THE INCREDIBLE JOURNEY

CONTINUES

OCTOBER 1—PRODUCT MEETS STAFF

In the wee hours of the morning, a CVS truck appears at McGee's store with his order. McGee unloads the tote in the back room and, voilà, there is the bottle of Listerine that originated in the Australian eucalyptus grove back in May. He displays it on the shelf according to the dictates of the store presentation managers at Woonsocket who determine ideal store layouts and product placement.

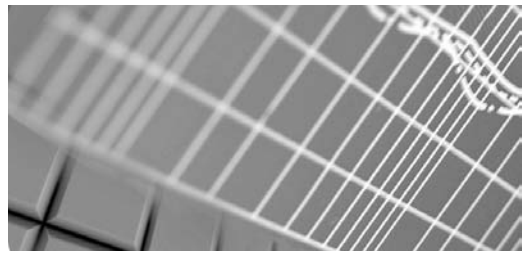
OCTOBER 2—THE PURCHASE

Now for the last step of our journey—the customer. A man walks into McGee's store to pick up aftershave and a box of chocolates for the date he's planned for the evening. On impulse, he decides to buy a bottle of Listerine. His purchase is recorded by the cash register and sent to E3 and Category Map that night for future forecasting. In a few days, McGee will place an order for a replacement bottle of Listerine. And so begins the cycle again.

How do store managers know how much product to stock?

CVS management frowns upon stores keeping extra inventory in the back room because it ties up capital. So instead of having each store manager project demand, once a year, category managers at headquarters analyze annual point-of-sale data generated in each store and calculate the weekly sales rate for every product by store. Then they multiply that number by 4 to get the minimum shelf quantity (MSQ). In other words, at any given time, CVS carries four weeks' worth of supplies on the shelves. At Mike McGee's store in Framingham, Massachusetts, the MSQ for the 500-milliliter bottle of the best-selling Listerine flavor, Cool Mint, is 20 because the store sells an average of five bottles per week.

CHAPTER



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THE REAL-TIME SUPPLY CHAIN AND BEYOND

The pace of business change and creativity today is both exciting and relentless. Innovative retailers in different market segments have learned to design and deploy their supply chains to improve their competitive positions in the markets they serve. They create supply chains that enable them to develop and deliver products, and provide levels of service at price points that their competitors cannot match.

What tools do they use to accomplish this? This chapter explains the importance of some of the current trends in retail supply chain management, including:

- The "always-on" connection and its impact on supply chain partners
- A realistic look at global sourcing
- Inventory management and product identification technology
- Strategic thinking for supply chain success
- The concepts of emergent behavior and adaptive behavior

We all sense that something profound has happened in the world since the invention of online communication. But it's about a lot more than the Internet or eCommerce, as you'll see in this chapter. It is about combining various types of technology with people skills—fine-tuning our abilities to cooperate and observe and learn from other business partners in a supply chain.

POWER ON DEMAND

As an historical analogy, let's consider what happened some 200 years ago at the beginning of a time period that came to be known as the Industrial Age. The people of the time sensed that powerful potential had been released with the invention and growing popularity of the steam engine. For the first time, this invention provided a movable source of power that could be generated on demand and efficiently harnessed to perform a wide variety of tasks.

The Industrial Age was not so much about the steam engine as it was about the possibilities it opened up with the power and convenience that it created in business. Of course, as the era continued, technology outgrew the steam engine as more advanced engine capabilities evolved: internal combustion, jet engines, electric motors, and even atomic power.

In much the same way, the Internet has created a new kind of "power on demand" that has changed the way business is done. Today, even the tiniest specialty firms work as part of a global, multidirectional communications network that is "always on." As more and more companies use the Internet, EDI, and other communications networks to create always-on connections, they find ways to share data that enable them to better coordinate their interactions. They also learn and adapt to changing conditions more quickly. These capabilities clearly result in efficiencies that can be turned into business profits.

The always-on connection is a new light that sheds steady illumination on a landscape that, before real-time connections, could be seen only in periodic snapshots. The effect is a lot like seeing a sequence of still photos turn into a moving picture. As more pictures are taken at shorter intervals, you cease to see a sequence of still photos and instead come to see a continuous, moving

image. This continuous, moving image is what we see as we move from the snapshot or batch-time world into the real-time world.

Supply chain management is a process of coordination between companies. Those companies that learn to coordinate comfortably in real time will become incrementally more efficient. They will become more profitable and perhaps see new opportunities more quickly than their competitors who are still working in a batch-time world of business snapshots.

