliver the beer. Initially, these orders exceed the inventory that distributors have on hand, so they ration out their supplies of Lover’s Beer to the retailers and place even larger orders for the beer with the brewery that makes Lover’s Beer. The brewery cannot instantly increase production of the beer, so it rations out the beer it can produce to the distributors and begins building additional production capacity.

At first, the scarcity of the beer prompts panic buying and hoarding behavior. Then as the brewery ramps up its production rate and begins shipping the product in large quantities, the orders that had been steadily increasing due to panic buying suddenly decline. The glut of product fills up the distributors’ warehouses, fills all the retailers’ unfilled back orders, and exceeds the actual consumer demand. The brewery is left with excess production capacity, the distributors are stuck with excess inventory, and the retailers either cancel their beer orders or run discount promotions to move the product. Everybody loses money. Figure 6-1 illustrates how each company sees the product demand and the distortion that causes the problems.

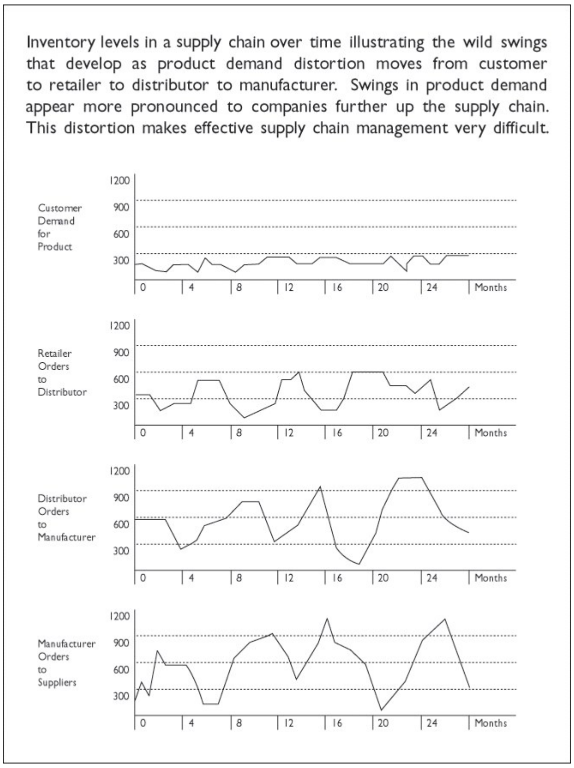

Figure 6-1. Product demand distortion swings: the bullwhip effect.

Anything that disrupts a steady and orderly supply of product can create a bullwhip effect: a retailer who stops ordering in an attempt to reduce inventory, for example, or delays in material or information that cause backlogs in some parts of the supply chain. A study by Georgia Technical University estimated supply chain problems cost companies between 9 and 20 percent of their overall value in a six-month period.[1] The costs of the bullwhip effect are felt by all members of the supply chain:

- Manufacturers add extra production capacity to satisfy an order stream that is much more volatile than actual demand, and/or production schedules are thrown off as the plant scrambles to supply the inflated demand numbers.
- Distributors carry extra inventory to cover the variability in order levels, which ties up additional funds.
- Transportation costs increase because excess transportation capacity has to be added to cover the periods of high demand.

- Labor costs also go up in order to respond to the high demand periods.
- Retailers experience problems with product availability and extended replenishment lead times, which results in poor customer service and out-of-stocks.
- During periods of high demand, there are times when the available capacity and inventory in the supply chain cannot cover the orders being placed. This results in product rationing, longer order replenishment cycles, and lost sales due to lack of inventory.

[1] "The Bullwhip Effect," newsletter of Factory Logic, Inc., Austin, Texas, 2001.

Coordinating the Supply Chain

Research has identified five major factors that cause the bullwhip effect. These factors interact with each other in different combinations in different supply chains, but they are all the result of inadequate or incorrect information, and the net effect is that they generate the wild demand swings that make it almost impossible to run an efficient supply chain.

These factors must be understood and addressed in order to successfully coordinate the actions of any supply chain, and we'll examine them one at a time. They are as follows:

1. Demand forecasting
2. Order batching
3. Product rationing
4. Product pricing
5. Performance incentives

Demand Forecasting

Demand forecasting based on orders received instead of end user demand data will inherently become more and more inaccurate as it moves "up" through the supply chain. Remember, the companies that are removed from direct contact with the end user can lose touch with actual market demand if they view their role as simply filling the orders placed with them by their immediate customers.

If a supply chain participant sees only the data from the business either directly "above" or "below" them in the chain, they see only part of the picture. If the fluctuations in the orders that come to them are being caused by the bullwhip effect, then when they use this order data to do their own demand forecasting, they end up adding further distortion to the demand picture, passing it along in the form of orders they place with their suppliers.

