

The Elements of Supply Chain Management

Tom Albright and Stan Davis

EXECUTIVE SUMMARY

- *Supply chain management* (SCM) has received increasing attention as companies seek to gain and maintain a competitive advantage in the market.
- This article discusses points that companies beginning a SCM program should consider. Although it provides many illustrations, the article concentrates on the supply-chain practices followed by Mercedes U.S. International in developing the new M-class sports utility vehicle.
- SCM encompasses not only planning and controlling the flow of materials from suppliers to end users (*logistics-based SCM*) but also the philosophy adopted by a company toward supplier relationships (*strategic SCM*).
- SCM seeks to unify skills and resources of business functions found both within an enterprise and outside. The thrust is to develop relationships and to synchronize the flow of products, services, and information.
- Supply-chain considerations are an integral part of an organization's value chain and essential to many business initiatives, including just-in-time (JIT) manufacturing, total quality management (TQM), electronic data interchange (EDI), outsourcing, and target costing.

Supply chain logistics is a primary activity in an organization's value chain. To engage in strategic cost management, managers must identify and assess primary and secondary activities and the processes necessary for the organization to compete. These activities and processes are referred to as an organization's *value chain*.

A company's value chain includes primary activities that create value for customers both *inside and outside* the firm (Thompson and Strickland, 1996). Understanding the costs associated with each activity of the value chain provides an understanding of the organization's cost structure, which allows a firm to set cost or niche strategies. Typically, a value chain includes six primary activities (Thompson and Strickland, 1996):

1. Purchased supplies and inbound logistics;
2. Operations;

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3. Outbound logistics;
4. Sales and marketing;
5. Service; and
6. Profit margin.

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Supply chain management is integrally involved in the first three links in the chain and is becoming integrated into a firm's strategy. In developing a strategic plan, a company should carefully analyze potential relationships with suppliers. Because successful SCM is a key element in other management techniques, such as JIT, TQM, EDI, target costing, and outsourcing, assessing the power relationship is important. Given the demands that these programs place on suppliers, proper relationships with key suppliers are essential.

ALLIANCES WITH SUPPLIERS

Successful SCM practices begin with the selection of key suppliers, then developing trusting, mutually beneficial relationships that last over long periods. Alliances with suppliers are usually necessary only for vendors that supply integral, strategically important components to the manufacturing process.

The objective of aligning closely with suppliers is not to acquire the lowest possible price but, rather, to secure acceptable prices in return for superior service and reliability. Another benefit of developing strong alliances with suppliers of key components is the assistance suppliers can offer in designing new components and production processes.

But developing strong alliances is often difficult because of mistrust on both sides of the purchase arrangement. The supplier-purchaser relationship has long been an arm's-length transaction, with both sides seeking as much short-term gain as possible. Thus, developing long-lasting ties and sharing sensitive information is often difficult. Seeking to develop alliances built on trust and mutually beneficial outcomes requires a change in mind-set at many companies.

IMPROVING RELATIONSHIPS WITH SUPPLIERS OF STRATEGIC PARTS

The following four practices help foster improved relations with suppliers of strategic parts (Landry 1998):

1. *Power balancing.* In buyer-supplier relationships in which a buyer represents a large proportion of a supplier's business, the buyer may be in a position to demand price (or other) concessions. Such an uneven power distribution is not conducive to building a healthy strategic alliance. Equal dependence between partners occurs when the proportion of a supplier's total output that is sold to a customer roughly equals the proportion of total purchases acquired by a customer from that supplier. For example, if a supplier sells about 25 percent of its total output to a strategic partner, then a power balance is achieved if the buyer's proportion of total purchases is 25 percent for that supplier. Maintaining relative dependence between suppliers and buyers increases the likelihood that both parties will have a vested interest in the success of the other partner as the degree of relative dependence increases.
2. *Codependency.* Apart from balancing power in a supplier-buyer relationship, developing a codependency in the relationship can benefit the alliance. When

The objective of aligning closely with suppliers is not to acquire the lowest possible price but, rather, to secure acceptable prices in return for superior service and reliability.

