

Lean Supply Chain Management in the Fashion Industry

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Executive Summary

Fashion is the bellwether of change. In keeping with its reputation for the highest level of customer responsiveness, the fashion industry is poised to respond strategically to major changes occurring in today's global supply chains. A Lean Supply Chain Management strategy can address the necessary elements of change that will ultimately enable a simpler, more efficient and responsive operations model.

The seminal issue today is "the China question." How will global supply chains adapt to the end of the quota system and the consequent impact on sourcing? Attendant issues are ramp-up to Radio Frequency Identification (RFID) and the shipping delays imposed by growing shortages in transportation and port capacity as well as Homeland Security checks. Shipping delays necessitate compensating efficiencies at other points. RFID will ultimately transform the central issues of supply chain management -- how information is gathered, shared, and synchronized among trading partners -- but it is not yet mature enough to provide the necessary efficiencies. Lean Supply Chain Management, however, can enable cost savings and more efficient operations by realigning process according to a demand-driven model, as it also lays the groundwork for the next level of hands-free, wireless RFID-enabled processes.

Lean Supply Chain Management is a supply chain operational and strategic philosophy that uses Web-based technologies to continuously reconfigure dynamic supplier networks. Such networks are able to execute superlative customer value at the lowest cost. They enable real-time collaborative synchronization of demand priorities, manufacturing and logistics/delivery, intelligence, and lifecycle management.

As the first in a series of thought leadership pieces from Lawson called "Lean is Fashionable," we explore the impact of Lean in the fashion and apparel industry during a period of momentous change. The next two parts of the series will focus on:

- How Lean Manufacturing relates to Lean Supply Chain Management and where it differs and sometimes conflicts
- The action steps for moving to a Lean Supply Chain.

In the same way that we discuss Lean Manufacturing, AMR Research uses the terminology Demand-Driven Supply Networks (DDSNs). We both urge that 2005 is the foundation year for companies to create roles and responsibilities for lean, demand-driven networks.

Involving all partners -- customers and suppliers -- in this supply chain planning process is critical. We believe that this is a survival issue for all. Stable, long-term partnerships evolve into a supply chain ecosystem that supports ongoing benefits for all members. Lean Supply Chain Management not only enables trading partners to use a synchronized platform and tools but also instills cultural and organizational changes in all participants up and down the supply chain.

External Drivers of Change

January 1, 2005 rings in a new era for the fashion industry. The US Textile Quota System and similar protectionist regulations enacted by the European Union and other developed countries have officially ended after a ten-year phase-out. The World Trade Organization (WTO) has successfully spurred global manufacturing capacity while capping the market share of the most capable competitors: China, India, Pakistan, and Brazil. Consequently the \$495 billion international trade in textile products that was formerly allocated by a set number of products to specific manufacturers, is now subject to free market competition. The WTO has essentially taken the fashion industry and shaken it like a snow globe.

The end of the quota system

Textile makers, apparel makers, and retailers may all belong to the same supply chain, but none of them have the same view of free trade. US textile makers vigorously opposed ending the quota system that had protected their pricing power by limiting imports and splintering sources for retailers. On the other end of the spectrum, many retailers welcomed the end of quota because lower prices drive retail. In the middle were garment manufacturers. Many had already adapted to competition from imports by re-inventing themselves as designers or had developed their own offshore sources for the more labor-intensive parts of their production process.

In the long lead-time preceding the change, supply chain participants have been making new arrangements that will essentially restructure the fashion industry. Some results are already known. For example, the New York Times reports, "Without rules ... restricting how much fabric or how many garments they can buy from any country, name brands and merchants like Tommy Hilfiger, Ralph Lauren, J.C. Penney, and the Gap will purchase most of what they want from five or six countries, not the 50-plus countries that are now part of their networks." The Times went on to predict that China, left unimpeded, will capture as much as 70 percent of that market.

Still other consequences will follow over time. We'll hazard some predictions:

- Contract manufacturers, facing competition from every entrepreneurial low-cost producer in China, will add value to product delivery for their upstream partners. They will take increasing responsibility for the supply chain itself, for example, by stepping up vendor-managed inventory (VMI) efforts
- In-country representation will become more essential than ever as the number of eligible product and service suppliers grows exponentially. However, retailers will increasingly conduct direct communications with the manufacturer, while keeping the sourcing agent involved
- Commodity manufacturers are endangered by China's ability to out-produce them at much lower costs. In the future, they will have to use their reputation as a reliable low-cost/high-service resource to create a brand identity.