The Challenges of Technology

As beneficial as all this sounds, it is not easy to automate a supply chain. There are many challenges to be faced by companies and their supply chain partners, who must commit to sharing data and keeping up with the technology once they've embarked on the course together. As *Advanced Manufacturing* magazine's online columnist Predrag Jakovljevic correctly observed, "Neither planning nor execution tools can fix a dysfunctional supply chain, but planners need to analyze and optimize both areas."[1]

Here are a few examples of issues that commonly create tension:

- It is often difficult to get suppliers on board. Mega-retailers like Wal-Mart, Albertsons, and Target can mandate the adoption of certain systems or technologies, but not everyone has this kind of clout. Deciding to automate a supply chain means not only your employees but other key players in the chain have to learn how to work with the new system. When automation means less work for the distributors, or layoffs of pickers and packers in the warehouses, not everyone is going to cooperate cheerfully.
- Most supply chains are made up of companies large and small, and not all of them can afford to make similar investments in technology. Better-funded partners in the chain must decide if their less prosperous partners' participation is important enough to step in and assist with the initial costs and/or system upgrades to allow the necessary interface.
- Retail is an intensely people-oriented business, and people throughout the supply chain may protest the lack of human contact in a highly automated system. Distributors' representatives may be more comfortable with phone calls and sales visits. Store managers pride themselves in knowing their inventory inside and out. They may balk at using a system that places automatic reorders or that stocks each store with exactly the same items and quantities. A balance must be struck between using technology and maintaining the uniqueness and camaraderie of the business relationships.
- "If you can't convince people that using the software will be worth their time, they will easily find ways to work around it," wrote Lee Pender in a 2001 article for *CIO* magazine. Forecasters and planners will soon decide the data is "useless" if they don't realize it takes a while to get the bugs worked out of a new implementation, and to input enough historical data to

the system to ensure accurate output. Retailers must also be confident about the security and reliability of their own systems, as well as those of their supply chain partners.

- The same *CIO* article mentioned the dilemma of companies that buy software and customize it. Customization is expensive, and often the original developer of the software or hardware will not support the altered system. In other words, companies can inadvertently lock themselves into using "homegrown" systems that may not provide the agility required to react to market changes or multichannel demands.[2]
- Multiple distribution channels require multiple supply chains. Office Depot is an example of a retailer with two separate supply chains—one for retail and store shipments, the other for corporate accounts that buy online or through its office supply catalogs—both under the purview of an executive vice president of supply chain to help avoid duplication of efforts.[3]

GLOBAL SOURCING

Another major supply chain trend today is a by-product of technology. Global sourcing is the ability of a company to get what it needs from anywhere on the planet, a trend that has skyrocketed in the last 50 years. The primary reasons companies look outside their traditional regions for manufacturing capacity are to take advantage of lower-cost materials and labor, or that they have discovered a more favorable climate for their type of business—more tax advantages, familiarity with certain types of industries, perhaps fewer environmental restrictions, and so forth. Many nations have, in turn, scrambled to make these foreign investment arrangements even more appealing.

There are two types of technology that have allowed global sourcing to blossom. One is the use of communications technology, such as the Internet, cellular phones, wireless technology, and the like. The other is that international freight companies have developed larger and more sophisticated vessels, more than double the size of "traditional" cargo ships. They can now carry so much more freight per load that they have significantly reduced shipping costs—by some estimates, up to 70 percent less than in past decades.

While the cost impacts of these developments may be impressive, they also increase the complexity—and literally stretch the length—of the retail supply chain. A 2003 study by Maersk Logistics, the giant Danish-based shipping company, showed that compared to a domestic supply chain, there may be as many as seven additional partners in a global supply chain—from customs departments to compliance authorities to the freight companies themselves. The long overseas manufacturing and shipping journey may add only 2 to 5 percent to the final cost of the item but may account for 30 to 50 percent of the item's total time in the supply chain.[4]

More partners and more distance between them also mean more room for

error. Back in 1988, professors Constantinos Markides and Norman Berg criticized some of the first efforts to move American manufacturing operations offshore in a report published in the *Harvard Business Review*. Alan Braithwaite, executive chairman of LCP Consulting in the United Kingdom, says their initial points ring true almost 20 years later:

- There are risks that the total acquisition cost may be greater than anticipated and erode the net benefits that the initial purchase cost implies. When all factors including transportation, handling, duty, obsolescence, inventory, lost sales, and "market blocking" are factored in, the total cost may not be as attractive as the headline advantage—labor costs are typically as little as 7 to 10 percent of the total product costs, and even less on the selling price (of most items).
- The extended chain cannot be as responsive to demand variations as local sourcing; hence, there may be opportunity costs of lost sales.
- There may be risks with quality and execution due to the long-distance relationships and the many handoffs in the process to move the product to its destination. Inaccuracies cause service failure and hence (increase) cost.
- Valuable know-how may be given away to vendors, allowing others to enter markets and for product and engineering skills to be lost.
- The long-term impact on supply and demand is less clear and may distort markets, both in terms of the benefits gained and also for the risks of secure supply.[5]

Markides and Berg did not take into account another reasonable assumption that has come to light more recently—that unstable governments and terrorist threats can disrupt commerce just about anywhere in the world today. In addition, the glut of containers entering the United States—at least 7 million of them per year—has caused enormous backlogs at seaports, in Customs, and with Homeland Security's efforts to screen the incoming merchandise in antidrug and antiterrorism efforts.[6]

Braithwaite, working with England's Cranfield School of Management, has charted the types of supply chain risks companies face (as seen in Figure 10-1), in three external and three internal categories. The external categories include the following:

- *Demand risks* are potential or actual disturbances to the flow of product, information, and/or cash that begin in one company and impact other companies and customers "downstream" in the supply chain.
- *Supply risks* are the upstream equivalent of demand risk; they relate to potential or actual disturbances to the flow or product or information that disrupt companies "upstream" in the supply chain.
- *Environmental risks* are external, uncontrollable events that can impact a company directly or through its suppliers or customers, upstream or downstream.