- a supplier commits substantial specialized resources to meeting the demands of a purchaser and the purchaser chooses to single-source with that supplier, both parties have a vested interest in the success of the purchaser. This relationship reduces maneuvering for short-term gains by suppliers and strengthens the desire for mutually beneficial outcomes for both parties.
3. *Target costing.* Instead of seeking the lowest bid, establishing target costs for components, then rewarding suppliers when those targets are reached encourages joint problem solving.
 4. *Personal ties.* Developing trust between suppliers and purchasers usually begins at the individual level. Establishing joint teams consisting of employees from both the purchaser and the supplier helps foster good working relationships. Trust increases as each side begins to feel more comfortable with members from the other organization.

Many organizations often single-source numerous strategic components yet fail to establish the trust and partnership ties that can provide additional benefits for both parties. As the following example illustrates, treating suppliers as partners in strategic alliances provides long-term benefits other than obtaining low costs on supplied components.

THE MERCEDES M-CLASS SPORTS UTILITY VEHICLE

During the recession that began in the early 1990s, Mercedes-Benz struggled with product development, cost efficiency, material purchasing, and problems in adapting to changing markets. In 1993, these problems caused the worst sales slump in decades, and Mercedes lost money for the first time in its history.

In a search for additional market share, new segments, and new niches, Mercedes started developing a range of new products. Perhaps the largest and most radical of these new projects was the M-class, a sports utility vehicle that moved from concept to production in a relatively short time.

To design vehicle and production systems, Mercedes-Benz U.S. International used *function groups* that included representatives from every area of the company (marketing, development, engineering, purchasing, production, and controlling). The role of these function groups was to develop specifications and cost projections. Note also that a modular construction process was used to produce the M-class. First-tier suppliers provided modular systems (rather than individual parts or components) for production of about 65,000 vehicles annually.

Mercedes included suppliers early in the design stage of the vehicle. By including suppliers as members of the function groups, Mercedes was able to take advantage of their expertise and advice on matters such as supplier capability, cost, and quality. The synergy generated by these cross-function groups also allowed the groups to solve larger design issues, such as how to more efficiently and economically switch from manufacturing left-side-drive vehicles to right-side-drive vehicles. Significant time savings were recognized because of the design improvements implemented by the function groups. Because supplier personnel were at the Mercedes plant on a full-time basis during the launch, other issues (such as quality problems or slight modifications to the product) could be addressed in a more timely fashion.

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SUPPLIER INVOLVEMENT IN JIT AND TQM

Initiating cost savings and quality programs requires a commitment not only from an organization itself, but also from parties outside the organization, such as transporters and suppliers of goods. Management initiatives such as JIT, TQM, target costing, and outsourcing require significant cooperation between suppliers and purchasers.

The JIT philosophy advocates *waste elimination*, including wasted materials resulting from a manufacturing process and wasted time in delivery and movement of goods. Additional sources of waste include machine setups, rework, warehouse space required by large inventories, and capital required to carry large inventory levels (which can mask production problems).

The success of JIT and TQM depends on developing innovative *performance measures* for suppliers. These measures include quality, response time, and number of delivery points. The ability to sustain a long-term relationship enables purchasers to work with suppliers over time to achieve acceptable performance on such measures. Buyers that frequently change suppliers end up buying from companies that are at the beginning of the learning curve. Thus, many benefits of a long-term relationship are foregone.

In addition to quality issues, lower inventory levels require suppliers to provide more shipments in smaller quantities. Suppliers must be able to respond quickly to orders and ship in lot sizes desired by the purchaser. In some cases, manufacturers may also require delivery of goods *to the point of production*, thus reducing the need for inventory and also reducing the expense and time of moving materials from a receiving dock to a holding area, then to the point of production.

These demands have caused a different type of relationship to develop between purchasers and suppliers. Many purchasers and suppliers are forging relationships based on long-term commitments, thus saving negotiation, inspection, and other costs associated with contracting with many suppliers. Properly orchestrated, a close relationship between suppliers and purchasers can be a win-win situation when organizations initiate programs such as JIT and TQM. Buyers receive high-quality goods delivered on schedule, and suppliers gain long-term commitments that enable them to plan for future orders with the understanding that buyers will continue to assist them in improving quality and service. These quality and service improvements can then be transferred to other customers the supplier may service.

MERCEDES AND IN-SEQUENCE DELIVERY

Mercedes designed its manufacturing facility consistent with the JIT philosophy, so there is little warehouse space at the factory where the M-class is made. Instead, Mercedes relies on *in-sequence delivery*, a system whereby pre-constructed modules arrive in a prescribed sequence and are placed on the manufacturing line.

