The Five Principles of Supply Chain Management

An Innovative Approach to Managing Uncertainty

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INTRODUCTION: THE OPERATIONAL EXCELLENCE CHALLENGE

Identifying and Managing Factors that Contribute to Uncertainty

Over the past decade, companies have adopted *supply chain management* as a critical element of their corporate strategies. Despite these efforts, many companies have not realized the benefits of constructing *collaborative* relationships with supply chain partners.

As manufacturing companies continue to focus on their core competencies, they have made significant strides to integrate their internal business processes and information flows. Companies are leveraging core competencies to compete as part of a larger supply chain. This compels corporate leadership to more completely understand their customers' needs. What do they want? Where do they want it? When do they want it? How do they want to receive it? What are they willing to pay for the products and services?

While constructing and operating a competitive supply chain is the primary objective of supply chain management, several impediments to achieving this goal exist. First, demand uncertainty is so substantial in most supply chain environments that if it is not adequately addressed, it can severely degrade anticipated performance in terms of unit cost, speed, quality, and responsiveness. Second, supply chains with long and variable response times cannot take full advantage of collaborative relationships due to their inability to respond to environmental changes. Third, companies with poor information infrastructures lack the capabilities necessary to acquire, store, manipulate, and transmit data effectively and quickly. Fourth, business processes are often not designed properly, both intra- and inter-organizationally, to adapt to evolving business and supply chain conditions. Finally, decision support systems, operating policies and performance metrics that guide daily operating decisions may not be adequately designed to contend with supply chain uncertainty.

Strategic and tactical modeling paradigms employed in supply chain decision support systems are inadequate in many operational environments because of the manner in which uncertainty is treated. Collaborative relationships that focus on reducing the uncertainty in operating environments by employing improved information systems and business processes will result in more efficient supply chain performance. However, these collaborative arrangements by themselves cannot compensate for fundamentally flawed and operationally ineffective manufacturing and distribution environments.

The Essential Foundation: Integrated Business Systems

It is essential to think of the supply chain in terms of five interconnected business systems: engineering systems, marketing systems, manufacturing systems, logistics systems, and management systems. Opportunities for supply chain efficiency tend to occur at the boundaries of these individual functions. The greatest competitive advantage comes to those companies that focus on both (1) integrating these five systems intra-organizationally, and (2) integrating these business functions as much as possible with their collaborating supply chain partners.

Integration of these five systems alone is insufficient for competitive advantage. Leaders must deal more explicitly with the impact of uncertainty on the supply chain decisions they make. Sharing information can be extremely beneficial; however, in practice, simply passing data such as customer orders is not sufficient to substantially reduce the impact of uncertainty. Manufacturing and distribution systems must be designed and operated to *explicitly* deal with uncertainty.

Supply Chain Operational Excellence: The Five Principles

A competitive advantage will exist only if several key attributes exist in a supply chain. Five guiding principles are necessary for effective supply chains. Each principle is detailed below, including an illustration of practical application from an actual client's experience.

(1) Know the customer. Without a clear understanding and definition of customer requirements, a supply chain cannot be effectively constructed. To gain this understanding requires the use of classical market research techniques, the construction of an information infrastructure to capture customer transaction data, and the storage and analysis of these data from an operational perspective. The objective is to obtain a clear statement of the customer's requirements. A supply chain's requirements vary by customer, product, and location. These requirements must be thoroughly understood and be the foundation for constructing an efficient and effective supply chain.

Application

Not all products and customers are equal. Each product-customer combination does not demand an equal portion of the total demand for capacity. This fact can significantly impair statistical forecasting methods from being able to construct an accurate demand forecast.

By meeting with the customer and presenting the financial benefits associated with collaborating, the client was able to influence its customers' ordering behavior to reduce order volatility. This has two significant implications. Both companies now hold far less finished goods stock, and the client can routinely respond to all customer demands with available capacity.

(2) Adopt lean philosophies. During the past two decades, operationally excellent companies have focused on creating lean organizations. As a consequence, these companies have shortened internal lead times and made them more predictable and repeatable, reduced work-in-process inventories from months of supply to days, implemented just-in-time delivery strategies for their most costly component materials, and have worked to dramatically reduce setup times. These actions have substantially reduced indirect costs and improved use of physical space. More importantly, they have created cross-trained, empowered and more highly motivated workers. For maximum supply chain efficiency, all partners must engineer, align, and execute their processes so that the entire chain has the aforementioned attributes. Lean supply chains must also be designed as a system that quickly and profitably responds to market demand fluctuations. Therefore, lean philosophies must be extended beyond a company's internal operations to the entire supply chain. No combination of software systems can compensate for a poor physical operating environment.