The one certainty is that all supply chain partners will feel the effects of the end of quota.

Manufacturing shifts to low-labor-rate countries

Quota systems are formulated to accomplish one task: government control of trade under the guise of protecting local industries. Being realistic, governments want to control trade as a political bargaining chip. In addition to China's recent self-imposed export tariffs, industry experts expect new export controls to emerge as well.

Politicians and the media talk as though lower labor costs drove the shift in textile and apparel manufacturing jobs from developed to developing countries. Certainly it is one major cause. There is no denying that paying a Chinese factory worker the equivalent of \$1 an hour instead of paying a US factory worker \$20 will lower the cost of finished goods. But some developing countries are more cost-competitive for other reasons as well.

China and India in particular have invested more in physical plant (though investments in IT infrastructures have lagged). According to Industry Week, 29 percent of Chinese factories are less than five years old, and another 25 percent are between five and ten years old. Very little Chinese apparel manufacturing is now government subsidized; private investors have taken over the lion's share. Along with unmatched vertical integration, China has more specialization in textile production and garment manufacturing. Related businesses locate close to each other for JIT benefits, and within a shorter supply chain, processes and technologies evolve rapidly.

Doom-and-gloom views of a world market swamped by cheap imports overlook key demographic changes. China and India have become consumer as well as producer countries. Part of China's enormous apparel output in 2005 will go to clothe its own citizens – nearly 25 percent of the world's population. The same is true of India, Pakistan, and other developing countries. China, India, and other Asian countries now have a growing number of designers focused on domestic markets. These demand shifts are occurring at the same time as the end of the quota system.

Finally, ever since factories began, capital has sought to lower production costs by locating manufacturing in areas where land, materials and labor costs are lowest. The money trail crosses two centuries: leading from England to New England to the Southeast US to Mexican maquiladores and Asian contract manufacturers, or from Western to Eastern Europe and Asia. Ironically, this cycle is already impacting China's hot manufacturing provinces; in some areas, labor rates have risen to the point that work is outsourced.

The real costs of outsourcing

The fashion industry is highly labor-intensive, and it is easy to see the cost advantage in contracting offshore. However, the real costs of sourcing from a low-labor-rate country involves increased costs in other areas and tradeoffs:

- Logistical costs for in-country and ocean transportation
- Quality costs
- Cost of changes to the fashion plan
- Building in extra time for shipping.

According to a 10/04 Inbound Logistics article by Rick Moradian, VP for APL Logistics, "Although the Chinese government is investing heavily in roads, rails and air, and ocean ports, as well as material handling equipment to improve and expand its infrastructure, continuous manufacturing growth keeps outpacing these efforts." Ships from China reach US west-coast ports in about 20 days and east-coast ports in 25. A recent Aberdeen Group survey found that over a third of responding companies spent almost as much

time moving goods onto the ship and from the receiving port to their own facilities, as was spent in the ocean passage.

Logistics costs are only part of this picture. Aberdeen notes, "Many enterprises have increased their inventory positions to account for the greater lead times.... However, this results in excess inventory carrying costs. In addition, excess inventory of short lifecycle and seasonal products can cause increased discounting or write-offs and missed sales opportunities." In addition to hedging their bets on inventory, buyers typically make one big buy per season for the fashion plan, incurring a huge capital risk.

It is far too soon to tell if the fashion industry will see a reverse outsourcing trend such as Toyota led in the automotive industry. Toyota built production facilities in the US in order to shorten lead times and eliminate logistics costs, and has widely publicized the jobs it created for American workers as an added public-relations advantage. Perhaps the China trade will do the same, led by Haier, a Chinese appliance and electronics manufacturer. Haier has built a \$40 million dollar industrial park in Camden, South Carolina – also home to two fabric mills and two garment manufacturers.

Shipping delays

Freight transportation is currently experiencing a global meltdown. The largest companies have locked up ocean, trucking, and rail capacity with long-term contracts, and it is difficult for smaller companies to get any space with available shippers. In the US, rising fuel costs and driver shortages due to new regulations decreasing service hours have reduced truckload capacity by 10 percent. This situation has resulted in dramatically increased transport costs. That said, the shortage is a short-term issue. Several years of carrier bankruptcies contributed to the current pressure; those carriers are missed now that the economy is improving.