For example, from the moment a new vehicle order is initiated, manufacturers of the cockpit module have 169 minutes to manufacture (to specifications) and deliver the module to the proper place in the manufacturing line at the Mercedes plant. Mercedes and its suppliers stay in constant contact through EDI facilities that transmit order specifications and other information between the plant and first-tier suppliers.

Exhibit 1 illustrates Mercedes' in-sequence delivery system. When an order is initiated, suppliers are notified through an EDI transmission of the specifications for the new vehicle. Suppliers are then expected to deliver their products in a predetermined order as each module is needed in the manufacturing process. This system moves one step beyond the simple JIT philosophy by requiring various suppliers to synchronize their efforts so that production can occur uninterrupted.

TARGET COSTING

Because most costs are designed into a product, target costing must begin at the design stage of product development. It is at this stage that supplier selection becomes most critical. The indexes developed by Mercedes allowed the company and its suppliers to work closely to align the cost of a function group with its perceived value, as defined by customers. (All numbers provided here have been altered for proprietary reasons; however, the tables illustrate the actual process used in the development of the M-class.)

MERCEDES AND TARGET COSTING

During the concept development phase for the M-class, Mercedes team members used various indexes to help determine critical performance, design, and cost relationships. To construct the indexes, various forms of information were gathered from customers, suppliers, and members of the design team.

Exhibit 1. In-Sequence Delivery

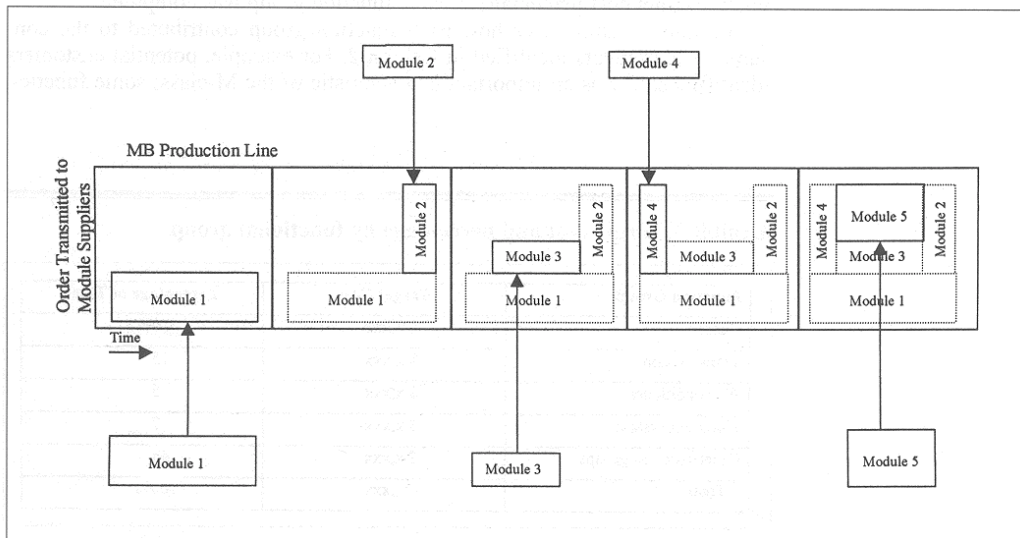


Exhibit 2. Relative importance ranking by category

Category	Importance	Relative Percentage
Safety	32	41%
Comfort	25	32
Economy	15	18
Styling	7	9
Total	79	100%

Although the actual number of categories used by Mercedes was much higher, Exhibit 2 illustrates the calculations used to quantify customer responses to the M-class concept. For example, values shown in the *importance* column resulted from asking a sample of potential customers whether they consider each category extremely important when considering the purchase of a new Mercedes product. Customers could respond affirmatively to all categories that applied.

WORK OF THE FUNCTION GROUPS

To gain a better understanding of various sources of costs, function groups were identified together with target cost estimates. As shown in Exhibit 3, the relative target cost percentage of each function group was computed.