Supply Chain Skills—Taming the Bullwhip Effect

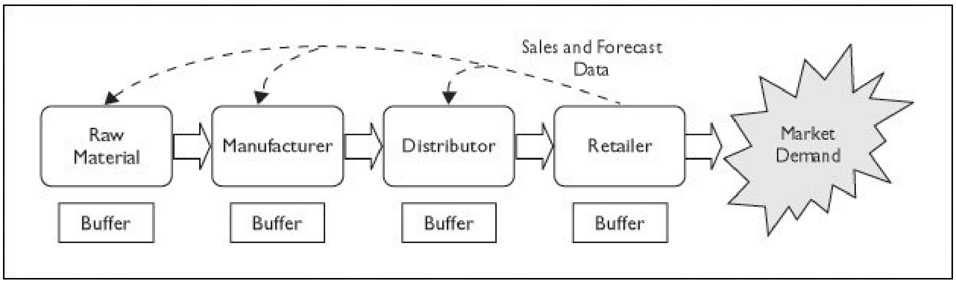

Figure 6-2. Flow of inventory through a synchronized supply chain.

A very effective response to the bullwhip effect is to manage the entire supply chain as a single entity and synchronize it to the timing of actual market demand. This requires the supply chain participants closest to the end use customers (generally, the retailers) to share their sales numbers and forecasts with the other companies in the supply chain. Each company can then manage its actions based on the most accurate data about market demand.

Buffers in the supply chain are determined by the degree of uncertainty about future market demand and the service levels required by the market. The lower the levels of uncertainty about demand, the smaller the buffers can be and still maintain high service levels. Companies can manage their buffers by using either productive capacity or inventory, whichever is most cost-effective for them.

Synchronized supply chains avoid the volatile waves of demand generated by the bullwhip effect, and increased predictability makes the productivity of each company easier to manage. The whole supply chain becomes more efficient and profitable.

This model is called “drum-buffer-rope.” Market demand is the constraint on the system, and it sets the “drum beat” or pace of the supply chain. Individual companies manage uncertainty in their stage of the supply chain by using their “buffer”—either inventory or productive capacity. Buffers are kept low because uncertainty is minimized by sharing data. This data is the “rope” that ties the participants together and allows them to synchronize their actions.

Clearly, one way to counteract this distortion is for all companies in a supply chain to share a common set of demand data from which to do their forecasting. The most accurate source of this demand data is the supply chain member closest to the end use customer, if not the customers themselves. Sharing point-of-sale data among all the companies in a supply chain goes a long way toward taming the bullwhip effect, because it lets everyone respond to actual market demand instead of supply chain distortions.

Order Batching

Order batching occurs because companies place orders periodically for amounts of product that will minimize their order processing and transportation costs. As discussed in the “Inventory Management” section in Chapter 3, companies tend to order in lot sizes determined by the EOQ (economic order quantity) of the product. Because of order batching, these orders vary from the level of actual demand, and this variance is magnified as it moves up the supply chain.

The way to address this type of demand distortion is to find ways to reduce the cost of order processing and transportation. This will mean smaller EOQ lot sizes and more frequent ordering, but the result will be a smoother flow of orders that distributors and manufacturers will be able to handle more efficiently. Ordering costs can be reduced by computerization of the order process, something most companies already do. Transportation costs can be reduced by using third-party logistics suppliers (3PLs) to cost-effectively pick up many small shipments from suppliers and deliver small orders to many customers.

Product Rationing

Product rationing is the response that manufacturers take when they are faced with more demand than they can meet. One common rationing approach is for a manufacturer to allocate the available supply of product based on the number of orders received. Thus, if the available supply equals 70 percent of the orders received, the manufacturer will fill 70 percent of the amount of each order and back-order the rest. This leads distributors and retailers in the supply chain to raise their order quantities artificially, in order to get the amount they think they deserve as “good customers.” This type of behavior, known as **shortage gaming**, can be disastrous to the supply chain because it greatly overstates product demand. Indeed, it becomes quite a game with some merchants.

There are several ways to respond to this. Manufacturers can base their rationing decisions on the historical ordering patterns of a given distributor or retailer, rather than on their present order sizes. This eliminates much of the motivation for the shortage gaming that otherwise occurs. Manufacturers and distributors can also alert their customers in advance if they see demand outstripping supply. This way product shortages will not take buyers by surprise and there will be less panic buying.

Product Pricing

When prices of products fluctuate, distortions in demand can result. If special sales are offered and product prices are lowered, it will induce customers to buy more or buy sooner than they otherwise would (so-called forward buying). Then prices return to normal levels and demand falls off. Instead of a smooth flow of products through the supply chain, price fluctuations can create waves of demand and surges of product flow that are hard to handle efficiently. Even very liberal (or “free”) return policies can skew demand figures one way or the other and end up cracking the bullwhip.

With a nod to Wal-Mart, answers to this problem generally revolve around the concept of “everyday low prices.” If the end customers believe that they’re getting a pretty good price whenever they purchase the product, they will make their purchases based on real need and not other considerations. This, in turn, makes demand easier to forecast, and companies in the supply chain can respond more efficiently.