Application

The client's plant has progressed through several lean improvement initiatives over the past five years. A considerable amount of time and money was invested in new equipment and in training plant personnel. To create this lean environment, the plant fundamentally changed the way in which it operated on a daily basis. The plant's management team created U-shaped material flow cells to produce all products in the product family. Equipment operators were cross-trained to respond to changing conditions. Now, instead of producing large product lot sizes in a functionally organized facility, small lot sizes flow through dedicated equipment. Raw materials are stored at their point-of-use. Inexpensive raw materials are stored in substantial quantities, while expensive raw materials are managed with more attention. The result of these efforts is that flow times through the plant are now both short and predictable. Flow times are measured in *minutes*—-instead of days or weeks. A significant benefit is that the client company's higher-level planning models are more accurate because the lead-times input to them are much more reliable.

The importance of creating this lean and responsive physical environment as part of a supply chain improvement strategy cannot be overstated. Without aggressive improvements in the physical operating environment, the impact of other supply chain improvements will be minimal.

(3) Create a supply chain information infrastructure. An effective information infrastructure, both intra- and inter-organizationally, is necessary for a supply chain to achieve competitive advantage. Today, B2B collaboration via the Internet makes it much easier for supply chain partners to share timely demand information, inventory status, daily capacity usage requirements, evolving marketing plans, product and process design changes, and logistics requirements—to mention just a few. However, true collaboration requires more than just data exchange between successive supply chain partners. Rather, it requires joint planning of inventory and production strategies, and the reliable execution of operational plans on a continuing basis. How capacity is used daily must be considered from a systems perspective and not just a local viewpoint. Simply passing data (even customer demand data) among partners does not realize the true economic potential of collaboration.

A traditional collaborative planning and forecasting (CPFR) initiative is merely a starting point that barely scratches the surface of the true financial rewards and competitive advantages that are possible through a true collaborative supply chain. What is recommended is much more substantive and comprehensive.

Application

The client is significantly invested in information technologies and a team of highly talented IT professionals. A commercial ERP system is not used; internally developed systems are tightly integrated instead. Planning information pertaining to booked orders, finished goods inventory levels, planned shipments, and raw material replenishment is readily accessible. The facility's principal performance metric is on-time delivery. Three years ago, the client launched a Vendor Managed Inventory (VMI) system that captures and stores information about its customers' inventory levels and demand. The majority of the company's customers were willing to share these data. Data gathered daily from customers are now used extensively in the planning, scheduling and execution processes.

(4) Integrate business processes. Business processes must be established both intra- and inter-organizationally to support the supply chain's strategic objectives, as illustrated in Figure 1, below. These processes, coupled with the information infrastructure, support the efficient flow of material through the supply chain. While much attention has been placed on understanding business processes within organizations, it is essential to understand what processes must be built inter-organizationally to leverage and enhance partners' capabilities. These inter-organizational processes must be designed to take advantage of the increased information that drives daily supply chain decisions.