Exhibit 4 summarizes how each function group contributed to the consumer requirements identified in Exhibit 2. For example, potential customers identified safety as an important characteristic of the M-class; some function

Exhibit 3. Target cost and percentage by functional group

Function Group	Target Cost	Percentage of Total
Chassis	\$ x,xxx	20%
Transmission	\$ x,xxx	25
Air conditioner	\$ x,xxx	5
Electrical system	\$ x,xxx	7
Other function groups	\$ x,xxx	43
Total	\$xx,xxx	100%

Exhibit 4. Function group contribution to customer requirements

Function group \ Category	Safety	Comfort	Economy	Styling
Chassis	50%	30%	10%	10%
Transmission	20	20	30	
Air conditioner		20		5
Electrical system	5		20	
Other systems	25	30	40	85
Total	100%	100%	100%	100%

groups contributed more to the safety category than did others. Mercedes engineers determined that chassis quality was an important element of safety (50 percent of the total function group contribution).

Exhibit 5 combines the category weighting percentages from Exhibit 2 with the function group contribution from Exhibit 4. The result is an importance index that measures the relative importance of each function group across all categories. For example, potential customers weighted the categories of safety, comfort, economy, and styling as .41, .32, .18, and .09, respectively. The rows in Exhibit 5 represent the contribution of each function group to the various categories. The importance index for the function group is calculated by multiplying each row value by its corresponding category value, then sum-

Exhibit 5. Importance index of various functional groups

Function group \ Category	Safety	Comfort	Economy	Styling	Importance Index
	.41	.32	.18	.09	
Chassis	.50	.30	.10	.10	.33
Transmission	.20	.20	.30		.20
Air conditioner		.20		.05	.07
Electrical system	.05		.20		.06
Other systems	.25	.30	.40	.85	.35
Total	1.00	1.00	1.00	1.00	

Exhibit 6. Importance index of various functional groups

Index Function group	(A) Importance Index	(B) % of Target Cost	(c) A/B Target Cost Index
Chassis	.33	.20	1.65
Transmission	.20	.25	.80
Air conditioner	.07	.05	1.40
Electrical system	.06	.07	.86
Other systems	.35	.43	.81
Total		1.00	

The target cost index is calculated by dividing the importance index by the target cost percentage by function group.

ming the results. For example, the chassis importance index of .33 is computed as follows: $((.50 \times .41) + (.30 \times .32) + (.10 \times .18) + (.10 \times .09) = .33)$.

As shown in Exhibit 6, the target cost index is calculated by dividing the importance index by the target cost percentage by function group. Managers at Mercedes used indexes such as these during the concept design phase to understand the relationship of the *importance* of a function group to the *target cost* of a function group. Indexes less than one may indicate a cost in excess of the perceived value of the function group. Thus, opportunities for cost reduction—consistent with customer demands—may be identified and managed during the early stages of product development.

OUTSOURCING

A popular trend among manufacturing organizations is to minimize on-site value-added activities by outsourcing significant portions of the assembly processes. Original equipment manufacturers (OEMs) have increasingly begun to outsource their production processes to contract manufacturers in an effort to reduce costs.

OEMs now outsource some of the manufacturing processes that they formerly considered core competencies. OEMs are focusing their efforts on design and innovation issues. It has been estimated that contract manufacturers will achieve a cumulative annual growth rate of 25 percent between 1996 and 2001. EDI and partnering with suppliers are essential for OEMs that seek to reduce costs by using contract manufacturers (Roberts 1998).

Outsourcing Manufacturing Assembly Processes at Mercedes

Many manufacturers contract with suppliers for parts, then manage assembly in-house, but Mercedes took a different strategy by outsourcing assemblies of the M-class to suppliers. Engineers divided the M-class into systems that were combined to form a completed vehicle. As many as 18 modules to be

delivered in sequence have been outsourced to suppliers, which purchase the subcomponents and assemble the module for Mercedes.