This does not mean retailers can't have sales without the approval of all other members of their supply chains! It just means the sale events should be structured to move product already in stock at the store, such as end-of-season or slow-moving merchandise, or product that the other partners can supply without an artificial ramp-up of production or distribution.

Performance Incentives

Performance incentives are often different for different companies and individuals in a supply chain. Each company views itself as managing its role or position in isolation from the rest of the supply chain. Within companies, individuals can also see their jobs in isolation from the rest of the company. It is common for companies to structure incentives that reward its sales force on sales made each month or each quarter.

Therefore, as the end of a month or a quarter approaches, the sales force offers discounts and takes other measures to move the product in order to meet the quotas. This results in product—for which there is no real demand— being pushed into the supply chain. It is also common for managers within a company to be motivated by incentives that conflict with other company objectives. For instance, a transportation manager may take actions that minimize transportation costs at the expense of customer service or inventory carrying costs.

Alignment of performance incentives with supply chain efficiencies is a real challenge. It begins with the use of accurate activity-based costing (ABC) data that can highlight the associated costs. Companies must be able to quantify the expenses incurred by forward buying due to month-end or end-of-quarter sales incentives. Companies also need to identify the effect of conflicting internal performance incentives. The next step is to experiment with new incentive plans that support efficient supply chain operation. This is a process that each company needs to work through in its own way.

Collaborative Planning, Forecasting, and Replenishment

To facilitate the coordination that is needed in supply chains, an industry group known as the Voluntary Interindustry Commerce Standards (VICS) Association keeps up-to-date on the technique known as collaborative planning, forecasting, and replenishment (CPFR) and its related issues. This committee documents best practices for CPFR and creates guidelines to follow for CPFR.

The CPFR process is divided into the three activities of planning, forecasting, and replenishment. Within each activity there are several steps.

Collaborative Planning

- Negotiate a front-end agreement that defines the responsibilities of the companies that will collaborate with each other.
- Build a joint business plan that shows how the companies will work together to meet demand.

Collaborative Forecasting

- Create sales forecasts for all the collaborating companies.
- Identify any exceptions or differences between companies.
- Resolve the exceptions to provide a common sales forecast.

Collaborative Replenishment

- Create order forecasts for all the collaborating companies.
- Identify exceptions between companies.
- Resolve the exceptions to provide an efficient production and delivery schedule.
- Generate actual orders to meet customer demand.

CPFR in Action

For an example of how CPFR can work, let's return to the example of Nimble Company. In the discussion of product design in Chapter 3, you learned how Nimble Company developed a home entertainment system that was much simpler to manufacture than a competitor's system. The simpler design is supported by a less complex supply chain that reduces production costs and increases responsiveness to market demands. All of this is central to the competitive success that Nimble Co. is enjoying.

Nimble Co. has collaboration agreements in place with its supply chain partners and has an ongoing planning, forecasting, and replenishment process in place with these partners. Nimble Co. receives POS data, showing the actual sales of its systems in retail stores. From these same retailers, Nimble Co. receives regular updates of their sales forecasts and their inventory levels of Nimble Co. home entertainment systems. Nimble Co. uses this data to plan its production schedule. It also shares this data with the component manufacturers who provide parts for its home entertainment system, so the component manufacturers can plan their own production schedules.

In looking at the sales data and forecasts, Nimble Co. sees that demand for its product is growing faster than anticipated in the company's yearly plan and makes the decision to increase production. Nimble Co. revises its production schedule for the year and takes the new plan to its key component suppliers to negotiate additional purchases of their components.

It turns out that one component supplier cannot quickly ramp up production—but a second supplier has a component that could fill the need with just a slight design modification. Because all affected parties know what is going on and have enough lead time, the design changes are made and production schedules are increased to meet the rise in product demand without any retailers running out of inventory.

The benefits illustrated here clearly show supply chain collaboration in action:

- First, the bullwhip effect is diminished because all companies in the supply chain can see real-time sales data and share sales forecasts. This allows everyone to optimize their production schedules, inventory levels, and delivery schedules.
- Next, there are the benefits associated with Nimble Co. being able to quickly see a real rise in customer demand and coordinate with its suppliers to increase production schedules over previously planned levels.
- Third, even though one component supplier was not able to accommodate Nimble Co.'s increased production schedule, another supplier had a workable substitute. Changes were made to the product design, production was increased, and no retailer lost sales revenue due to running out of inventory.

Companies that can integrate their supply chains will have a significant competitive advantage, but this type of collaboration is not easy to implement, and it will take time to become more common in business. However, prominent companies are already beginning to lead the way. Wal-Mart, Dell, and Procter & Gamble share point-of-sale data with all the other companies in their respective supply chains, including inventory data. Sharing this kind of information provides a basis for each company to make decisions about its own activities that will yield better efficiencies and profits—for itself and for the supply chain as a whole.

