DESIGN OF SUPPLY CHAINS FOR QUICK RESPONSE: THE CASE OF APPAREL INDUSTRY

Sophia Daskalaki

Department of Engineering Sciences
University of Patras
+30.61.997810, sdask@upatras.gr

Abstract
Quick Response is a philosophy that greatly influences the way that supply chains of certain products operate to reach customers. It is based on the idea of feeding back to the whole supply chain information retrieved at the selling points of the products. Until now this information was only available to the retailers, while manufacturers almost never had to adopt their production plans to customer desires. Competition in modern world pressures manufacturers and product designers to reconsider their position and relation to customers. This paper concentrates on the aspects of designing the apparel supply chain so to be able to operate under the concept of Quick Response.

Keywords: Supply Chain Management, Quick Response, Textile & Apparel Manufacturing

1. Introduction
Quick Response (QR) as a new philosophy in management was conceptualized more than 10 years ago; back then it was referred as a mode of operation for the entire supply chains that produce consumer products so that customers receive the products they want in the desired timeframe [Hunter, 1990].

The ideas of QR are applicable to products with long cycles from design to market and long supply chains involving several manufacturing firms, each taking responsibility for a specific set of the required production stages, and a network of distributors and retailers. Such products are garments, footwear, automotive, furniture, household accessories, etc. All of these products carry elements of fashion and retailers take high risks when a new product is introduced in the market. Sales depend on whether the new products look appealing to the customers, therefore this information is very useful to all partners in the supply chain. Today supply chains for the above products make little use of this information, because in most cases sales data are processed very late to be useful and almost never are fed back to production stages. With the help of data collected at the selling points, manufacturers may adjust production plans in orders to satisfy more consumers and protect retailers from unnecessary markdowns and leftovers in the shelves at the end of the selling periods.

2. Quick Response and Apparel Supply Chains

In apparel industry most supply chains for garments still operate in a traditional manner, which prohibits the chain of getting even close to this type of management. It suffices to think that for seasonal goods (which have approximately 20 weeks of selling season), the production process in the apparel manufacturing floor is reaching to its end at the same time that initial deliveries of products reach the shelves and their selling period starts. Meanwhile the production of the required quantities of textile at the textile manufacturing floor is already completed [Hunter, 1992]. This occurs because orders to apparel manufacturers are solely based on buyers' (retailers and wholesalers) intuition on how a product is going to perform in the market. To make things worse, buyers take decisions on the distribution of the different sizes and colors for each style in their order based on previous experience. Nuttle et al. [Nuttle, 1991] in a simulation study showed that apparel retailing would respond much better to customer requests had they re-estimated customer demand at the end of each week of the selling season and placed small and frequent re-orders to their suppliers. This new form of operation benefit enormously retailers who result in much higher GMROI (Gross Margin Return on Inventory), significantly more inventory turns, much better service level (measured in percentage of customers who find their initial choice) and significantly less lost sales and merchandise jobbed off (products on the self at the end of the selling season).

In order to understand the apparel supply chain let us take a closer look. Table 1 gives the list of the main partners in the apparel supply chain, as well as some partners of less importance. The first group consists of the yarn manufacturers, textile manufacturers, apparel manufacturers, distributors and/or retailers. The second group comprises mostly small enterprises that take responsibility for specialized processes in the manufacturing process and work mostly as subcontractors to the main partners. While in most cases the main partners to expedite processes utilize partners in the second group, under certain circumstances this may introduce major delays in the chain. Each partner in the supply chain uses the indicated input material as main raw material and after several internal processes the product is transformed to the corresponding output material.

Main Partners	Input Material	Output Material	Possible Partners & Subcontractors	Input Material	Output Material
Yarn Manufacturers	Fibers	Yarn	Yarn Dyer	Undyed Yarn	Dyed Yarn
Textile Manufacturers	Yarn	Greige Fabric	Textile Dyeing & Finishing	Greige Fabric	Finished Fabric
Apparel Manufacturers	Greige Fabric	Finished Garments	Embroidering / Printing	Cut pieces of garments	Embroidered or printed pieces
Distributors	Garments	Garments	Cut & Sew	Finished Garments	Sewn garments
Retailers	Garments	Garments			

Table 1. Apparel Supply Chain

Apparel goods are divided in two major categories in terms of their selling period and the length of their cycle time:

- Goods with continuous flow or basic goods, sold year-round having a life cycle of several years

- Seasonal goods, sold only throughout a limited period (called a season) having a life cycle of one year.

Seasonal goods are further divided to other categories based on how fashionable they appear. The element of fashion in clothing determines the length of the selling season, which may vary from twenty down to almost six weeks [Forza, 1997].