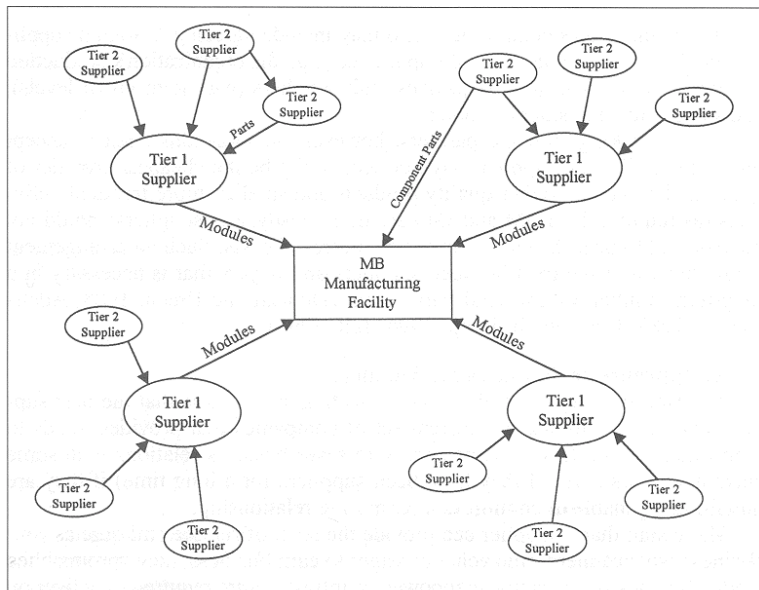
By assembling the modules off-site, Mercedes has reduced plant and warehouse space requirements. In addition, the number of suppliers used has been drastically reduced by this outsourcing of systems. For example, the cockpit requires more than 150 parts from about 35 vendors. By outsourcing the cockpit to one vendor, Mercedes has reduced its involvement from potentially 35 vendors to only one.

First- and Second-Tier Suppliers

Note that Mercedes has developed a two-tier supplier network. First-tier suppliers provide finished modules to Mercedes. Second-tier suppliers are the vendors from which first-tier suppliers purchase parts. At the beginning of the production process, Mercedes maintained strict control over both first-tier and second-tier suppliers with respect to cost and quality issues. As the level of comfort and trust grew between Mercedes and first-tier suppliers, Mercedes gave first-tier suppliers more freedom to make their own arrangements with second-tier suppliers. Exhibit 7 illustrates Mercedes' two-tier relationship with suppliers.

The benefits to Mercedes are numerous. By outsourcing more than 80 percent of vehicle components to a limited number of first-tier suppliers,

Exhibit 7. Mercedes Two-Tier Supplier Network



Mercedes reduces the overhead associated with purchasing activities and also saves on labor and employee-related costs. Further, by having established strong alliances with first-tier suppliers, Mercedes enjoys a higher level of service from suppliers and benefits from the expertise developed by suppliers as they seek ways to improve current operations. Finally, because much of the product is manufactured off-site, suppliers of major modules are encouraged to work together to continuously improve not only their own module but the integrated product as well.

Organizations need to accept the fact that the best supplier may not necessarily be the cheapest provider of goods and services.

DEVELOPING SUPPLIER RELATIONSHIPS

Developing strategic alliances with suppliers can be very rewarding. Although each organization's experience with building supplier relationships is unique, three suggestions can make a venture more likely to succeed.

Commit to Partnering Before Seeking Partners

Because developing strategic alliances with suppliers will change many practices, top management must be committed to establishing these relationships and accepting the changes that they will bring. Some of these changes include:

- Accepting a smaller vendor base from which to purchase supplies;
- Including suppliers in the early stages of design and development of new products; and
- Developing the ability to share information with vendors that will make their jobs easier.

An organization's commitment also may include agreeing to train a supplier's employees in various areas of importance (e.g., the organization's production practices), developing joint objectives with suppliers (e.g., joint profit levels), and striving to be a better customer.

Before seeking strategic partners, however, organizations need to accept the fact that the best supplier may not necessarily be the cheapest provider of goods and services. Higher-quality products and smaller, more frequent deliveries (as required by TQM and JIT) are more costly, and suppliers should not be expected to bear the entire burden of increased costs. Such an arrangement would not foster the trust between suppliers and buyers that is necessary in a long-term, mutually beneficial partnership (Duncan and Breen, 1988; Adair-Heeley, 1988; Hay, 1990b; Kepp, 1994; Tait, 1998).

Select Appropriate Suppliers for Alliances

The first thing to remember when selecting suppliers is that the best supplier may not be among the current set of companies that provides goods to your organization. It may be necessary to sever business relations with some current vendors (even if they have been suppliers for a long time) if they are unwilling or unable to commit to a partnering relationship.