Though quota processing delays by US Customs have been lifted, another set of government regulations remains in effect: the Homeland Security initiative, which requires ocean shippers to file manifests for container-packed cargo 24 hours before leaving a foreign port. Further, accompanying documentation must verify that the shipment has not been altered since the container was packed and sealed in the warehouse.

The risk here is that a do-not-ship order from Customs can immobilize the whole ship and not just a few containers with missing manifests. Manual systems are the most error-prone. Shippers with logistics systems can pull data electronically from product catalogs to prepare documents. Look for XML translation capabilities in both logistics and ERP software to expedite that data transfer.

RFID

At the same time that the fashion and apparel industry is making seismic adjustments to the end of the quota system, it must also deal with RFID mandates. Two of the largest global retailers expect their top suppliers to start using RFID tags on cases and pallets as of this year:

In the next five years, RFID technology will play a crucial role in mitigating the disruptions and leveraging the potential of the global shifts discussed so far. AMR Research calls RFID and the Electronic Product Code (EPC) standards "a transformation in the making. RFID allows the immediate 'polling' of inventory, supporting real-time monitoring and management of any item or container in the supply chain. Real-time access to this data will revolutionize all aspects of the supply chain planning and execution markets."

RFID will be extremely useful for detecting bottlenecks and facilitating flow in distribution and customs processing, but it will have an even greater impact on retail operations, according to John C. Peck, Professor Emeritus, Clemson University and Chairman, Foxfire Technologies Corp. He cites a recent study by A.T. Kearney predicting that once RFID can be used economically for unit identification at the point of sale, retailers will see one-time cash savings from a 5 percent reduction in overall inventory, an annual 7.5 percent benefit in reduced labor cost, and recurring annual improvement in out-of-stocks amounting to \$700,000 per \$1 billion in sales.

Notwithstanding considerable hype in the marketplace, RFID-based item-level tracking will not happen any time soon. The technology is still in its early stages. This year Wal-Mart and Department of Defense suppliers will begin to tag cases and pallets, not individual items. Although many experts think that item-level tracking of low-value commodities may never happen; but item level RFID labeling of high-value and popular controlled drugs like Vioxx is already happening now.

Among the critical barriers to immediate widespread use of RFID are:

- Cost issues: including the cost of tags, RFID infrastructure, integration with enterprise business systems, and process re-engineering to enable profitable tag use. Until tags reach the 5-cent range, possibly in 2007, they are not feasible for unit identification
- Standards issues: EPC Gen 2 tags are expected to reach the market in late 2005, and EPC has to be harmonized with ISO 18000. In addition, intellectual property issues need to be resolved
- Reliability issues: Sources indicate that tags are read reliably about 80 percent of the time, far lower than the 99+ percent reliability rate of UPC barcodes
- Data management issues: including the handling of very large volumes of data, data synchronization issues, and data security and privacy concerns
- Shortages: of skilled technicians and production bandwidth to meet the potential demand for tags and infrastructure components.

Lean Supply Chain Management

With its tremendous point-of-demand data collection capabilities, RFID is the mechanism that may eventually enable true demand-driven supply networks. In the meanwhile supply chain members can start positioning themselves to take advantage of its transformational potential by leaning-out their operations. Lean practices will enable them to evaluate and remove the vestiges of the old quota-linked batch mentality and start moving toward an on-demand market.

Hand-offs in a conventional linear supply chain impede the flow of demand information in one direction and the rapid supply of goods and services in the other. In a Lean supply chain, the focus is on removing unnecessary activities impeding the free flow of information and goods and services, providing superior value to the end customer and increased profitability to all supply network partners.

What is Lean?

Lean Supply Chain Management uses Internet-enabling technologies to effect collaborative, real-time synchronization of product/service transfer; demand priorities, vital marketplace information, and logistics delivery capabilities. The Lean discipline has its roots in the core principles of the Toyota automobile production system:

- Always create value for the end customer
- Rigorously identify and eliminate waste (i.e., all non-necessary activities that do not add value)
- Continuously improve processes.

Lean supply chains will differ from lean manufacturing in a number of significant ways. The most obvious is scale. A lean manufacturer aims for the optimal logical flow for operational processes taking place primarily within company walls. Lean supply chain managers aim for the optimal connections in a network that crosses organizational and national borders and involves many-to-many relationships among many customers and suppliers. Every source, every process, every hand-off will be examined to remove waste and create value for the customer.