Seasonal and fashion garments have a life cycle that normally starts a year before they reach market. Designers design the new styles and after a number of evaluations and iterations among certain people they proceed with production of samples. Fashion shows or scheduled show rooms follow and it is there that retailers and distributors prepare their orders. This event takes place six to eight months before the beginning of the actual selling season. Manufacturers are collecting the placed orders and initiate orders for raw materials. Right at the start of the selling period the initial orders are delivered to the selling points. The initial order is approximately 65% of the total order and the rest is delivered later in the selling season, usually after its first half. As it turns out from the above description, current supply chains operate based on the buyers' plans, which are fixed and limited changes are allowed from manufacturers. Thus, during the selling period popular styles that were not predicted as such will be sold out quickly and problematic styles will remain in the shelves until the end of the season. Retailers are then forced to implement marketing techniques for reducing unpleasant stock. In addition, the two deliveries of clothes result to large inventories for retailers, which is quite undesirable, given the outlook of modern retailing stores

Current business practices may not allow much longer the rigidity that apparel supply chains carry inherently. The answer is flexibility for the entire supply chain, increased responsiveness to consumer demands, smaller delays for intermediate products for further processing and a spirit of cooperation among partners. This requires deep changes in mentality of participating companies, support from technology, as well as major shift in objectives of production managers throughout the chain. Moreover, before full-scale implementation of QR management system across the apparel industry it is necessary for researchers to study the impact of this implementation across different products of the sector.

3. Quick Response Implementation

Previous studies on QR implementation in apparel supply chains have resulted to major improvements for the chain operation. It is now well understood that supply chains have to be designed to operate in such a mode and not to limit themselves to the implementation of the necessary information and communication technologies like EDI and bar-coding.

Designing supply chains for QR requires changes that can be categorized in four major directions:

- Integration across partners in the chain
- Order management and sales forecasting
- Inter-company integration for each enterprise in the chain
- Production planning for flexible manufacturing across the chain

3.1 Integration across partners in the chain

Computer integration among the different partners in a chain is considered to be of prime importance for reducing time to market. Establishing communication across all members of the chain requires first the identification of the essential information that needs to be shared among chain partners and second the implementation of supporting technologies with suitable architectures. Information exchange throughout a large part of the chain may be viewed as interactions within the triangular structure customer-manufacturer-supplier (Fig.2). In such a structure the intermediate supply chain member may be any of the manufacturers that produces products for another manufacturer, wholesaler or retailer (called customer). The supplier, on the other hand, may also be a manufacturer who provides an intermediate product as raw material to the manufacturer or a fiber supplier if we refer to the beginning of the pipeline.

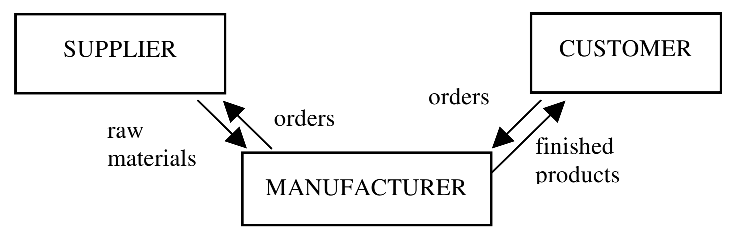

Fig. 2: The triangular structure customer-manufacturer-supplier

Previous study [Daskalaki, 1996] on the information flow that traditionally is exchanged within the triangular structure reveals that order management is the major function that governs communication among partners. This is true for both interfaces of the triangle: customer-manufacturer and manufacturer-supplier. The messages that are exchanged between partners concern: quantities of products desired for an order, price lists, availability of materials and finished products, and delivery schedules. Messages of smaller volumes concern other functions like design and quality management. Such messages are dimension charts and quality problems. The technology for chain members' integration is well advanced and is based on the EDI technology. EDI supports the transfer of structured data by agreed message standards for the exchange of a variety of commercial forms (invoices, orders, reports, etc.) from one computer to another by electronic means. Standards for the needs of the textile/clothing industry are still under development and comprise EDITEX, an important initiative towards standardization of ordering, invoicing, dispatching, cataloguing, and special process instructing.

3.2 Orders management and sales forecasting

Forecasting has always been a major function of production planning in manufacturing businesses. However, whenever used in clothing manufacturing, forecasting is performed manually based on "intelligent" guesses of production managers and sometimes automatically based on orders from previous periods. On the other side, from section 2 it is clear that production in the traditional clothing supply chain is driven by buyers' orders. As a result, for each garment style the volumes that finally reach markets are the best estimates for consumers' demand set by people in commerce. Apart from the total volume for each different style, the buyers are also called to estimate demand for a number of colors and sizes and these are long-term forecasts on what might be selling more than half a year later. In fact, after sales begin and forecasts become more accurate, there is no mechanism to retrofit this valuable information into the orders of either the apparel manufacturers or the others more upstream in the chain.

