

The U.S. apparel industry: a supply chain review

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Apparel industry has short product life cycles, tremendous product variety, volatile and unpredictable demand, and long and inflexible supply processes. These characteristics, a complex supply chain and wide availability of data make the industry a suitable avenue for efficient supply chain management practices. The industry has also been in a transition over the last 20 years: significant consolidation in retail, majority of apparel manufacturing operations moving overseas, and more recently, increasing use of electronic commerce in retail and wholesale trade. This paper aims to review the current state of operations and recent trends across the apparel supply chain in the U.S. We use industry wide data, articles from business journals, industry reviews, and extensive interviews with an apparel manufacturer in California, and a major U.S. department store chain to describe the current operational practices and how the industry is restructuring itself during the transition, focusing at the apparel manufacture and retail segments of the supply chain.

1. Introduction

Apparel industry is characterized by short product life cycles, volatile and unpredictable demand, tremendous product variety, and long and inflexible supply processes. These characteristics and a complex supply chain make apparel industry a prime candidate that efficient supply chain management practices can make a difference. Despite the potential and availability of enormous amount of data enabled by information technologies, we see that the industry has been neglected in terms of supply chain management research and practice. The main objective of this paper is to review the operations and identify major supply chain issues in the apparel industry in order to provide a background for researchers, educators and practitioners. Our primary focus is the apparel industry in the U.S., for which we will provide an overview in the remainder of this section.

The textile and apparel supply chain in the U.S. consists of about 25,000 companies employing about 500,000 people (excluding retailing channels) in four segments. At the top of the supply chain, there are fiber producers using either natural or “man-made” (synthetic) materials. Raw fiber is spun, woven or knitted into fabric by the second segment, usually called textile mills. The third segment of the supply chain is the apparel manufacturers or manufacturers of industrial

textile products. The final segment is the retailers which makes the apparel and other textile products available to consumers. Below, we briefly outline each segment. The discussion for this section builds heavily on U.S. International Trade Commission (1999), Brown and Rice (1998), Ostic (1997), Hammond and Kelly (1991) and National Academy of Engineering (1983).

FIBER and YARN PRODUCTION

Fibers are usually classified into two groups: natural and man-made. Natural fibers include plant fibers such as cotton, linen, jute and cellulosic fibers and animal fibers such as wool that are produced by agricultural firms. Agricultural firms are scattered all around the U.S. and are usually small in size. Synthetic fibers include nylon, polyester and acrylic. Synthetic fiber production usually requires significant capital and knowledge, and thus synthetic fiber producers, such as DuPont and Celanese, are large, sophisticated and very few in number (about 75 in the U.S.). Top ten U.S. producers share 90 % of the U.S. synthetic fiber production. Natural and synthetic fibers of short lengths are converted into yarn by spinners, throwsters and texturizers. This conversion process is also capital intensive and is considerably different for each type of fiber. Blending different fibers may need additional sophistication. A typical fiber plant can manufacture about 1 million pounds of fiber per day, supporting approximately 100 fabric plants.

FABRIC PRODUCTION

This segment of the supply chain transforms the yarn into fabric by weaving, knitting or a non-woven process. In a weaving process, yarns are interlaced lengthwise and widthwise at right angles. Yarn may be woven by a simple procedure to produce generic goods and then dyed for a specific fabric. Alternatively, dyed yarns may be woven. In knitting, yarn is inter-looped by latched and spring needles. The process may output rolls of knitted fabric or may specialize in a particular apparel such as sweaters or hosiery. Non-woven processes involve compression and interlocking fibers by mechanical, thermal, chemical or fluid methods. This segment of the chain consists of about 3,600 companies of two types (U.S. Census Bureau 2000). Thousands of small and medium companies are engaged in production of limited range of fabrics and a small number of huge firms such as Burlington and J.P. Stevens produce a wide range of fabrics. On average, a fabric plant manufactures about 1 million square yards of fabric every week supporting approximately 4 apparel manufacturers.

APPAREL MANUFACTURE

More manufacturing companies are involved with this part of the supply chain. Apparel manufacturing starts with the design of the garment to be made. Patterns are made from the design which is then used to cut the fabric. The cut fabric is usually assembled into garments, labeled and

shipped. The apparel segment is the most labor-intensive and fragmented segment of the supply chain. Capital and knowledge requirements are not significant, making it attractive for new entries. There are currently about 15,750 companies in this segment (U.S. Census Bureau 2000). The firms in the women's and girl's categories tend to be smaller, while firms in the less fashion sensitive men's and boy's clothing, knit-wear and underwear categories can utilize economies of scale and tend to be larger in size. Average number of employees in men's apparel companies is about 92, compared to only 33 in women's apparel companies (U.S. Census Bureau 2000). Apparel companies usually specialize in narrower product categories and rarely produce garments of both genders.

Traditional manufacturers (and integrated knitting mills for knit-wear) are engaged in all phases of apparel manufacturing: product design, material sourcing, production of apparel in house and marketing of the finished goods. Jobbers also perform all of these activities except for production of garments. The production is contracted out to contractors either in U.S. or overseas. Contractors are engaged in manufacturing of garments and are not responsible for sourcing raw material or the design and marketing of these garments. The distinction between manufacturers and contractors is not very clear as manufacturers may contract out their work or perform contract work for other manufacturers, and contractors sometimes may start their own private labels. Some U.S. manufacturers cut fabrics in U.S. and send cuts to a low wage country to be assembled. The assembled garments are then shipped back to U.S. for finishing. Manufacturers pay tariff only on the value added outside the U.S. with this type of production, which is often called 807 sourcing. A profitable choice for such production sharing is Caribbean Basin region countries because of their proximity to U.S. market. Mexico is further advantaged with reduced tariff under NAFTA and more control over delivery with ground transportation options.