Starting Supply Chain Collaboration

The best place to start in an effort to promote collaboration is to measure the bullwhip effect within a company. Over a period of time—perhaps a quarter or a year—compare the volume and frequency of orders received from customers with the volume and frequency of orders the company places with suppliers. Plot them out on a graph so everyone can see the difference between the company's incoming customer orders and its outgoing supplier orders. What is the extent of this divergence? Where is the company located in the supply chain? Retailers are, of course, at the "front" of the chain (close to the end customer), but the same calculations work for companies at the "back" of the chain (manufacturers or their suppliers). Remember, the distortion caused by divergence of incoming orders with outgoing orders increases as it moves back through the supply chain.

Many companies are not aware of the supply chain costs that are associated with the bullwhip effect. Traditionally, demand variability caused by the bullwhip effect was taken as a given, and companies worked on their own to develop better ways to respond to the fluctuations in demand. But increasingly, the experts have decided it is far more efficient for companies to work together to combat the bullwhip effect, by collaborating with other supply chain partner companies to reduce the fluctuations together.

Once the magnitude of the bullwhip effect has been established in a particular company, it is up to the people in that company to estimate the cost consequences in different departments. Production costs, production scheduling, transportation costs, and shipping and receiving costs all are impacted to a certain extent by bullwhip conditions. What inventory levels are needed to maintain service levels in such a volatile situation, versus what they would normally be without these fluctuations? What is the effect on product availability and order lead times—are sales lost because of lack of inventory? These are the kinds of factors that will show a company how much it actually costs to deal with the constant hypervigilance that is required by having to adapt to these unnecessary demand fluctuations. This is the basis upon which to discuss what it might be worth to fix the bullwhip effect.

Information Systems

One of the requirements for successful CPFR is known as **global data synchronization**. The name means just what it says—every company should be able to synchronize its data with partner companies' data so they can work together to plan, forecast, produce, and deliver the right amounts of goods. This requires information technology (IT) that can support a company's internal operations and also enable collaboration among companies in a supply chain. Using high-speed data networks and databases, companies can share data to better manage the supply chain as a whole, as well as their individual positions within the supply chain. Today, the effective use of this technology is key to a retailer's success.

You would think in this highly wired Internet age that this would be fairly easy—just start e-mailing data! But the business world runs on a mishmash of different types of computers and software. Many companies don't have compatible systems and either cannot or will not upgrade them. Even if they did, they collect different types of data that may or may not be useful to their partner companies. In this environment, "collaboration" and data synchronization become increasingly complex feats.

All information systems are composed of technology designed to perform three main functions: data capture and communication, data storage and retrieval, and data manipulation and reporting. Different systems have different combinations of capabilities, and the specific combination necessary for the retailer (or other supply chain partner) depends on the demands of the job.

Data Capture and Data Communications

The first functional area is composed of systems and technology that create high-speed data capture and communications networks. This is the technology that can overcome the lag times and lack of big-picture information that gives rise to the bullwhip effect. We will look at the following:

- The Internet
- Broadband
- EDI (electronic data interchange)
- XML (eXtensible Markup Language)

The Internet

The Internet is the global data communications network that uses what is known as Internet Protocol (IP) standards to move data from one point to another. The Internet is the universal communications network that can connect with all computers and communication devices. Once a device is hooked to the Internet, it can communicate with any other device that is also connected to the Internet, regardless of the different internal data formats that they may use.

Before the Internet, companies had to put in expensive, dedicated networks to connect themselves to other companies and move data among their different computer systems. Now, with the Internet already in place, companies have a way to quickly and inexpensively "connect" their computer systems. If needed, extra data protection and privacy can be provided by using technology to create virtual private networks (VPNs) that utilize the Internet to create very secure communication networks.

Broadband

Basically, this means any communications technology that offers high-speed (faster than a 56K dial-up modem) access to the Internet with a connection that is always on. This includes technologies such as coaxial cable, digital subscriber line (DSL), metro Ethernet, fixed wireless, and satellite. Broadband technology is spreading, and as it does, it becomes possible for companies in a supply chain to easily and inexpensively exchange large volumes of data in real time.

Most companies have connected themselves internally using local area network (LAN) technology (such as Ethernet) that gives them plenty of internal communications capability. Many companies have connected some or all of their different geographical locations using wide area network (WAN) technology (such as T1, T3, or frame relay). What is then required are additional high-speed, relatively low-cost connections between separate companies, and that is the role that broadband will play.

Electronic Data Interchange

Electronic data interchange (EDI) is a technology that was developed to transmit common types of data between companies that do business with each other. It was first deployed in the 1980s by large companies in the manufacturing, automobile, and transportation industries. It was built to automate back-office transactions such as the sending and receiving of purchase orders (known as “850” transactions), invoices (810), advance shipment notices (856), and back-order status (855), to name just a few. It originally was built to run on big, mainframe computers using value-added networks (VANs) to connect with other trading partners. That technology was expensive.