Make sure that a supplier can provide the level of service and quality your business will require. Some vendors, eager to earn business, may "promise the world" but lack the capacity, manpower, or infrastructure required to deliver on their end of the bargain.

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Another important point to consider is the supplier's commitment to entering into a partnership arrangement. Because a strategic alliance requires two-way commitment, suppliers should be willing to accept their responsibilities in the partnership, such as the requirements imposed on suppliers under such initiatives as TQM or JIT, or a commitment to continuous improvement. Finally, inquire about the performance of suppliers with a few of their other customers to ensure that their dependability, quality, and service are acceptable (Hay, 1990a; Anonymous, 1994).

Be Prepared to Sell the Relationship

Ask the question, "Why would a supplier want to align itself with this organization?" A cursory glance at the requirements imposed by TQM or JIT programs may leave a vendor asking, "What's in it for me?"—a valid question. A supplier's willingness to enter into such a relationship depends in part on its ability to meet the increased requirements.

Key selling points include the fact that, because fewer vendors will be supplying like goods, the result should be an increased volume for supplier partners. Other rewards for suppliers include the assurance of business, technical, production, and training assistance; financial help (if necessary) to acquire facilities needed to meet the customer's needs; and the ability to take advantage of any production or technological gains that result from doing business with other customers. Unless the arrangement is mutually beneficial, the prospect that suppliers will enter into helpful strategic alliances are greatly reduced (Duncan and Breen, 1988; Morgan, 1993a, 1993b).

LOGISTICS-BASED SUPPLY CHAIN MANAGEMENT

Logistics-based supply chain management (LSCM) has long held a prominent place within operations management as an area for cost savings. Traditionally, LSCM has involved management of material flow from supplier to manufacturer (inbound logistics) or from manufacturer to customer (outbound logistics). This approach, however, was restricted because it ignored material flow *within* an organization. Recent approaches have encompassed total materials flow: from the supplier of materials, through the manufacturing organization, to purchasers of finished goods.

Specifically, LSCM activities include (Copacino, 1997):

- Sourcing and purchasing;
- Conversion (manufacturing), including capacity planning and operations management;
- Production scheduling and materials planning;
- Distribution planning and warehouse operations;
- Inventory management (including inbound and outbound transportation); and
- The linkage with customer service, sales, promotion, and marketing activities.

LSCM can provide value-added activities in many areas including transportation, inventory, and information (Ross, 1998). Each is discussed in more detail here.

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Transportation

The primary goal of transportation is to have goods delivered on time, undamaged, and cost-effectively. Deregulation of the transportation industry has made contracting for the delivery of inbound and outbound freight more beneficial. Although a common practice is to contract with the lowest bidder for transportation services, many shippers are beginning to demand not only low prices but also a higher level of service. Given the increased importance of JIT deliveries and maintaining low inventories, managers often incorporate the cost of missed delivery schedules into the cost of transportation.

Two philosophies exist toward selecting carriers:

- Repeatedly soliciting bids for individual transportation engagements; and
- Developing a relationship with certain carriers to encourage higher-quality performance.

By sharing shipment responsibilities, sellers and buyers can include carriers in negotiations and reach agreements on such issues as:

- Traffic volume;
- Frequency and quality of service;
- Rates; and
- The carrier's liability for loss, delay, or damage.

Agreements that include all three parties—buyer, supplier, and transporter—will likely be more beneficial to all parties. The buyer gets to specify its issues of importance (e.g., on-time delivery vs. cost; damaged goods vs. on-time delivery), whereas the seller gets to specify its own issues of importance. The transporter gains a better understanding of what the buyer expects, what the seller expects, and what services are most important to customers—including what services the customers are willing to pay for (Carter and Ferrin, 1995).

Inventory

LSCM can also aid in controlling inventory levels and ensuring that goods are delivered in good order to other manufacturing units or to buyers outside the organization. Marketing, manufacturing, and purchasing personnel should all participate in forecasting material needs to achieve an effective purchasing and delivery plan.

Traditional solutions for inventory management include mathematical formulas such as the *economic order quantity* (EOQ) formula and *materials requirement planning* (MRP) techniques, which are used to optimize production schedules. Many computerized programs exist to aid manufacturers and wholesalers in maintaining an effective inventory management system (software packages used for SCM are discussed later in this article).