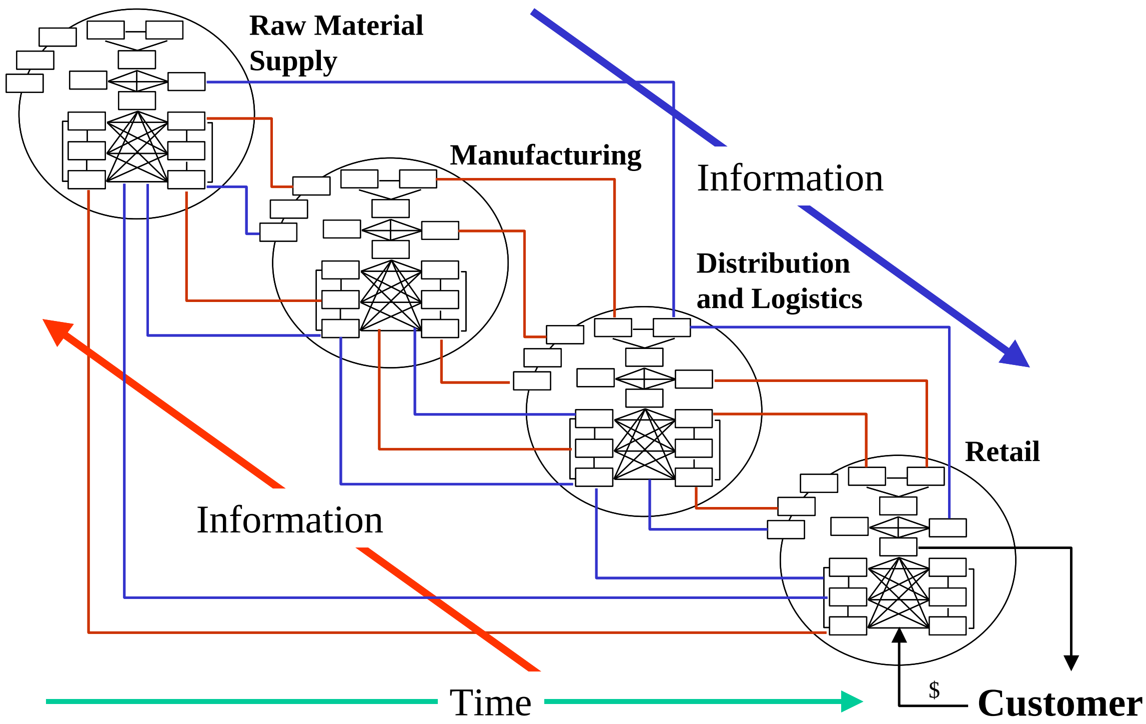

Figure 1 – Integrated information systems and business processes

Application

Many of the client's customers control their inventories using standard order point and order quantity logic. When their inventory position (defined as on-hand inventory plus outstanding orders, minus any backorders) falls to or below a reorder point, they place a replenishment order. While the logic is clear, these customers often deviate from the logic in order to handle some impending circumstance (such as a large demand spike). Provided that the necessary raw materials are available, the team leader decides the production priorities and production sequences through the facility. Similarly, orders are placed to raw material suppliers when the inventory position for a raw material drops to its reorder point. Reorder points at each location are calculated as forecasted demand over some fixed replenishment lead-time. A few periods of safety stock are added. The production planner is responsible for managing the reorder points for raw materials and for finished goods inventory. When material shortages occur, or when insufficient production capacity exists, the production planner attempts to resolve as many shortages as possible and works with the team leader to establish production priorities.

Based on the client's ability to produce and move material quickly, on the accessibility to timely information, and on the facility's management, the company was able to achieve significant performance improvements. This was accomplished through a better understanding of the demand characteristics of their customers and by rethinking the coordination of production and finished goods inventory.

(5) Unify decision support systems. Academics and software providers have designed and built Decision Support System (DSS) environments for individual companies and supply chains. These environments are based on different philosophical models. Also, they differ in how they forecast demand, and how they drive production and allocation decisions. Their goal is to generate plans that simultaneously consider all elements of the supply chain. No matter which approach is taken, these systems and their embedded rules drive many daily supply chain activities. Therefore, they have a substantial impact on the operating behavior, and consequently, on overall supply chain performance. How much they enhance this performance depends on both the accuracy of their input data and the modeling approaches employed. These decision support systems need to address uncertainty in an explicit manner——and most do not.

Application

The client's manufacturing planning systems followed standard materials requirements planning (MRP) logic. Due to high uncertainty of customer demand, large inventories were created as a result of the MRP logic. When a customer order arrived, the inventory often was not sufficient to satisfy demand. Limited production capacity was not explicitly considered. Therefore, frequent production overtime was necessary in order to meet daily production requirements. This operating philosophy neither resulted in an effective use of capacity and inventory, nor provided a high level of customer service.

To remedy this, the basic principles of the *No B/C Strategy* were applied. The total capacity demanded by each product was examined, and the products were placed into two categories. The top four products were designated as A-type products and the remaining products were designated as B/C-type products.

By reducing the demand uncertainty generated by a single customer, reprioritizing some basic production planning rules, and stocking inventory in only A-type products, the client was able to leverage its past investments in achieving several operational improvements for itself and its customers. On-time delivery and customer service levels increased significantly, with substantially lower finished goods inventories.