EDI allows retailers and suppliers to improve their supply chain performance with a technique called **vendor-managed inventory** (VMI). The vendor (supplier) is responsible for (and now technologically capable of) checking the product quantities in stores themselves and filling as needed to prevent out-of-stocks. Salespeople aren’t crazy about VMI, and neither are distributors—it takes some of their control away, including the ability to use sales promotions and discounts as incentives to move product. But, in effect, VMI shortens the retail supply chain and can reduce both overstocking and out-of-stock problems.

Many companies have large existing investments in EDI systems and find that it is very cost-effective to continue to use these systems to communicate with other businesses. Standard EDI data sets have been defined for a large number of business transactions. Companies can decide which data sets (and/or which parts of each data set) they will use. EDI systems can now run on any type of computer, from mainframe to PC, and they use the Internet for data communications as well as VANs. Costs for EDI technology have come down considerably.

XML

An abbreviation for **eXtensible Markup Language**, XML is a technology that has been developed to transmit data in flexible formats among computers, and between computers and humans. Where EDI uses rigid, predefined data sets to send data back and forth, XML is extensible—that is, it can be extended or expanded. It can be used to store any type of structured information and to encapsulate information to pass between computers that would otherwise be unable to communicate.

A little background in “computerspeak” here will help in understanding the importance of XML. Most Internet users by now are familiar with HTML (HyperText Markup Language), which is used to create Web pages. HTML is part of a larger language, a “mother tongue” for computers called SGML (Standard Generalized Markup Language). SGML is so huge that using it would bog down most applications, which do not require that much complexity anyway. So XML is a handier, scaled-down version of SGML that is easy for programmers to use and understand. And XML is a public format—the technology is not owned by any particular company. Anyone can use or view documents written in XML if he or she has a browser that works with XML, and most modern browsers either can read it outright or have the capability to process it by default.[2] (The clearest and most in-depth information we’ve been able to find about XML and related technological developments is from the University of Cork in Ireland, a “Frequently Asked Questions” page that is updated regularly, at www.ucc.ie/xml/.)

Once certain standards have been agreed upon, XML can be used to communicate a wide range of different kinds of data and related processing instructions among different computer systems. XML can also be used to communicate between computers and humans, because it can drive user interfaces (like Web browsers) and respond to human input. Unlike EDI, the exact data transactions and processing sequences do not have to be previously defined when using XML.

There are many evolving XML standards in different industries, but as yet, none of these standards has been widely adopted. The industry that has made the most progress in adopting XML standards is the electronics industry. They have implemented the RosettaNet XML standards (www.rosettanet.org).

In the near term, XML and EDI are merging into hybrid systems, evolving to meet the needs of companies in different supply chains. At this point, it is not cost-effective for companies with existing EDI systems that are working well enough to replace them with newer XML systems all at once. Instead, XML extensions are being grafted onto EDI systems. Software is available to quickly translate EDI data to XML and then back to EDI. Service providers are now offering Internet-based EDI to smaller suppliers who do business with large EDI-using customers.

In the longer term, EDI will be wholly consumed by XML as XML standards are agreed upon. As these standards become more widely accepted, they will enable very flexible communications among companies in a supply chain. XML will allow communications that are more spontaneous and free-form, like any human language. This kind of communication will drive a network of computers and people interacting with other computers and other people. The purpose of this network will be to coordinate supply operations on a daily basis.

And who said computer programming was boring?

Data Storage and Retrieval

The second functional area of an information system is the technology to store and retrieve data, known as database technology. A database is an organized grouping of data that is stored in an electronic format. The most common type of database uses what is called **relational database technology**. As the name suggests, a relational database stores related groups of data in individual tables and allows for retrieval of the data with the use of a standard language called structured query language (SQL).

A database is a model of the business processes for which it collects and stores data. The model is defined by the level of detail in the data it collects. The design of every database has to strike a balance between highly aggregate data at one extreme and highly detailed data at the other extreme. This balance is arrived at by weighing the needs and budget of a business against the increasing cost associated with more and more detailed data. The balance is reflected in what is called the data model of the database.

As events occur in a business process, there are database transactions. The data model of the database determines which transactions can be recorded, since the database cannot record transactions that are either more detailed or more aggregated than provided for in the data model. These transactions can be recorded as soon as they happen, called “real-time” updating, or they may be captured and recorded in batches that happen on a periodic basis, called “batch” updating.

A database also provides for the different data retrieval needs of the people who use it. People doing different jobs will need different combinations of data from the same database. These different combinations are called “views.” Views can be created and made available to people who need them to do their jobs. For instance, a database may contain the sales history for a range of different products to a range of different customers. A view of this data designed for a customer might show the customer the different products and quantities they purchased over a period of time and show detail of the purchases at each customer location. A manufacturer’s view might show all the customers who bought their group of products over a period of time and show details of each of the products that each customer bought.