This approach to optimizing the value stream will require a strong collaborative approach and transparency that spans the network as well as the enterprise. It is a formidable task. The Aberdeen Group's recent Lean Strategies Benchmark Report finds that most manufacturers are still struggling with implementing Lean simply within their four walls:

- Lean techniques are used sporadically by 67 percent of respondents
- Lean knowledge remains in the hands of a few individuals in 87 percent of companies surveyed
- Fully 93 percent of respondents still rely on spreadsheet- and paper-based solutions to perform high-value functions, such as line design and load-leveling production.

Survival in today's harshly competitive environment, however, requires, lean highly responsive manufacture interdependent with its lean supply chain ecosystem.

The Lawson viewpoint on fashion's future

In stark contrast to earlier fashion markets that stressed conformity, current fashion serves consumers who want to develop a unique style, regularly updating their core wardrobe with trendy clothes and accessories. Trends are short-lived and consumers are fickle, resulting in volatile seasonal sales patterns.

Few companies have adapted to this market as well as the retailer Zara, based in La Coruña, Spain. "While its rivals typically start planning their lines nine months before they hit the shelves, Zara has a reputation for instant reaction to fashion trends and rapid restocking of stores to meet demand on popular items. It's also not afraid to cancel items that aren't selling. Zara can make a new line --from the initial concept to when it arrives in the shops --in just three weeks. Zara lines rarely stay on the shelves for more than a month, and new stock often sells out in days, CNN reports.

CNN quotes a reaction from retail analyst Richard Perks, of Mintel, "They've got to get the design. They've got to engineer it for low-cost production. They've got to take the gray fabric and print it. They have got to get it out to their outworkers to be made up, and they've got to ship it from Galicia across Europe. That is an unbelievable achievement." Zara has set the bar high for the entire industry.

The Holy Grail of the fashion industry has been “the lot size of one” – cost-effective and timely unit production of highly customized goods upon demand. Zara and its holding company, Inditex (Industria de Diseño Textil, SA), are closing in on that target. The secret, according to CEO José Castellano, is its “reliance on communication, and the way [Zara] uses existing technology to take control of almost every aspect of design, production and distribution.” This includes:

- Communication about customer demand: Store managers place up to two orders a week. Product managers are the link between store managers and production, and rotation of the merchandising
- Close collaboration between teams: Five different teams (design, product, merchandising, sourcing, and patterns) share the same space and work closely together
- Short production runs: Small lots take out much of the financial risk inherent in the industry.
- Emphasis on time-to-market rather than on costs: “Logistics is a basic component of our business model and allows us to move quickly when it comes to giving our customers what they want, and it accounts for a sizeable chunk of our investments. Agility and speed-to-market are vital elements of the Inditex vision of the fashion business,” according to Inditex General Manager Juan Carlos Rodríguez Cebrián.

Any company can employ these methods. Castellano has used and improved on this model since Zara, his flagship business, started as a small lingerie company in 1975. Group net sales for Inditex are now nearly €4.6 billion (US\$5.6 billion), with an annual growth rate of about 25 percent in recent years.

Inditex holds nearly 100 companies specializing in textile design, production, and distribution activities, and most of them are located close to La Coruña. They serve its eight brands, each operating through its own chain of stores to reach a well-defined segment. The vertical integration and specialization of Inditex resembles the Chinese “cluster” cities of specialized suppliers and manufacturers. It provides the ability to meet market demand with minimum inventory, maximum speed, and optimal ability to fine-tune fabrics, patterns, and styles to customer demand.

International consolidation

Vertical integration gives Inditex an advantage that will be hard for its competitors to duplicate – except through post-quota sourcing arrangements and adopting lean supply chain practices. Fashion industry consolidation on the local and global level has already begun and will be ongoing. Polo Ralph Lauren, for example, had licensed out their brands to manufacturers in the European Union and Asia under the quota system. They are now buying their licenses back so they can go direct to those markets.

The reversal of the licensing trend could cause almost as many changes as has the end of the quota system. For manufacturers, licensing complements their regular production and helps them fully utilize their capacity. For designers, selling distribution rights to another territory has been the most expedient way to enter the market. However, licensing can dilute the value of the brand, and apparel is nothing without branding and brand recognition.

Going forward, retailers will try to gain more control over the supply chain in order to improve their speed-to-market, and this will drive Lean ideas through their networks. Because retailers are close to the customers, RFID implementation will consolidate

their ability to segment, analyze, and anticipate demand. Unlike Inditex, with its wholly owned supply network, most retailers will have to turn to the open market to identify the most responsive partners.