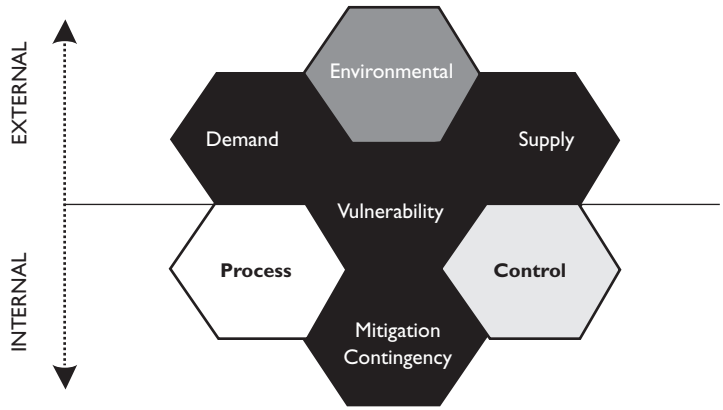

Figure 10-1. The drivers of supply chain risk. (The use of global sourcing increases supply chain risks, making companies vulnerable in a number of areas.) (Source: Alan Braithwaite, LCP Consulting, Ltd., Berkhamsetd, United Kingdom and Cranfield School of Management, Bedfordshire, United Kingdom. Used with permission of Alan Braithwaite.)

The internal risks can be categorized as follows:

- *Process risks* are disruptions to the managerial or value-adding activities undertaken by a company, which are likely to be dependent on internally owned or managed assets and a functioning infrastructure.
- *Control risks* occur when the rules, systems, and procedures used by a company are applied or misapplied, either way with incorrect results. They include anything from safety stock policies to order quantities to the way assets are managed in a company.
- *Mitigation* is a hedge against risk built into the operations; hence, the lack of mitigation can itself be a risk. *Contingency* is the existence of a plan, and resources that can be mobilized to carry it out, in case a risk is identified.

In short, retailers must consider all aspects of their global partnerships to accurately quantify the risks as well as the benefits, and even when cost savings are evident, they must still plan much further in advance in order to take advantage of them. Every company's senior management team deals with potential risk factors differently, and Braithwaite's conclusion is that "global sourcing is not a consistent proxy for higher sustained profits."[7]

RETAIL TECHNOLOGY TRENDS

The types of technology most likely to impact retail supply chain partners in the coming years are as follows.

In inventory management, order pickers who pull and group products to prepare them for shipment in a traditional warehouse generally start at an assignment desk, where they are given their orders on papers known as **picking labels**. They refer to the labels as they go through the warehouse and select the merchandise that corresponds with the labels.

Using **voice-activated technology**, the picker wears a headset and microphone, and a wireless terminal on his or her belt that links to the software of a warehouse management system (WMS). The system tells the person what to pick (and perhaps where it is located); the worker responds by speaking to the system through the microphone. The system is sophisticated enough to recognize human speech, and it can be programmed to trigger inventory counts and restocking activities. Voice-directed picking is 10 to 20 percent more accurate than the old system and has the side benefit of keeping the warehouse cleaner with the elimination of paper labels.[8]

Universal Product Codes, more commonly known as *UPCs* or **bar codes**, have been in existence for more than 30 years. The original idea behind this system of instant product identification by a computerized reader or scanner was to speed up checkout time at stores and improve the accuracy of prices, and for these aims it has been a huge hit. There are literally trillions of bar codes printed and placed on products worldwide every year! But technology will certainly change—and perhaps eventually eliminate—bar codes in the coming decades, for several reasons.

First, the plethora of new products demands the constant creation of new codes, and with only 12 digits in the United States and 13 digits in Europe's Electronic Article Numbering (EAN) bar code system, these systems are reaching their practical limits. Second, the global nature of business also makes a single code system a smarter idea. The Uniform Code Council (UCC) suggests adopting a 14-digit code system called **Global Trade Identification Numbers (GTIN)**. Third, there are limits to the amount of information that can be contained in a single bar code—hence, the development of two- and three-dimensional (2-D and 3-D) bar codes. They require special bar code readers. All three of these developments in bar code technology require significant additional investment on the part of supply chain members.[9]

Some businesses are hesitant to make bar code investments because they believe the future of product identification is in **radio frequency identification (RFID)**. RFID tags are small computer chips placed on products. The chip transmits a large volume of information about the product to a wireless reading device, far more than a bar code can contain. The device does not have to make contact with the chip, or even be in its line of sight, in order to "read" it. RFID allows for an amazing amount of precision and accuracy in inventory management, giving companies the capability to literally track a shipment's exact whereabouts in the supply chain.