Data Manipulation and Reporting

Different supply chain systems are created by combining processing logic to manipulate and display data with the technology required to capture, communicate, store, and retrieve data. The way that a system manipulates and displays the data that flows through it is determined by the specific business operations the system is designed to support. Information systems contain the processing logic needed by the business operations they support. Chopra and Meindl define several kinds of systems that support supply chain operations:

- *Enterprise resource planning (ERP)* systems gather data from across multiple functions in a company. ERP systems monitor orders, production schedules, raw material purchases, and finished goods inventory. They support a process-oriented view of business that cuts across different functional departments. For instance, an ERP system can view the entire order fulfillment process and track an order from the procurement of material to filling the order to delivery of the finished product to the customer.

  ERP systems come in modules that can be installed on their own or in combination with other modules. There are usually modules for finance, procurement, manufacturing, order fulfillment, human resources, and logistics. The focus of these modules is on carrying out and monitoring daily transactions; the downside of most ERP systems is that they lack the analytical capabilities needed to optimize the efficiency of these transactions.

- *Procurement systems* track the procurement activities that take place between a company and its suppliers, with the purpose of streamlining the procurement process and making it more efficient. Such systems typically replace supplier catalogs with an online product database that contains all the needed information about products the company buys. They also keep track of part numbers, prices, purchasing histories, and supplier performance.

  Procurement systems allow people to compare the price and performance capabilities of different suppliers. This way the best suppliers are identified so that relationships can be established with these suppliers and prices negotiated. The routine transactions that occur in the purchasing process can then, for the most part, be automated.

- *Advanced planning and scheduling (APS)* systems are highly analytical applications. Their purpose is to assess plant capacity, material availability, and customer demand. These systems then produce schedules for what to make in which plant and at what time. APS systems base their calculations on the input of transaction-level data that is extracted from ERP or legacy transaction processing systems. They then use linear programming techniques and other sophisticated algorithms to create the recommended schedules.
- *Transportation planning* systems calculate what quantities of materials should be brought to what locations at what times. The systems enable people to compare different modes of transportation, routes, and carriers, and use the comparisons to create transport plans for goods. The software for these systems is sold by system vendors. Other providers (known as “content vendors”) provide the data required for these systems—mileage, fuel costs, shipping tariffs, and so on.
- *Demand planning* systems use special techniques and algorithms to help a company forecast demand. These systems take historical sales data and information about planned promotions and other events that can affect customer demand, such as seasonality and market trends, and use this data to create models that help predict future sales.

  Another feature often associated with demand planning systems is *revenue management,* which lets a company experiment with different price mixes for its various products in light of the predicted demand. The idea is to find a mix of products and prices that maximizes total revenue to the company. Companies in the travel industry (airlines, rental car agencies, hotels) are major users of revenue management techniques. Other industries are just catching on to the value of this feature.
- *Customer relationship management (CRM)* systems automate many of the tasks related to servicing existing customers and finding new ones. They track buying patterns and histories of customers, and they consolidate it in a place where it is quickly accessible to customer service and salespeople. This enables them to better respond to customer requests.
- *Sales force automation (SFA)* systems allow a company to better coordinate and monitor the activities of its sales force. These systems automate many sales-related tasks—scheduling sales calls and follow-up visits, preparing quotes and proposals for customers and prospects, and so on.

Any of the preceding types of systems can be combined to form a supply chain management (SCM) system—a suite of different supply chain applications, tightly integrated with each other. An SCM system could be an integrated suite that contains advanced planning and scheduling, transportation planning, demand planning, and inventory planning applications. SCM systems rely on ERP or relevant legacy systems to provide them with the data to support the analysis and planning they do. These systems have the analytical capabilities to support strategic-level decision making.

[2]Peter Flynn, ed., “The XML FAQ v. 4.0,” (online at www.ucc.ie/xml), University of Cork, Ireland, January 1, 2005.

Inventory Management Systems

Retailers and most of the companies that service them also require computerized inventory management systems for the types of activities described in Chapter 3—tracking historical demand patterns for products, monitoring inventory levels of different products, calculating economic order quantities, and determining the levels of safety inventory that should be held for each product. These systems are used to find the right balance for a company between the cost of carrying inventory and the cost of running out of inventory, which also includes the resulting loss of sales revenue.

The latter consequence can be significant. Research has shown that when a product is out of stock, 31 percent of customers buy it at another store, 26 percent substitute another brand, 19 percent substitute another item of the same brand, 15 percent delay the purchase, and 9 percent end up not purchasing anything in that category.[3] Add the first and last categories on the list, and the store has only a 60 percent chance of making a sale in an OOS situation. Some of these consequences are bad for the retailer; others are bad for the manufacturer.

The same study indicates that so far, neither SCM nor POS technology has been able to impact the overall global out-of-stock numbers, which hover at between 8 and 10 percent in most stores. However, software manufacturers continue to try.

Along the way, before the finished merchandise arrives at a store, there are several types of inventory control systems at various points on the supply chain. These include the following:

- A *manufacturing execution system (MES)* focuses on carrying out the production activities in a factory. This kind of system is less analytical than an APS. It produces short-term production schedules and allocates raw materials and production resources within a single manufacturing plant. MES is similar in its operation to an ERP system; frequently, MES software is produced by ERP software vendors.