Lawson customers span the whole fashion and apparel supply chain. Among them, those who supply goods and services to US and European retailers want to have the technology infrastructure in place to serve customer demand rapidly and communicate electronically with partners. Most of the apparel industry typically communicates by fax. Providing partners with order visibility and shared data is a huge competitive advantage in an industry historically run via the fax machine.

Collaboration Is The Future

To work with the speed, responsiveness, and clockwork integration of a Zara, apparel industry supply chain partners will have to collaborate closely in a demand-driven network. More specifically, they will have to master two collaborative disciplines:

- Collaborative planning, forecasting, and replenishment (CPFR): a real-time alternative to traditional forecasting
- Collaborative product commerce (CPC): a management philosophy that leverages a company's supply chain to design and produce products.

Such collaboration was suspect even five years ago. Defensive forecasting and finger pointing as a form of partner management were common. Product design was a jealously guarded trade secret. Now technology is at a level where it can support process calibration and cost control -- benefiting everybody involved --and the Internet provides the mechanism for real-time collaboration. Responding rapidly and imaginatively to fashion trends is key to survival, absolutely requiring collaboration.

Now: CPFR synchronizes supply and demand

CPFR is the implementation of data and information transfer tools that facilitates timely, interactive communication of demand forecasts and inventory statuses among a chain of trading partners. It enables channel retailers, distributors, transportation providers, and manufacturers to synchronize supply with network demand from one end of the channel to the other. In the past, supply chains were burdened by isolated forecast, planning, and inventory systems, and consequently lacked accurate and timely demand information as well as visibility beyond immediate trading partners. CPFR simplifies and connects overall channel demand planning with a single, real-time plan of forecast and supply.

Previous industry initiatives – from still widely used EDI through quick response (QR), vendor-managed inventories (VMI), continuous-replenishment planning (CPR), and efficient consumer response (ECR) – attempted to overcome this lack of integration. Unfortunately, while achieving inventory reductions, none of these techniques really addressed the critical issue: How to achieve the level of continuous, systematic collaboration necessary to link total channel demand and supply. CPFR has been deployed to respond to this issue.



Figure 1: CFPR end-to-end management model defined by the Voluntary Interindustry Commerce Standards (VICS) committee in 2004, illustrating iterative business processes and their relationship in a continuous cycle.

The outer blue circle identifies what the manufacturer is doing at each stage in the cycle. The inner blue circle shows the corresponding business process performed by the retailer at that same stage. Overprinted on the colored arrows are the names of tasks they share. Ideally the same personnel who perform the tasks designated for manufacturer and retailer form a joint project team to accomplish the collaborative tasks. In a CPFR partnership, the manufacturer and the retailer have a collaborative agreement with specific business goals, for example, for forecast accuracy and order fill rates. The CPFR committee has also developed a scenario based on this model called Collaborative Assortment Planning, for trading partners in apparel and seasonal goods.

A complete implementation of the VICS CPFR model is not for everyone. Some companies choose a stage or two and do “CPFR lite.” Others take a more traditional and less structured approach to collaboration, using the Internet and EDI to coordinate their inventory management efforts with partners. Still, according to VICS, “over 300 companies have implemented the process. Numerous case studies of CPFR projects document in-stock percentage improvements of from 2-8 percent for products in stores, accompanied by Inventory reductions of 10-40 percent across the supply chain.”

An Lawson customer, TAL Apparel Ltd, and its supply chain partner, JC Penney, have one of those successful implementations based on a ten-year history together. TAL produces over 50 million pieces a year, including one of every eight dress shirts sold in the US. It has production facilities in Hong Kong, Thailand, Malaysia, Taiwan, China, USA, Indonesia, and Mexico. TAL's Dr. Harry Lee explained that the company's supply chain management relationship with Penney went through three stages before they tackled CPFR: rapid replenishment to warehouse, direct shipment to stores, and vendor-managed inventory (VMI), producing incremental savings at every step. VMI alone saves 15 percent of inventory and operational costs.

The CPFR initiative with Penney's introduced a Make to Measure (MTM) offering that TAL produces to actual demand and ships directly to the consumer. Dr. Lee said that with MTM:

- The garment is tailor made for the individual customer
- Measurements are captured on the Web or in store
- Customer order and measurements are sent to factory
- MTM software automatically generates the pattern and marker
- Factory cuts, makes and ships to individual customer or store in 3 weeks
- Benefits include zero inventory and increased customer loyalty.