Based on studies performed in [Nuttle, 1991] the estimates of customer demands that drive production may be erroneous up to ±35% on the total volume. On the other hand, QR management philosophy promotes that accurate estimates of demand improve planning of operations, controllability and speed of response. The best strategy for the chain is to request from retailers to select Point-of-Sale (POS) data in their premises. With the help of modern forecasting techniques it is feasible to improve estimates of customer demands broken down to sizes and colors. The improved estimates may then be used from retailers for creating better stock replenishment plans, for determining quantities for re-orders and for planning markdowns [Hunter, 1996].

While till now forecasts are issued independently by each partner and are never shared with other members of the chain, this can be another major point for change. The transfer of this information upward in the chain can be quite valuable for manufacturers who would like to plan production operations in an adoptive way to benefit the whole supply chain. In our modern and very competitive world it is well understood that short-term forecasting is an absolute necessity for staying ahead in the market and this should be introduced in the culture of the apparel supply chains. Large companies in the clothing retailing and apparel manufacturing have already succeeded in introducing elements of QR in their supply chains and competition in this aspect has already began.

3. 3 Inter-company integration for each enterprise in the chain

While intra-company (lateral) integration for communication among chain partners is very important, inter-company (vertical) integration is equally important for the survival of manufacturing companies in modern supply chains. Quick response requires flexibility of production planning to adopt consumer demands and therefore gives one more reason for the indispensability of ERP systems, without of which effective participation in integrated supply chains would be impossible.

In addition, automation and communication technologies for industrial environments expedite certain processes and ease information flow. Bar coding is at the top of the list in this context. In fact, use of Universal Product Codes (UPC) together with EDI technology, has been considered as the only aspects of quick response strategy in the early stages of its appearance [Kincade, 1995]. Bar coding may be introduced at several different points of the transformation process of products and if applied it facilitates inventory control, availability reporting, tracing of products and replenishment of stock.

3. 4 Production planning for flexible manufacturing across the chain

Introducing the QR philosophy in a supply chain greatly influence the way that current production and capacity planning systems are developed. The focus of most systems that perform these functions is on maximum utilization of resources. As a result delays are introduced into the production system emanating from the queuing up of orders in front of machines to keep them busy. Reaching consumers with the right products, however, requires time compression throughout all phases of production and this should be the primary concern of production planning (King and Moon, 1999).

As mentioned earlier the traditional operation of the supply chain is such that buyers (distributors and major retailers) place their orders six to eight months upfront the selling season of a specific product. With the placement of any order the apparel manufacturer agrees on a delivery schedule that consists of an initial delivery right at the beginning of the selling season and one more at a later date in the selling season. The standard procedures for apparel manufacturer even today is to input all orders in their planning system, group them and schedule production in a way that maximizes utilization of resources. This capacity planning procedure works perfectly as long as production managers keep up with the delivery schedule agreed with each individual client. There is no concern on delay times for each individual product, except only when it violates agreed delivery times. The result is long lead times, unacceptable to any modern philosophy in consumer business.

The new philosophy (Hunter, 1992) requires that only the initial delivery be fixed but much less in volume compared to traditional operations. It further allows the retailers to collect information from sales each week in the selling season and adjust their initial plan for orders based on short-term forecasts. The updated stock replenishment schedule may include several reorders and deliveries continually adjusted to on-going sales and consumers´ behavior. Planning systems at the manufacturing sites must be designed suitably to handle this new scheme of orders and plan production in such a way that delay time is minimized. Then lead times for new deliveries will be kept at its minimum and reordering system will be satisfied.

In addition to the changes in the planning systems the new reordering scheme influences production itself. Small lots are better handled by flexible production methods and more specifically by modular production, where teams of differently skilled workers produce a product from start to the end. It is now well known that modular production reduces lead times when applied to garment manufacturing. The request for small lots is more difficult to apply to textile or yarn manufactures due to the requirements for long set-up times in these processes. Careful studies of the upper stream production stages in garment supply chains is possible to reveal that small lot production is not always as bad as it is considered even in textile weaving that requires very long set-up times [Goddard et al., 1996a; 1996b].

4. Summary and Conclusions

In this paper several design issues for applying QR in the apparel supply chains are examined. It is our conclusion that QR influences several operational areas and requires major changes throughout the entire supply chain. However, QR has been named as the optimal scheduling system for the apparel supply chains because its main objective is to "keep production in line" with distribution and therefore soon all involved partners will have to follow the required changes.

While simple to be expressed in words, not all supply chains are still ready for adopting this scheduling system. Reasons can be attributed both in technological deficiencies in affordable scales of economy but also in strong psychological reaction to a major change in mentality and culture in a very traditional sector.

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