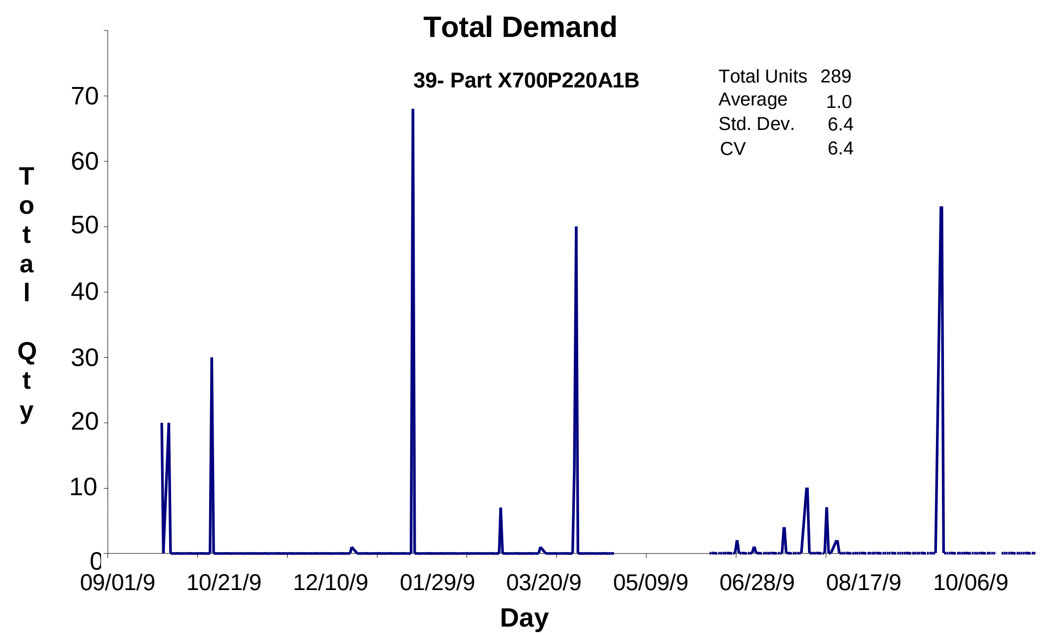

Figure 2 – Typical product demand patterns contribute to uncertainty in supply chain planning

A New Decision Modeling Paradigm

While commercially available Advanced Planning and Scheduling (APS) systems have led to considerable improvements in supply chain efficiency in many companies, success in implementing these systems depends on the extent to which the *Five Principles of Supply Chain Management* are followed. Strategic and tactical modeling paradigms employed in supply chain decision support systems are inadequate. Hence, supply chain manufacturing and distribution systems are often not appropriately designed and operated. Typical consequences of poor design are inventories concentrated in the wrong products at the wrong locations, and production metrics that do not match projections or meet management's performance expectations. A fundamental cause of this failure is the environment's uncertainty and the inability to construct accurate demand forecasts for most items. Given that creating accurate forecasts is difficult, if not impossible, entirely new paradigms like the *No B/C Strategy* must be used to ensure responsiveness. An integrated supply chain needs to be created that quickly and repeatedly moves the right quantities of materials to customers for those items that experience highly uncertain demand.

When designing a supply chain planning system, a clear process must be established that considers the operational dynamics that support successful execution. Planning model designs need to consider both customer requirements and the physical structure of the supply chain. Reasonable customer lead-time expectations must be established so that the cost structure remains competitive. Supply chain operations must be designed around specific customer service objectives. Other supply chain practices must consider flow times through facilities and, more importantly, through the entire supply chain. Inventories must be maintained in critical locations to support the overall operation of the supply chain.

While reducing demand uncertainty and decreasing lead times are necessary for increasing operational effectiveness, it is equally critical that rules and policies be established to effectively coordinate production and inventory.