In managing inventory levels, it is essential for businesses to know with as much certainty as possible the lead time for delivery of supplies and for the production of goods. Without understanding the time required between recognizing the need for a good and its production, maintaining an optimal inventory balance is difficult. Unknown lead times increase the chance of over- or under-stocked inventory, both of which are costly to a business (Ross, 1998; Copacino, 1997).

LSCM at Hewlett-Packard

At Hewlett-Packard (HP), benchmarking is used to aid LSCM planning. Inventory is an insurance against uncertainty. HP attacks this uncertainty at three sources: suppliers, manufacturing, and customers. Although not all sources of uncertainty can be eliminated, tracking certain measures enables manufacturing organizations to reduce their exposure to uncertainty. At HP, benchmark indicators include the following:

1. *Suppliers.* HP tracks on-time performance, average days or hours late, and the degree of inconsistency (the standard deviation of late measures). Tracking these measures helps HP know how much extra stock to keep on hand per supplier while minimizing the probability of stockouts.
2. *Manufacturing.* Downtime (for the process, not just a machine), repair time, and variation in repair time are key performance indicators. HP uses a probability distribution of performance and focuses on the reliability of the process.
3. *Customers.* Greater levels of order variation require greater levels of safety stock. HP tracks average demand and the variability of demand by customer (Davis, 1993).

Vendor-Managed Inventory

To control costs and improve the supply chain, leading companies use vendor managed inventory (VMI). By yielding (or at least sharing) the responsibility of managing inventories with suppliers, buyers reduce inventory carrying costs and receive improved service from suppliers (Tyndall et al., 1998). Suppliers benefit by gaining better insight into buyers' requirements and processes, and also from the increased information flow concerning future demands. By entering into a VMI agreement with a supplier, one wholesaler reduced delivery and administrative charges and also average inventory (from 10 days to 6 days) while keeping service levels constant. The company also reduced the time from order to delivery from 48 hours to 10 hours. Finally, the company gained a competitive advantage by sharing some of the associated cost savings with customers (Holstrom, 1998).

Organizing suppliers into a consortium can enable manufacturers to control inventory costs. Coordinating the activities of first- and second-tier suppliers can yield lower transaction costs by sharing operating insights and best practices. The increased cooperation among consortium members facilitates the sharing of information learned about third-tier suppliers and thus helps identify substandard suppliers. FedEx, among other organizations, has begun offering management services explicitly to help other companies set up consortium buying arrangements. Toyota has also developed supplier associations that foster communication and cooperation across major suppliers. The associations do the following (Stuart et al., 1998; Tyndall et al., 1998):

- Standardize quality control;
- Facilitate supplier interaction; and
- Provide forums that build trust.

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Information Technology

With shorter turnaround times and smaller orders becoming the norm, the ability to withdraw information from a logistics management system is crucial. Many buyers and suppliers set up EDI facilities that provide an unfettered information flow to ensure that orders and inventory levels are constantly monitored and maintained.

Characteristics of an LSCM system include:

- Rapid and accurate transaction processing;
- Real-time technologies integrated with other functions in the organization; and
- Advanced decision-support capabilities.

These systems also should include modeling, transportation, routing, and scheduling capabilities that are linked to suppliers and purchasers (Copacino, 1997).

By choosing to link with suppliers through some form of EDI, companies can share long-term and short-term forecast demands to aid upstream suppliers in their scheduling requirements. One Volvo plant uses EDI hookups with a supplier to share forecasts of goods three to four days in the future. The EDI system then creates sales orders and initiates purchase orders so that the forecast can be met. Further, EDI links are planned for suppliers of Volvo's suppliers (second-tier suppliers) to further expedite the transfer of information and maintain proper materials flow among suppliers and Volvo (Anonymous, 1998a).

Other organizations use the Internet to share information with key suppliers. Using secure websites, manufacturers such as Boeing, Dell, and Thompson Consumer Electronics have designed ways to improve communications with suppliers and customers. Boeing allows customers to browse its catalog and order spare parts from an Internet site, which processes about 4,000 transactions per day. This has reduced order-processing costs by 25 percent and also shortened delivery time.

Thompson Consumer Electronics receives customer demand forecasts on its secured Internet site. This information is entered into Thompson's SCM software for scheduling and production requirements (Thompson uses SCM software manufactured by i2 Technologies). Further, Thompson posts its demand forecasts on line, thereby allowing suppliers to know when components are needed. As a result, Thompson has shortened lead times from three or four weeks to as little as one week in many cases.