Wal-Mart made headlines when it mandated its Top 100 suppliers to be RFID-compliant by January 2005, which sent them scrambling. The problem has been that this new technology is expensive. The chips themselves cost far more to manufacture—now and in the foreseeable future—than the much simpler bar code label, and they require new, more sophisticated types of readers and software. Thus far, most companies are experimenting with RFID tags on

SUPPLY CHAIN SKILLS—HOME DEPOT'S SELF-CHECKOUT PAYS OFF

In 2003, Home Depot announced plans to increase capital spending 21 percent (to $4 billion) for store remodeling and using technology to improve customer service. The list of projects included the creation of digital dashboards to monitor store operations, reengineering business processes to focus employees' efforts on the sales floor, upgrading point-of-sale equipment, speeding up replenishment at stores, and implementing SAP (the leading ERP software system).

The company decided its best move would be to use technology to up-sell goods and services. Self-checkout aisles allow Home Depot to deploy an average of two cashiers to the floor instead of standing behind the checkout counter. These people can restock shelves or sell big-ticket items like appliances and kitchen cabinets. If one former cashier sells just one customer on a home installation in every Home Depot store, that equates to $1 billion in additional revenue per year! Kiosks can be used to handle special orders when products such as window treatments aren't in-store.

The result: a steady increase in average tickets (sales totals). The retailer closed 2004 with an average ticket of $54.89, up 7.3 percent from fiscal 2003's tally of $51.15.

On the back end of the store, Home Depot is rolling out an automated inventory replenishment system. Its pilot project with the new system showed 20 percent fewer out-of-stocks. The 2005 goal is to have auto-replenishment systems for 20 percent of the SKUs carried in Home Depot stores.

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caseloads or containers rather than individual products. RFID-related expenditures are expected to approach $27 billion by 2015, compared to $2 billion in 2005.[10]

THINKING STRATEGICALLY

In addition to linking to other members of a supply chain, companies that are competitors are learning to link up for procurement purposes in collaborative **trade exchanges**. Six major airlines, for example, have joined forces to buy at least some goods together. The trade association Grocery Manufacturers of America has spearheaded one of the largest trade exchange efforts with more than a dozen major consumer goods companies. The idea is still fairly new, but member companies of the GMA trade exchange can purchase materials, supplies, and services from each other, and even share cargo space jointly to

increase efficiency. Companies that regularly order electronic components can do so on iSuppli, an online trade exchange for manufacturers.[11] All of this collaboration is enabled by technology and aimed at reducing costs and improving supply chain efficiencies.

Many of the global supply chain risks outlined earlier in this chapter can be managed with strategic thinking. Companies can design products using generic materials or components that can be used in a number of products instead of just one. Orders can be filled based on a forecast made just before the order is placed, improving accuracy. RFID technology will allow products to be correctly identified and tracked at every moment during their journey through the supply chain.

The Self-Adjusting Feedback Loop

Tracking performance and making adjustments accordingly is sometimes called a **self-adjusting feedback loop**, and it is another useful tool in the supply chain arsenal. A simple example of the principle is the cruise control in an automobile, which constantly compares the vehicle's actual speed to the speed it was set for and responds to bring the actual speed in line with the desired speed. This causes the engine to either accelerate or decelerate accordingly. You might say the cruise control is operating the engine in order to achieve its goal.

Other examples of self-adjusting feedback loops are a thermostat that controls the temperature in a room and a guided missile that zeros in on a heat source or radar emission source. Self-adjusting feedback loops use negative feedback to continuously correct their behavior—and that does not mean "negative" in the sense of criticism. This type of negative feedback occurs when a system compares its current state with its desired state (or goal) and takes *corrective action* to move it in the direction that minimizes the difference between the two states. A continuous stream of negative feedback guides a system through a changing environment toward its goal.

How can the self-adjusting feedback loop be used in a supply chain? As companies link up using always-on communication networks to conduct business, they begin to collect useful data as a by-product of their interactions: electronic purchase orders, order status, order receipts, invoices, payment histories, and so on. It is no longer a huge administrative chore to regularly track performance in the "big four" areas of customer service, internal efficiency, demand flexibility, and product development.

Performance can also be tracked by individual store or sales associates. For example, Home Depot receives more than 200 customer comments per store, per week—and it's not because they fill out and mail in customer comment cards. Every sales receipt has a code number printed on it, with instructions prompting consumers to rank their sales experience in a simple format on the company's Web site.[12]

Similarly, corporate customers can use supply chain "report cards" to grade the performance of their suppliers and to ask for suppliers' critiques in return. The next step is for companies to move beyond using these report cards as merely convenient tools for "beating up" their suppliers, looking instead for ways to work together to meet mutually beneficial performance targets. A dominant company in the chain can set the performance targets, or groups of companies can negotiate among themselves to set targets. The important things are that all participating companies in a supply chain believe the targets are achievable—and that when they are achieved, there will be rewards as a result.

The natural desire to receive these rewards is what brings the self-adjusting feedback loop to life. If companies and people in a supply chain have real-time access to the data they need, then for the most part, they will steer toward their targets. If they are rewarded when they achieve these targets, then they will learn to hit them more often than not, allowing companies to realize the profit potential of the feedback loop.

SCM as a Strategy Game

Supply chain management is often such serious business that perhaps it would be helpful to think of it for a moment as a game of strategy. From childhood, most of us learn and improve our skills by playing games. Companies such as Wal-Mart and Dell and their supply chain partners have, in many ways, created evolving games of managing their supply chains. They have steadily learned and developed supply chain organizations that are better than those of their competitors, and that clearly hold business advantages for them.