This is the "lot size of one" in the market now - with no need for the customer to leave home to pick up the purchase.

Next: CPC transforms product design and management

Where CPFR manages the supply chain from the inventory perspective, collaborative product commerce (CPC) manages the same relationships from the product design perspective. CPC requires businesses to execute product management processes in relation to how they will impact the production, planning, and distribution of products required by supply chain partners to meet specified or documented customer demand. It includes, and frequently improves upon, the traditional product management processes for cost, quality, and features.

Collaborative design and product management bring together cross-functional teams at every stage of the product life cycle, from concept to design, production and distribution. The Internet provides the forum for real-time collaboration even when team members work half a world away in various time zones.

Mass customization and shorter product life cycles will be key business drivers for adoption of collaborative techniques, along with the need to reduce time-to-market and time-to-profit. Other benefits include extending design resources, sharing demand information, and pooling intelligence to navigate complex market forces. The fashion industry in particular stands to benefit from cross-cultural collaborative design, since consumers want something new and different all the time.

To implement CPC, companies will have to extend visibility upward to management, across functional silos, and outward to partners. In addition, they will need more precise coordination of supply chain activities, as well as change management practices that most retail, textile, and apparel companies have not yet considered. Companies will have to ask and answer hard questions about how to control projects and products. The most pressing need, however, is for trust. Until supply chain partners can overcome their mutual suspicions, the grounds for collaboration do not exist.

Conclusion

The fashion industry is poised to leverage the great changes occurring in supply chain networks. Sourcing arrangements, logistical requirements, and technology innovations are creating new alignments among trading partners. To compete successfully for consumer attention and purchases, companies face increasing pressures for speed-to-market and asset allocation, and they need help from their partners to optimize the value stream for the customer. Industry conditions now favor those who can run a Lean supply chain,

apply the lessons learned from Lean manufacturers, or adapt them as needed. It requires greater supply chain collaboration -- from inventory control through product design and lifecycle management -- assisted by appropriate technology.

The next installment in this quarterly series from Lawson will translate Lean Manufacturing principles to the Lean Supply Chain. The third will discuss the action steps for moving toward a Lean Supply Chain. We hope you will use these papers to kick off discussions with your trading partners. They were written with your long-term success in mind.

Meet the Authors

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A 25-year veteran of the textile, apparel, and sewn products industries, Bob McKee is the Fashion Industry Strategy Director for Lawson, a leading supplier of Enterprise Resource Planning (ERP) software to the mid-market. He is responsible for software and solutions design, development and marketing for the Lawson US apparel business. He serves the company's apparel customers directly by providing counsel on reducing cycle times, forecast demand planning, managing global production, and response to industry changes.

Prior to his career in software, Mr. McKee spent many years in the apparel manufacturing industry where he held senior-level operations and sourcing positions for companies including O'Bryan Brothers, Holloway Sportswear, Bachrach Clothing, The Company Store, Warnaco, and Hartmarx. During this time, he oversaw importing/exporting from over 30 countries, raw material and inventory management, inter-plant transportation, and production planning and scheduling. A member of AAFA and APICS, McKee frequently speaks at global supply chain and apparel industry events and has contributed to many leading publications.

David Ross, Ph.D., CFPIM

Learning Consultant for Lawson

Supply chain expert and published author, David Ross is a learning consultant at Lawson, a leading supplier of Enterprise Resource Planning (ERP) software to the mid-market. A seasoned executive with more than 30 years of industry experience, Ross heads the company's education and training program. He advises mid-market manufacturing, food and beverage, and apparel customers on how technology can provide a competitive advantage in today's complex, global supply chains.

Previously, Ross held senior operations management positions within the manufacturing and distribution industries at companies including McMaster-Carr Supply Company and Illinois Tool Works. He then focused on technology within the ERP industry, working with Computer Sciences Corporation, SSA and Epicor. Besides numerous articles, he has published three books on logistics and supply chain management. His first book, *Distribution Planning and Control* (Kluwer, 1996), is a cornerstone for the APICS Master Planning of Resources CPIM course. In addition, he has written *Competing Through Supply Chain Management* (Kluwer, 1998) and *Introduction to e-Supply Chain Management* (St. Lucie, 2003).

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