Root Cause: Weak Links

Linkages are the ways partners in the supply chain coordinate their joint enterprise. They include any of the supply chain components — physical, information, financial, or knowledge flow. Strong links lead to a well-coordinated effort; weak ones to an uncoordinated effort.

Supply chain partners are like warships at sea, where their combined strength is presumably greater than that of any one member. When under way, the movements of the fleet must be coordinated. For example, to maintain their formation, all must turn at the same time when the course they are steering is changed. Moving independently creates chaos, and leaves the fleet vulnerable to attack. Ships at sea have many ways to communicate their course changes. These include radio transmissions of voice messages; semaphore (signaling flags); encrypted radio signals; blinking lights; and, particularly if submarines are part of the formation, underwater telephones.

***Jim Ayers** is a principal with CGR Management Consultants in Playa del Rey, California. He can be reached at (310) 822-6720 or jimayers@compuserve.com.*

The supply chain has similar needs for linkages. As one might expect, there are many variations as well.

Some have also likened the supply chain to a symphony. At the symphony, the conductor leads musicians. The sheet music defines the production and timing of contributions from each orchestra member. In supply chain management (SCM), linkages play the roles of conductor and sheet music.

Supply chain linkages are a special category. Supply chain linkages can range from "tight" to downright "unwieldy." So supply chain partners must be careful in their design. In general, "less is more" and "elegant simplicity" will win out over complex, expensive linkages. This column points to some of the efforts under way to establish strong links across supply chains.

Theory of constraints

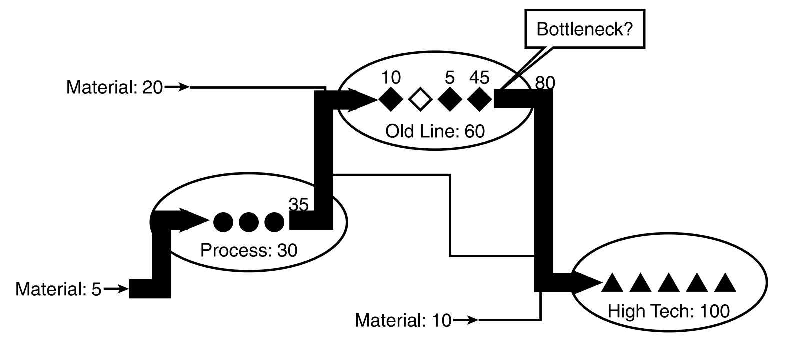
In formulating the theory of constraints, Eli Goldratt and Robert Fox observe that a production system can produce no more than its "capacity constraint resource," or CCR. They use this principle as a foundation for what they call the "drum–buffer–rope way." While the authors focus on individual factories, the lessons apply equally to the supply chain.

To illustrate its application, we return to our supply chain case study. From Exhibit 1, we see that the longest lead-time operation in the supply chain is 45 days at *Old Line*. This is likely to indicate the presence of a CCR at that operation. Managing the CCR is the core of the drum–buffer–rope, or DBR approach. The *drum* sets the beat determined by the capacity of the CCR. This is equivalent to takt time, or the interval at which products are produced. A supply chain that operates 5000 minutes a week and is designed to produce 1000 units per week will have a takt time of five minutes (5000 minutes/1000 units) with level loading of work centers in the supply chain. This drumbeat paces the entire supply chain's production. Because it is the constraining resource, there is no point in letting other operations march faster than the "drum" will allow.

Managing the CCR is the core of the drum–buffer–rope, or DBR approach.

The *buffer* is a device to protect capacity at the CCR. This

Exhibit 1. *Identifying the CCR in a Supply Chain*



protection is in the form of inventory that assures a supply of work for the CCR in case of upstream disruption in supply. The size of the inventory is equivalent to the number of days needed to recover from any anticipated disruption upstream interruptions. If a disruption at *Process* stops the flow of material to Old Line, a buffer will keep the CCR at Old Line going until the disruption is fixed.

The DBR system's final component is the *rope*. The rope is symbolic of the link between the CCR and the front end of the production process, or gating operation. Its purpose is to prevent production in excess of capacity at the CCR. This avoids the common problem of launching more production into the supply chain than it is capable of handling.

Like the ships at sea, the linkage that communicates along the supply chain should fit the situation. Alternatives range from digital signals from linked information systems to physical forms like the Kanbans. For an automated linkage, a proactive system approach could establish the routing of the signal and the appropriate responses.

The DBR system assures maximum output from the CCR, hence the entire supply chain system. For example, assume the supply chain partners determine that Old Line's operation is the system's CCR. As such, it will set the pace for the entire supply chain. Linkages will pace operations at both Process and High Tech. The form is less important than the realization that it is needed. Options include periodic (hourly, weekly, or even monthly) status or automated linkages for continuous monitoring.

Replenishment rules

Another component of supply chain linkage is the quantity–timing decision for production. This decision includes the rules by which partners will order and replenish stock along the supply chain. Monden also describes the alternatives used to set up Kanbans in the Toyota Production System.[2] The first option is *constant quantity*. With the constant quantity decision, the same quantity is produced when a production need is triggered. This is particularly appropriate for operations with high setup costs. The selected quantity should be sufficient to assure an economic transfer. The second decision option is *constant cycle*. With this rule, stock is replenished on a fixed cycle. The quantity is determined by the actual amount used.