There are only a few things required to start a game. In the early 1990s, SRC Holdings Group (formerly Springfield Remanufacturing Group) President and CEO Jack Stack wrote a popular business book, *The Great Game of Business*. In it, Stack laid out the four conditions that are needed (in this case, for a business pursuit) to qualify as a "game":

1. People must understand the rules of the game and how it is played. They must know what is fair, what is not fair, and how to score points.
2. People must be able to pick the roles or positions they want to play in the game. They must also get the training and experience necessary to keep developing the skills required to succeed in their positions.
3. All players must know what the score is at all times. They need to know if they are winning or losing, and they need to see the results of their actions.
4. All players must have a personal stake in the outcome of the game. There must be some important reward, either monetary or psychological, that provides a reason for each player to strive to succeed.[13]

Seen in these terms, the "game" of supply chain management is not quite as complex as today's business experts would have one believe. In fact, the

game is relatively simple, like soccer or basketball or golf—which is not to say that any of these pursuits can be mastered without years of practice and play! The main techniques and operations of supply chain management are well enough understood to be taught to a wide range of people in different supply chain positions. Online, real-time access is the way for everyone to know the score at all times and see the results of their actions. Profits generated by operating efficiencies provide people with rewards and reasons to strive to succeed.

In supply chain management, everyone can acquire and install technology, so technology alone cannot constitute a significant competitive advantage. The advantage, then, must lie in the way the game is played. Let's rethink the example of Alexander the Great in Chapter 1. Remember, his army did not have any type of technology that was not also available to his opponents—in fact, Alexander deliberately used less technology. He simplified his army's operations and equipment in order to make it more mobile and more efficient, and, therefore, his army could travel faster and lighter than his adversaries' forces.

Advantage goes to those players who learn to use simple technology and simple tactics extremely well. Alexander's soldiers were well trained in how to use their technology. Further, the simplicity of their tactics allowed the soldiers to remember and use them effectively in the heat of the moment, when it really counted.

Even today, supply chain success is often just a matter of consistent performance and making fewer errors than the competition.

Recognizing Emergent Behavior

In the workings of a free market system, we witness **emergent behavior**—an interconnected system of relatively simple elements, which begins to self-organize to form a more intelligent and adaptive higher-level system. The famous British economist Adam Smith referred to it as the "invisible hand" of the market, which "emerges" to set product prices so that available supplies are best allocated to meet market demands. Local interactions between large numbers of agents, governed by simple rules of mutual feedback, produce a macro effect that results in emergent behavior of the system as a whole.

If we begin to think of supply chain management as a game between companies and people who are motivated to achieve certain performance targets, we see emergent behavior in supply chains. Good "players" in the supply chains of particular markets seek each other out because by playing together they can create more efficient supply chains and generate better profits. Modern supply chains form like sports teams, who compete with each other for market share. Just as the games of basketball or soccer evolve over time, so too does the game of supply chain management. New tactics, techniques, and

SUPPLY CHAIN SKILLS—EMERGENT BEHAVIOR IN SUPPLY CHAINS

Steven Johnson is a "techie" and former magazine editor who authored the book *Emergence: The Connected Lives of Ants, Brains, Cities, and Software* (Scribner, 2002). Michael Hugos asked Johnson to share his insights, including how companies can organize their supply chains to encourage and benefit from emergent behavior.

Q: What is an "emergent system"? How is an emergent system different from, say, an assembly line?

A: The catchphrase I sometimes use is that an emergent system is "smarter" than the sum of its parts. They tend to be systems made up of many interacting agents, each of which is following relatively simple rules governing its encounters with other agents. Somehow, out of all these local interactions, a higher-level, global intelligence "emerges." The extraordinary thing about these systems is that there's no master planner or executive branch—the overall group creates the intelligence and adaptability; it's not something passed down from the leadership. An ant colony is a great example of this: Colonies manage to pull off extraordinary feats of resource management and engineering and task allocation, all by following remarkably simple rules of interaction, using a simple chemical language to communicate. There's a queen ant in the colony, but she's only called that because she's the chief reproductive engine for the colony. She doesn't have any actual command authority. The ordinary ants just do the thinking collectively, without a leader.

A key difference between an emergent system and an assembly line lies in the fluidity of the emergent system: Randomness is a key component of the way an ant colony will explore a given environment—take the random element out, and the colony gets much less interesting, much less capable of stumbling across new ideas. Assembly lines are all about setting fixed patterns and eliminating randomness; emergence is all about stumbling across new patterns that work better than the old ones.

Q: You refer to emergent systems as "bottom up," not "top down," because they solve problems by drawing on masses of simple elements instead of relying on a single, intelligent "executive branch." What does this mean for people who are trying to design and build emergent systems?

A: One of the central lessons, I think, is that emergent systems are always slightly out of control. Their unpredictability is part of their charm—and their power—but it can be threatening to engineers and planners who have been trained to eliminate unpredictability at every turn. Some of the systems that I've looked at combine emergent properties and evolutionary ones: The emergent system generates lots of new configurations and ideas, and then there's a kind of natural selection that weeds out the bad ideas and encourages the good ones. That's largely what a designer of emergent systems should think about doing; it's closer to growing a garden than it is to building a factory.