- *Transportation scheduling systems (TSS)* are similar to ERP and MES applications in that they are less analytical and more focused on daily operational issues. A transportation scheduling system produces short-term transportation and delivery schedules that are used by a company.
- *Warehouse management systems (WMS)* support daily warehouse operations. They provide capabilities to efficiently run a warehouse. These systems keep track of inventory levels and stocking locations within a warehouse, as well as the actions needed to pick, pack, and ship product to fill customer orders.

Supply Chain Skills—The Theory of Constraints Continued

We mentioned the book *The Goal* in Chapter 1, Eliyahu Goldratt's tale of a fictitious factory manager's quest to save the business from being closed for lack of profitability. What the manager and his staff members learn is how to apply the principles of what Goldratt calls the "Theory of Constraints."

This theory can apply to an entire supply chain as readily as it applies to a single business. In another book, *Basics of Supply Chain Management* (Boca Raton, FL: St. Lucie Press, 2001), Lawrence Fredendall and Ed Hill explain how to apply the Theory of Constraints in this manner.

It is based on the idea that all systems have at least one constraint, and that it is better to manage constraints than to try to eliminate them—because when one part of a system ceases to be a constraint, a different constraint will crop up in another part of the system. Constraints are inevitable because the capacities of each part of a system are not all the same. So, instead of forever reacting to new constraints or bottlenecks as they appear, why not choose a small group of constraints and manage them, deliberately and efficiently?

To apply this model, the first step is to define the goal and decide how to measure progress toward it. Goldratt's goal for a manufacturing company also works for a supply chain: "Increase throughput while simultaneously reducing both inventory and operating expense." (Remember, throughput is the rate at which sales to end customers occur.)

Once a goal has been defined and there is agreement on how to measure progress toward it, five steps can be taken to focus and clarify the situation, which should lead to the decisions necessary to reach the goal. The five steps are as follows:

- **Identify the system's bottlenecks or constraints.** Trace out the workflows and the paths that materials travel in a factory or a supply chain. Find out where slowdowns and backups occur.
- **Decide how to exploit these bottlenecks.** Figure out how to maximize the bottleneck activities. The rate of throughput for the entire system is set by the rate of throughput achieved by the bottlenecks. Ensure the bottlenecks operate at maximum capacity by providing them with enough inventory so they can continue to operate even if there are occasional slowdowns elsewhere in the system.
- **Do not try to maximize the operation of a non-bottleneck operation.** Additional productivity achieved by non-bottleneck operations that exceeds the capacity of the bottlenecks to process will be neutralized anyway by the slowdowns and backups caused at the bottlenecks. Synchronize all system operations to the rates that can be efficiently processed by the bottleneck operations.
- **Elevate the system's bottlenecks.** Add additional processing capacity to the bottleneck activities. Since the rate of throughput of the entire system is set by the throughput of the bottlenecks, improvements in the bottlenecks will increase the efficiency of the entire system and provide the best return on investment.
- **If in a previous step a bottleneck has been broken, go back to Step 1.** As the capacity of one system bottleneck is elevated, it may cease to be a bottleneck. The bottleneck may transfer to another operation that could keep up before but now cannot keep up with the new increase in capacity. Watch the entire system to see where slowdowns and backups occur; they may shift from one area to another. If this occurs, start again at Step 1.

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[3]Daniel S. Corsten, Thomas W. Gruen, and Bharadwaj Sundar, "Retail Out of Stocks: A Worldwide Examination of Extent, Causes, and Consumer Responses," Goizueta Business School, Emory University (Atlanta, Georgia), in *IntelligentCRM*, a newsletter of Intelligent Enterprise, CMP Media, LLC, San Francisco, California, March 27, 2001.

Assessing Technology and System Needs

When evaluating different systems that can be used to support a supply chain, it is important to keep in mind the goal—that is, the ultimate reason for using any of these systems. Customers want good service and good prices, and that's generally what guides them when they select companies with which to do business. Technology is a means for a company to be of service to its customers. Companies that keep this in mind do well.

In business, technology is only important insofar as it enables a company (or a supply chain) to deliver valuable products and services to its own customers profitably. Do not let the complexity or the details of any technology or system distract from this basic truth. Technology can be impressive, but it is not an end in itself.

Success in supply chain management comes from delivering the highest levels of service at the lowest cost. Technology is expensive and can quickly add a lot of cost to a business. It is a far better thing to use simple technology well than to use sophisticated technology without the skill to handle it.

E-Business and Supply Chain Integration

E-business absolutely requires the principles and practices of supply chain integration. In the words of Professors Hau Lee and Seungjin Whang of Stanford University, e-business specifically refers to "planning and execution of the front-end and back-end operations in a supply chain using the Internet."