A New Operating Philosophy: The No B/C Strategy

When considering how much inventory to carry and in which products, it is essential that inventory be carried in those items for which it will be most useful. Inventory held centrally by manufacturing is nothing more than stored production capacity, or stored time. By producing material and storing inventory in products whose demand is highly uncertain, manufacturers increase their financial risk, both in terms of un-sellable inventory and wasted capacity. No company knowingly produces material that they do not expect to profitably sell. But much of this inventory is not sold profitably. Most companies have significant inventory write-downs each year, and have to sell off inventory at less than cost. This occurs because in most industrial environments, it is virtually impossible to predict customer demand over a short lead-time. So why are companies generating forecasts that are so prone to error? Inventory fundamentally exists in supply chain systems because customer order lead-times are shorter than manufacturing and delivery lead-times. If companies have long lead-times, then they must stock some inventory. This is where traditional planning systems fall short.

For analytic tractability, most planning systems break the supply chain up by product and by location. Demand is treated as known and fixed by period and is estimated through some forecasting mechanism. Capacity is often considered by specifying production lead-times, even though it is well understood that lead-times are a consequence of systems design, and are not an input.

When considering the attributes of a new planning paradigm, the planning philosophies must include uncertain demand, customer lead-time requirements, finite production capacity, and inventory stocking decisions for different products and different customers. Not all products and customers behave identically. Not all customers for the same product behave identically, either.

The answer is a hybrid make-to-stock and make-to-order planning strategy that stores inventory in products while considering finite production capacity and highly uncertain demand. This philosophy, called the *No B/C Strategy*, categorizes products into ABC categories using a new method. Inventories exist only for products where there is a low risk of not selling them quickly. Production priority is given to those products for which the demand uncertainty is high and for which little stock is held. To permit this, the production and business processes as well as the information systems must be designed to ensure short and predictable flow times of the make-to-order items. If there is insufficient capacity to produce all demand in a given period, the demand for A-type products must be largely satisfied from inventory. Thus the stock levels for an A-type item must be established to meet not only the demand for that item, but also to compensate for the manner in which capacity will be used to implement this policy. Instead of creating forecasts for individual B/C-type products, a forecast is created for the aggregate capacity demanded across all B/C-type products. Typically, this forecast is much more accurate than ones for individual items.

The implementation of such a policy has numerous benefits. First, instead of managing stock in a wide variety of different products, inventories are concentrated in a much smaller number of individual products. This permits considerable simplifications in material handling and inventory management requirements. Second, overall inventory levels are dramatically reduced. This occurs because production is focused on what is required rather than what *might* be required. Third, since flow times are more predictable, customer service improves. Finally, obsolete inventories are largely eliminated.

This strategy can be implemented effectively only if all supply chain members can provide raw materials and components in a timely manner. This requirement commands each supply chain member to plan inventories, capacities, and production execution rules consistent with the strategy. This consistency is at the heart of a truly collaborative supply chain system that effectively manages and reduces uncertainty.

Conclusion

The client company detailed in the practical application of the *Five Principles* realized a 60% decrease in finished goods inventory for its top 10 products. At the company's central storage facility, finished goods stock levels dropped 40% across the product family. Simultaneously, customer service levels (on-time delivery) increased to 95.2%. Most notably, the on-time delivery performance for make-to-order products increased from 37% to 60%, and is still increasing to this day.

Applying all *Five Principles of Supply Chain Management* is necessary for the effective design and execution of supply chain systems. By actively pursuing only a subset of the principles, companies will not likely succeed in achieving expected supply chain performance improvements. Installing advanced information systems and streamlining business processes will not overcome a poorly designed physical operating environment, and vice versa. Business processes and rules must be tailored to the specific nature of the operating environments and to the supply chain's objectives. Finally, decision support systems and business processes must be capable of explicitly dealing with uncertainty. One such approach is to employ the *No B/C Strategy*.

Summary

Manufacturing companies with sophisticated and complex supply chains that are willing to embrace change and look at their supply chain operating paradigm in an innovative way can positively impact bottom line results. By adopting a new operating philosophy, the *No B/C Strategy*, and adhering to the *Five Principles*, these companies will see new supply chain efficiencies that previously were not possible. Such desirable results are not likely, however, without an open-minded viewpoint to change and unless all five principles are adopted and applied in earnest.

The Five Principles of Supply Chain Management

1. Know the customer.
2. Adopt Lean philosophies.
3. Create a supply chain information infrastructure.
4. Integrate business processes.
5. Unify decision support systems.

Citations

Muckstadt JA, Murray DH, Rappold JA, Collins DE. Guidelines for Collaborative Supply Chain System Design and Operation *Information Systems Frontiers* 2001; 3:4, 427-453.

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