Q: What do you mean when you say that emergent systems display "complex adaptive behavior"?

A: The complexity refers to the number of interacting parts, like the thousands of ants in a colony, or the pedestrians on a street in a busy city. Adaptive behavior is what happens when all those component parts create useful higher-level structures or patterns of behavior with their group interactions, when they create something, usually unwittingly, that benefits the members of the group. When an ant colony determines the shortest route to a new source of food and quickly assembles a line of ants to transport the food back to the nest; when thousands of urbanites create a neighborhood with a distinct personality that helps organize and give shape to an otherwise overwhelming city—these are examples of adaptive behavior.

Q: What is negative feedback, as opposed to positive feedback? What role does negative feedback play in the ability of a system to exhibit adaptive behavior?

A: Negative feedback is crucial, and it's not at all negative in a value-judgment sense. Positive feedback is what we generally mean when we talk about feedback, as in the "guitar effect" that we first started to hear as music in the 60s—music is played through a speaker, which is picked up by a microphone, which then broadcasts it out though the speaker, creating a sound that the microphone picks up, and so on until you get a howling noise that sounds nothing like the original music.

So positive feedback is a kind of self-perpetuating, additive effect: plug output A into input B, which is plugged into input A. Negative feedback is what you use when you need to dampen down a chain like this, when there's a danger of a kind of runaway effect, or when you're trying to home in on a specific target. Think of a thermostat trying to reach a preset temperature: It samples the air, and if the air's too cold, it turns the heat on, then samples it again. Without negative feedback, the room would just keep getting hotter, but the thermostat has been designed to turn the heat off when the air reaches the target temperature.

Ants use a comparable technique to achieve the right balance of task allocation throughout the colony. An individual ant who happens to be on foraging duty will sample the number of ants also on foraging duty that she stumbles across over the course of an hour. If she encounters a certain number, she'll switch over to another task (nest building, say) in order to keep the colony from becoming overrun with foragers.

Q: In your book, you mention a designer who has proposed building a learning network of traffic lights that will find an optimal solution to continually changing traffic conditions. You observe that, "You can conquer gridlock by making the grid itself smart." What is it that would make the grid smart, and would this grid be an example of an emergent system?

A: The idea proposed in the traffic model is not to take the traditional engineering, top-down approach and say: "Let's look at the entire city and figure out where all the problems are, and try to design the roads and the light system to eliminate the problems." The smart grid

Continued

approach is to give each light a local perspective with a little bit of information, and give it the goal of minimizing delays at its own little corner. So the light would be able to register the number of cars stacked up at the intersection, and it would be able to experiment with different rhythms of red and green, with some feedback from its near neighbors. When it stumbles across a pattern that reduces delays, it sticks to that pattern; if the delays start piling up again, it starts experimenting again. The problem with this sort of approach is that on Day One, it's a terrible, terrible system, because it doesn't yet know anything about traffic flows! You'd have to teach it quite a bit before you could actually implement it. But it would learn very quickly, and most importantly, it would be capable of responding to changing conditions in a way that the traditionally engineered approach would not. That's a hallmark of adaptability.

Q: Okay, let's apply these ideas to a system composed of many different companies—a supply chain, whose goal is to provide a market with the highest levels of responsiveness at the lowest cost to themselves. High levels of responsiveness require that these companies work together to design, make, and deliver the right products at the right price at the right time in the right amounts. What could these companies do to organize themselves into an emergent system?

A: There's a telltale term in supply chain systems, which may well be unavoidable—the term "chain" itself. Almost all emergent systems are networks or grids; they tend to be flatter and more horizontal, with interaction possible between all the various agents. The problem that supply chains have with positive feedback revolves around the distance between the consumer and those suppliers further down the chain; because the information has to pass through so many intermediaries, you get distortion in the message. Most emergent systems that I've looked at have a great diversity of potential routes that information can follow. The more chainlike they become, the less adaptive they are.

The other key here is experimentation: letting the system evolve new patterns of interaction on its own, since these can often be more useful and efficient than the preplanned ones. Of course, you don't want to waste a few economic quarters experimenting with different supply chains, most of which are a disaster. But that's where some of the wonderful new modeling systems for complex behavior can be very handy—you can do the experimenting on the computer and then pick the best solutions to implement in real life.

technology will continue to be introduced. Market demands and the desire for competitive advantage will drive companies to collaborate and innovate with each other to win at this game. Some chains (and retailers) will remain at the forefront; others will lag behind.

Computers are best used to automate the rote, repetitious activities that humans consider boring—the routine and/or mundane activities of recording and monitoring supply chain operations. Computers do these tasks very well.

SUPPLY CHAIN SKILLS—FUTURE BUSINESS TRENDS

In February 2005, Robert J. Bowman, senior editor of *Global Logistics & Supply Chain Strategies* magazine, shared his choices of 10 business trends that make supply chain management, in his words, "more complex than ever before." These are most definitely the areas to watch in retail as well as many other industries.

Look on the Web site SupplyChainBrain.com for the current issue of *Global Logistics & Supply Chain Strategies,* as well as archives of past issues and many case studies involving specific companies and how they are meeting these "top 10" challenges.