Dell has taken information-sharing one step further. By customizing about 30 web pages for top suppliers, Dell allows the suppliers to view its customers' demands so that the suppliers can better plan for future demands. Dell also has linked websites to bulletin boards where suppliers can post messages and share information. Manufacturers on the leading edge of SCM continually seek ways to increase information flow between suppliers and its customers (Stein and Sweat, 1998).

SCM SOFTWARE

SCM software integrates external communications (i.e., communications with suppliers and purchasers through either the Internet or EDI) and internal communications. SCM software includes (but is not limited to) products from:

- Manugistics, Inc.
- American Software, Inc.
- i2 Technologies, Inc.
- Numertrix Ltd.
- Red Pepper Software Co.

Using the PC-based Manugistics Routing and Scheduling Version 10 (MRS 10), Domino's Pizza updates and optimizes its routing schedules for delivery to production sites on a daily basis. Domino's previous system allowed updates only on a semiannual basis. Given dramatic changes in demand, Domino's hopes to save \$1 million during its first year by optimizing its trucking routes on a daily basis.

By linking with suppliers and purchasing an integrated SCM software package, Molson Breweries not only notifies suppliers in various manufacturing locations of upcoming demand but also gains valuable information about margins for particular production sites. Production scheduling and transportation now is handled more efficiently based on profit margins of products, demand in given areas, and supplier capabilities at a given time.

3Com Corp., a network equipment supplier, relied on linked Excel spreadsheets to keep production lines near target utilizations. As volume grew, planning and scheduling became more difficult. Therefore, 3Com started using Red Pepper's ResponseAgent to aid in its SCM efforts. Now schedules that balance material and capacity constraints are generated and what-if scenarios can be run in a matter of hours; previously, what-if scenarios took days to run (Mayer, 1996).

By using Internet technology, EDI, and SCM software, suppliers know what a customer needs before the customer asks (or, possibly, before the customer even realizes that it needs anything). Thus, technology has made the concept of a "seamless" supply chain a reality. Developing creative links with suppliers and customers appears to be a rich opportunity for innovative manufacturers to enjoy a competitive advantage over competitors that are unwilling or unable to invest the time and resources into improving their supply chains.

FUTURE TRENDS IN LSCM

Trends in LSCM include the following:

- A greater emphasis on establishing a balance between cost and service in the logistics function;
- Increasing third-party services for LSCM activities;
- Increasing emphasis on channel integration; and
- Expanding roles for EDI relationships between suppliers and purchasers.

The transportation and warehousing industry is slowly transforming itself into a full-service logistics manager for manufacturing organizations that outsource logistics functions. Successful third-party providers of logistics services will tailor their services to specific industries and manufacturers to develop an expertise and relationship not offered by ordinary transportation providers. Included in these services are EDI hookups linking suppliers and purchasers to further facilitate transactions among organizations (Copacino, 1997).

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Technology has made the concept of a "seamless" supply chain a reality.

Channel integration is the management of inventory, warehousing, and transportation across corporate boundaries.

Competition among third-party transportation providers (transporters of goods other than the supplier or the purchaser of the goods) is increasing. Thus, customers can not only demand lower prices but also expect more extensive services, furthering the benefits to businesses deciding to outsource logistics functions (Mireles, 1998).

Channel integration is the management of inventory, warehousing, and transportation across corporate boundaries (Copacino, 1997). Strategic supply chain management and logistical supply chain management techniques discussed in this article enable managers to reduce interorganizational barriers. Segmenting product offerings into channels allows manufacturers to better determine profitable and unprofitable product lines, differentiate between the level of service required by these channels, and possibly eliminate unneeded layers within some channels.

Another major trend in LSCM is an increased dependence on EDI. Organizations are just beginning to realize the vast array of benefits available from EDI and advanced information systems capabilities. Unfortunately, a recent survey conducted by KPMG as part of a Global Supply Chain Benchmark Study reports that many organizations are not taking advantages of recent information technology advances. The report indicates that organizations are making more use of SCM software for internal purposes, but that the exchange of information between organizations is still far behind where it could be with the capabilities of today's information technology (Anonymous, 1998b). ♦

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