Both methods pull material through the supply chain. According to Monden, the constant cycle method is favored for subcontractors in the Toyota Production System. These may take the form of "milk runs" to the supplier several times a day, a constant cycle method, to pick up material for assembly lines. The constant quantity method is favored for internal suppliers. The difference is the distance factor. Constant cycle delivery leaves less to chance from transportation disruptions over longer distances.

The supply chain requires linkages to trigger movements of material. In general, they will follow either the constant quantity or constant cycle rule. The rules can be mixed as we saw in application of the SCOR model. But one or the other should govern the movement of each item in the supply chain. Exhibit 2 displays the advantages and disadvantages of each.

Working out which method to use is subject to objectives for the supply chain, contractual discussions, experimentation, and logistics between partners in the supply chain. But agreement to linkages and replenishment rules will be vital to orderly and low cost movement of work through the supply chain.

Exhibit 2. ***Constant Quantity or Constant Cycle?***

Option	Advantages	Disadvantages
Constant quantity	• Better for close operations with minimal transportation requirements. • Can take advantage of EOQ economies for operations involving high set up costs. • Fast, does not require counting or tracking of inventory. • Simplicity. Compatible with visible signaling. Examples are the two-bin system and Kanban approaches. • Easier to predict time requirements once orders are placed.	• Can cause excess inventory in the system. Better for low cost, "C" items. Some companies expense items in this category.
Constant cycle	• Establishes a regular rhythm in the supply chain. Decreases variability from uncertainty about schedules. • Can take advantage of setup economies when setup times depend on sequence. An example is paint lines where different color sequences require different setup efforts.	• Variation in quantities can cause production to run behind. • Have to track production through the chain. Need to know usage at various points to signal correct quantity. • Fits higher value "A" items.

The 3C Alternative

Three managers from Lucent Technologies operations in Spain have devised and road tested a simplified tool for optimizing supply chain performance.[3] They call their methodology "3C," which stands for *Capacity, Commonality,* and *Consumption*. The method is an alternative to what they view as flawed MRP approaches. In particular, they object to the reliance on forecasts inherent in the MRP methodology.

In the 3C method, supply chain *capacity*, the first C, is the governing parameter over the amount of inventory in the system. Under 3C control, the chain should have a sufficient number of any one part on hand to produce to the capacity of the chain for usage of that part. To the extent parts are *common*, then the overall inventory is less, because a single part will support several products.

Exhibit 3 provides an example to explain the concept. The simple system we describe only has four parts and three products. The capacity of the supply chain is the number of units of each product that can be produced in a given period. This assumes that the system is producing nothing but that single product. The "target" inventory is determined by the maximum potential demand for the part during the period. For example, Part A's target inventory should be 20, because the Product 2 capacity is 20. Part C's target is 30 due to potential demand from Product 3. A level of 20 for Part A and 30 for Part C will cover the needs of any potential demand scenario.

As parts are *consumed*, then they are replaced in sufficient amounts to maintain the target inventory. This concept is applied to all "points of consumption" through the supply chain. Thus, actual demand provides the signal for replenishment in the chain. No stock is reserved for any single forecasted need. So a company using the 3C method would do away with forecasts for each of their products — eliminating a source of confusion and inventory overbuilding. With 3C, only capacity, not lack of parts, restricts what can be delivered to the customer. Frequent updating is abolished. Changes in the targets occur only at

Exhibit 3. ***The 3C Alternative Method***

	Product 1	Product 2	Product 3	Target
Part A	1	1	1	20
Part B	2		1	20
Part C	1		3	30
Part D		1		20
Capacity	10	20	10	

times when product or market changes make it necessary.

The authors have performed simulations demonstrating that 3C bests the MRP method in many cases. We believe 3C is a valuable addition to thinking about both supply chain systems and "rules of the road" among partners. We believe that supply chain management will call for simpler rule-making with respect to inventory maintenance and restocking rules. 3C fulfills the criterion for simpler methods.

Collaboration

Many tools and techniques have been developed to help create effective supply chains. One initiative addresses both the cultural and technical barriers to collaboration among supply chain partners. It is Collaborative Planning Forecasting and Replenishment, CPFR for short. CPFR requires a business relationship between partners and has taken root in the retail industry. Collaboration strives to better match demand and supply, improve inventory management practices, and capitalize on new systems through sharing. CPFR is primarily a link between retailers and their manufacturer suppliers. It is expected that the concepts will expand to other industries.

CPFR is moving forward with standards for communications, innovations in placing and filling orders, and roadmaps for business arrangements. The obstacles are not technical, however, but cultural. Top management commitment is necessary to forge partnerships. A key to successful implementation of CPFR will be removing these barriers. A primary barrier is the evolution of the "flow model." Often the planning cycles of manufacturers and their retail customers are unsynchronized. CPFR attempts to implement a common forecast that represents a compromise between the needs of both parties.

Notes

1. Goldratt, Eliyahu M. and Fox, Robert E., *The Race,* Croton-on-the-Hudson, NY: North River Press, 1986.
2. Monden, Yasuhiro, *Toyota Production System*, Institute of Industrial Engineers, 1983.
3. Fernández-Rañada, Miguel, Gurrola-Gal, F. Xavier, and López-Tello, Enrique, *3C: A Proven Alternative to MRPII for Optimizing Supply Chain Performance*, Boca Raton, FL: St. Lucie Press, 2000.