1. **Globalization.** In a relentless push for cost-cutting, companies large and small are sourcing product far from their markets. China is the location of the new gold rush for cheap manufacturing. Recent surveys by Deloitte Research found that more than 80 percent of manufacturers are either buying, or plan to buy over the next three years, components from other countries. Nearly half engineer products outside their home regions. In this regard, don't think of a supply "chain," forged from links of steel. Visualize a rubber band: stretch it too far, and it snaps.
2. **The need for supply chain agility, coupled with lower inventories.** Customers want it yesterday. Just-in-time is the new executive mantra. And products are getting to market with unprecedented speed. According to Deloitte, manufacturers over the last three years have cut product-development cycles by an average of 12 percent, to 16 months. By 2006, that span will have shrunk to 13 months. At the same time, companies are struggling to slash inventory levels, even as they acknowledge the need for core safety stocks in the event of supply interruptions, labor unrest, natural disasters, terrorist attacks or unforeseen shifts in consumer demand.
3. **Mass customization and make-to-order.** In another form of supply-chain agility, manufacturers are looking to meet the needs of individual customers, configuring product in countless ways. Dell Computer led the way on the consumer side. Cisco Systems has long offered a universe of options to its high-tech manufacturing base. The technique calls for highly efficient postponement programs, where basic components are customized at the moment of sale. The impact on supply chains? More complexity, of course.
4. **New-product mania.** Increasingly rare is the consumer item that looks the same—or even continues to exist—a year or two later. Faced with a limited base of consumers, suppliers and retailers are forever shoving new items into the limelight. SKU proliferation is rampant; just walk down the toothpaste aisle of any superstore. In 2003, Deloitte said products introduced within the previous three years would generate 29 percent of manufacturers' total revenues for the year. That compares with 21 percent in 1998, and a projected 35 percent in 2006.

Continued

5. **Value-added services.** Manufacturers used to make product or components, then sell them. Not anymore. In a bid to cut overhead, buyers are demanding a raft of underlying services from suppliers. Vendor-managed inventory (VMI) programs delay the ownership of goods until the last possible moment—and saddle the supplier with the job of managing stocks. Even contract manufacturers are getting into the game, offering third-party logistics services and direct shipment to end users, bypassing original equipment manufacturers (OEMs).
6. **Outsourcing.** The rush to abandon links of the supply chain to outsiders continues. First, it was back-office processes like accounting and payroll. Then came logistics. Next, nominal manufacturers gave away their assembly work to contractors. Other functions ripe for outsourcing include information-systems management, call centers, service-parts-repair, product engineering and chief executive officers (well, maybe not that last one). The result is more partners in the chain—and more chances for failure.
7. **Security.** For contemporary society, September 11, 2001 was in many respects the dividing line between Before and After. For business, it meant a whole new universe of security concerns. Billions of dollars have been spent on additional security measures, documentation and oversight. And it's still not enough. Ports and airports remain highly vulnerable to attack, analysts say. Listen to Noha Tohamy of Forrester Research: "The next terrorist attack is likely to be staged through a supply chain."
8. **New rules on corporate governance.** The hijinks of executives at companies like Enron and WorldCom have given rise to a slew of regulations, including the Sarbanes-Oxley Act, requiring companies to keep a tight rein over operations. The new reporting and accounting laws will have a huge impact on day-to-day supply-chain management, which touches virtually every aspect of a company's operations.
9. **Mergers and acquisitions.** Whether it's hard goods, soft goods or software, big companies are gobbling up smaller ones and growing even bigger in the process. This unstoppable trend raises some new issues of scalability for the survivors. How does a typical supply chain handle massive, overnight growth in revenues, product mix and customers? In most cases, not very well.
10. **Technology.** Wasn't this supposed to make things simpler? On the contrary, with every new convenience offered by innovative software or hardware, new complications arise. On balance, the impact on supply chains is usually a positive one, but getting to that point may require lots of time, money and migraines.

Source: Robert J. Bowman, "Supply-Chain Complexity Masters: A Special Report," *Global Logistics & Supply Chain Strategies*, Keller International Publishing, Great Neck, New York, February 2005.

They do not fall asleep, they do not miss details, and they can handle enormous volumes of data without complaint.

Human skills are best suited to the creative and problem-solving activities, putting their minds to work on problems that do not have clear right or wrong answers. These are the types of pursuits that call for people to collaborate, to share information and try different approaches to see which ones work best. People are good at strategic activities, and they like doing them—so they learn and keep getting better at them.

At a macro level, this will give rise to supply chains that, in effect, learn and grow smarter. Computers will listen to the hum and crackle of data flowing through the real-time, always-on supply chain. They will employ pattern recognition algorithms to spot exceptions and events, and they'll be programmed to bring these to the attention of human beings. Like good pilots and navigators, people will learn to respond effectively to these developments as they happen. People will learn to keep steering their supply chain on a course toward its desired performance targets.

ADAPTIVE NETWORKS

Cynical consumers may assume that the closer companies in a supply chain work together, the more they are probably conspiring to boost profits at the expense of the "little guy," but that is both a limited—and limiting—viewpoint. Instead, technology and the cooperation it enables can give retailers and their business partners the ability to recognize and smooth out excessive swings in demand, prices, and productive capacity. If other companies in other areas of the economy do the same, it should create greater stability.