In a November 2001 research paper entitled "E-Business and Supply Chain Integration" (and still available on Stanford University's Global Supply Chain Management Forum Web site, www.stanford.edu/group/scforum/), professors Lee and Whang introduce four key technological dimensions that create a sequence of greater integration and coordination among supply chain participants—culminating in entirely new ways to conduct business. The four dimensions are as follows:

1. *Information integration* is the ability to share relevant data among companies in a supply chain—sales history and demand forecasts, inventory status, production schedules, production capacities, sales promotions, and transportation schedules. This data should be available to the people who need it in a real-time, online format—over the Internet or a private network.

2. *Planning synchronization* is the joint participation of companies in the demand forecasting and the scheduling or inventory replenishment. It also includes collaborative design, development, and bringing new products to market.

3. *Workflow coordination* is the streamlining and automation of ongoing business activities across companies in the supply chain, like purchasing and product design.

4. *New business models* can emerge as a result of supply chain integration made possible by the Internet. Roles and responsibilities of companies in a supply chain can be redesigned to allow each company to truly concentrate on its core competencies, outsourcing the non-core activities to other companies. New capabilities and efficiencies will become possible.

The role of technology in global supply chains is discussed further in Chapter 10.

Chapter Summary

One of the most common dynamics in supply chains is the bullwhip effect. Small changes in product demand by the consumer at the front of the supply chain translate into wider and wider swings in demand as experienced by companies further back in the supply chain—the tail wagging the dog, so to speak. Without a well-coordinated supply chain that includes global data synchronization, companies at different stages in the supply chain come to have very different pictures of market demand. The chain fails to communicate accurate data, and each member suffers financial and logistical problems as a result.

Companies have learned that the bullwhip effect is no longer a business necessity—that it is more efficient for them to work together to reduce demand fluctuations by sharing data and coordinating their efforts.

The use of supporting technology is necessary for effective supply chain operations. This chapter explained the three major functions of information technology (IT) systems, as well as listed and defined all the types of software systems a company might use to forecast, schedule, manufacture, deliver, and/or track sales of goods and customer data. Together, various combinations of them are also sold as supply chain management (SCM) packages.

Clearly, technology has transformed the retail industry, allowing collaboration as never before. But the same problems are evident in the most sophisticated system as they were in the old-fashioned paper-in-triplicate invoice: The data must be accurate.

Discussion Questions

1. Aren't there some advantages to having a product that is in short enough supply to be considered "exclusive"? How would the bullwhip effect impact that type of product and its supply chain?
2. What kinds of extra or unnecessary costs would the bullwhip effect add to a retail supply chain?
3. What would a retail supply chain management system need in the way of types of data manipulation and reporting capabilities? Briefly list and explain your choices.
4. What is the difference between an APS, a CRM, and an ERP system, and which of the three would be the most beneficial to a retailer who could not afford to have them all?
5. How does the Theory of Constraints apply to retail stores? Are there "bottlenecks" in retail as there are in traditional manufacturing, shipping, and so on? Describe a couple of potential situations in which Goldratt's five points might be used to improve a store's operations.

The Incredible Journey Continues

SEPTEMBER 15—SHIPPING OUT

Because CVS usually orders products in volume, the pick quantities tend to be full pallets, so forklifts are used to transport the order instead of WL's network of automatic conveyor belts used for smaller orders. Every morning WL forklift operators use computers attached to their forklifts as well as handheld scanners with instructions screens linked to the McHugh system to learn what they need to pick up, where it's located, and where to transport it. When the lift operators get to the appropriate pallet, they scan the bar code with the handheld device so that the software can confirm it's the correct product. They next bring the pallet to the designated shipping door and use the onboard computer system and handheld to inform the McHugh system that the job is finished. Workers at the shipping door then load waiting trucks with the Listerine and other Warner-Lambert products ordered by CVS, says Mark Kuester, WL's director of logistics and customer support systems.

SEPTEMBER 16—THE HANDOFF TO CVS

The load appears at the CVS warehouse in Woonsocket. The trucking company sends WL confirmation of the delivery and who signed for it via EDI. As soon as the truck is unloaded, the CVS warehouse team generates an electronic receiving invoice telling the CVS accounts payable department that it received the goods from WL. The team also downloads the document to the company's data warehouse for future forecasting purposes and to the warehouse management system, which routes the pallets to the appropriate storage site in the warehouse. There they'll sit for as long as three weeks until they are shipped to fill orders placed by CVS stores.

What's noteworthy about CVS's supply chain?

CVS has 9 main warehouse facilities and 15 satellite facilities.The company's claim to supply chain fame comes from its ability to spread fixed costs across many stores by consolidating orders and coordinating demand and delivery between stores, says Gregory J. Owens, CIO-100 judge and worldwide managing partner for Andersen Consulting's supply chain management practice in Atlanta. If a truck has to deliver to one store, it might as well deliver to three others on the way. This saves money for CVS, which passes on the savings to its customers, says Owens.

Note: This figure has not been updated for 2005.