In industries ranging from electronics manufacturing to real estate development to telecommunications, the bullwhip effect and related boom-to-bust cycles have caused nothing but waste and disruption—and, of course, news headlines that unnerve consumers and investors. These cycles also bring with them all the related human hardships. Think of the wealth that was destroyed by the excessive investments that created more dot-com companies and more telecommunications capacity than were needed. Think of the shutdowns and job losses when these companies and their suppliers finally had to face the consequences of too much supply and not enough demand.

Adaptive supply chain networks using real-time information and "negative" feedback can effectively dampen excessive market swings. This ability alone will have a wealth creation effect that is even more powerful than what was created by the steam engine two centuries ago. Retailers should be excited to be part of it.

CHAPTER SUMMARY

The "always-on" connection of the Internet and other communications networks allows companies to see themselves and their supply chain partners' data in real time. This makes it possible to constantly adjust, week to week or even day to day, to gain significant new efficiencies in almost every aspect of business. At least, that's the ideal.

However, adapting to technology requires enormous flexibility and financial expenditures, and every company handles the changes differently. This chapter mentioned several of the most common challenges faced by supply chains trying to get all members "up and running" with compatible systems and software.

Global sourcing is so common as to not even be considered a trend anymore, but it is included in this chapter as a by-product of technology, and to prompt discussion of the inherent risks in "stretching" the supply chain across continents. Most of the risks can be grouped into one of six categories, and each must be mitigated to realize the full benefit of global business. Companies must see the risks realistically in order to decide whether the potential savings are worth using foreign suppliers and/or participating in trade exchanges.

Other types of technology mentioned in the chapter are employed to improve communication, increase supply chain efficiencies, and reduce costs—or all three.

The chapter ended by bringing the human elements of business back into the picture, because it is humans who will use the technology to make strategic decisions. The authors suggest seeing the basics of supply chain management as a sport or game to cut through the complexity. Everyone in the game needs to know how to play, how to score points, and how to get the skills they need to improve their performance. The self-adjusting feedback loop is harnessed to the supply chain through the daily actions of the people who carry out supply chain operations. They can be motivated by rewards for achieving predefined performance targets and armed with real-time information that shows them how to hit their targets more often than not.

The potential emergent behavior that can be created by this dynamic will create supply chains that are both highly responsive and very efficient. Real-time operation results in supply chains that can better adapt to business changes and deliver performance and profitability without compromising quality or service for the end users of retail products.

DISCUSSION QUESTIONS

1. Other than the obvious—steam engines, automobiles, airplanes, telephones, computers—name at least one other invention of past centuries that changed the way people and companies do business. Has it evolved into something that is still useful today?
2. Give a hypothetical example of each of the six types of risk to a global supply chain, as described in this chapter.
3. Is a supply chain a type of self-adjusting feedback loop? Why or why not?
4. How do you feel about competitor companies teaming up in trade exchanges? How much cooperation is "too much," in your opinion? How should companies avoid collusion or the appearance of unethical tactics?
5. In the "game" of supply chain management, name two of today's retailers that you believe have been left behind, so to speak. Explain the reasons for your choice. What could they do to catch up?

ENDNOTES

1. Predrag Jakovljevic, "It's One Thing to Plan, and Another to Execute," Advanced Manufacturing, © CLB Media, Inc., Aurora, Ontario, Canada, January 2005.
2. Lee Pender, "The 5 Keys to Supply Chain Success," *CIO* magazine, © CXO Media, Inc., Framingham, Massachusetts, July 15, 2001.
3. David Hannon, "Retailers Push the Logistics Learning Curve," *Purchasing* magazine, © Reed Business Information, Inc., New York, September 2, 2004.
4. Alan Braithwaite, "Making Global Networks that Maximize Net Margins," for Maersk Logistics, a division of A.P. Moller-Maersk Group, Esplanaden, Copenhagen, Denmark, 2003. Used with permission of the author.
5. Alan Braithwaite, "The Supply Chain Risks of Global Sourcing," © LCP Consulting, Berkhamsted, United Kingdom. Used with permission of the author.
6. 2004 estimate, Retail Industry Leaders Association, Arlington, Virginia.
7. See endnote 5.
8. "A Guide to Voice Technology in Warehousing," VoicePicking.com, © Information Technology Toolbox, Inc., Scottsdale, Arizona, April 2005.
9. "The UPC Bar Code at 30 Years of Age," Retail Insight, newsletter of LakeWest Group, LLC, Cleveland, Ohio, April 2004.
10. Evan Schurman, "RFID Market In for Major Shakeup, Report Shows," eWeek.com, © 2005, Ziff Davis Publishing Holdings, Inc., New York, April 7, 2005. All rights reserved.
11. Daniel Lord, "B2B eCommerce," © Business Insights, Ltd., London, United Kingdom, 2001.
12. "Home Depot Self-Checkout Boosts Sales, Satisfaction," eWeek.com, © Ziff Davis Media, Inc., New York, April 10, 2005.
13. Jack Stack, *The Great Game of Business* (New York: Doubleday/Currency Publishing, 1992).