RETAIL

Apparel products are made available to consumers in a variety of retail channels. Specialty stores, such as The Limited and The Gap, offer a limited range of apparel products and related accessories specializing in a particular market segment. Specialty stores accounted for 26 percent of all retail sales in dollars in 2000 (NPD Group 2001). Another 17 percent of the apparel sales took place in discounters or mass merchandisers such as Wal-mart, Kmart and Target. These retailers offer a variety of hard and soft goods in addition to apparel using an "everyday low prices" strategy. Department stores, such as Macy's, Nordstrom and Bloomingdales' offer a large number of national brands in both hard and soft goods categories. The market share of these stores in apparel amounts to 23 percent. Apparel chains, such as J.C. Penney and Sears, that offer a wider range of products command a market share of 15 percent. Off-price stores, such as Marshalls and T.J. Maxx buy excess stock of designer-label and branded apparel from manufacturers and other retailers and are

able to offer considerably low prices but with incomplete assortments. The market share of these stores is about 8 percent. The remaining 12 percent of the apparel sales is shared by mail order companies, e-tailers, factory outlets and other retail channels.

This paper aims to review the current state of operations and recent trends across the apparel supply chain. The review uses variety of literature including academic and trade journals, government statistics, industry reviews and case studies. In addition, we have conducted extensive interviews with the owner of a U.S. apparel manufacturer, a former fashion buyer for a large department store, and an independent specialty retailer. Next, we provide some background information for these sources.

In apparel manufacturing, our contact is Paugal Industries. Paugal Industries is an apparel manufacturer located in the Fashion District in downtown Los Angeles. Mr. Pierre Levy, originally from France, founded Paugal in 1983, after working as a sales representative for a large apparel retail chain where he accumulated intimate knowledge of the design, manufacture and retailing of apparel. Paugal is a women's apparel manufacturer specializing in products in the "fashion" category characterized by product life cycle of about 10 weeks. Like many companies in the women's category, Paugal is a small company. Paugal employs 18 regular employees. Paugal has two types of operations. In the first category, Paugal designs and develops women's sweaters under the name Ultraknits. Ultraknits has two brands; Fifi, targeting younger consumers and Loop, targeting consumers looking for distinctive fashion. All production in this category is performed by independent contractors. Currently, Paugal contracts its production out to four factories in China and Bangladesh. Major customers of Paugal in this category are department stores and specialty chain stores. Production volume for sweaters is about 40,000 units per month. In the second category, Paugal acts as an intermediary between the local contractors and mail order companies for women's dresses under the brand name Olive. Paugal is not responsible for the design of these dresses. Currently, Paugal uses two contractors which are both located in the Los Angeles area. All of the six customers in this category are mail order companies. Production volume for women's dresses is about 5,000 units per month. We selected Paugal for our research contact as it is a small manufacturing company reflecting the current situation in women's fashion business and it is working with major retailers and contracts some of its business to off-shore companies.

In apparel retailing, we talked to a former buyer for a major retail chain: Ms. Jennings and a buyer/owner of an independent boutique: Ms. Massoudian. Ms. Jennings worked for six years as an assistant buyer, department manager, group sales manager, cosmetics and fragrance manager, and operations manager for a large department store, which we will call LDS throughout the paper, and

two years as store manager for The Gap. Ms. Massoudian owned an independent high-end women's apparel store in Palos Verdes, California and was mostly involved with purchasing decisions. We selected buyers for our research contact, since the buyer is the person who directly makes the decisions for what to buy, whom to buy from, how much to buy, how much to price, when to mark-down, and how much to mark-down, whereas the store manager of a store in a chain has responsibilities in the daily maintenance of the store operations (both personnel and merchandise), and the chain executive is more concerned with financial control and administrative policy making.

The rest of the paper is organized as follows. Section 2 reviews the operations in the last two segments of the supply chain: apparel manufacture and retail. This section details the major operational decisions faced by the apparel manufacturers and retailers and show how these decisions are currently taken in practice through a rich review of the industry and specific examples. Section 3 reviews the recent trends in apparel manufacture and retail: retail consolidation, vertical integration and emergence of private labels; import penetration and production sharing; Quick Response systems; supplier selection for apparel retailers and electronic commerce. This section demonstrates by figures how the industry is restructuring and its impact on operations of apparel manufacturers and retailers. Section 4 summarizes our findings along with some suggestions for future academic research.

2. Apparel Manufacture and Retail Operations

This section aims to give an overview of important issues and decision making in the last two segments of the textile and apparel supply chain. We analyze the manufacturing and retailing operations separately, although vertical integration taking place in the recent years makes it difficult to distinguish the retailers from manufacturers (see Section 3.1).

2.1 Manufacturing Operations

Domestic apparel market can be divided into three different categories (U.S. Office of Technology Assessment 1987).

- “Fashion” products, with a 10-week product life—approximately 35 percent of the market.
- “Seasonal” products, with a 20-week product life—approximately 45 percent of the market.
- “Basic” products, sold throughout the year—approximately 20 percent of the market.

Men's and children's merchandise usually fall into the basic category, while women's merchandise dominates seasonal and fashion categories, showing the importance of fashion and resulting frequent design changes in the women's market. A similar categorization is made in Abernathy et al. (1995).

Manufacturing companies usually specialize in narrower product categories. The type of product the company focuses on not only defines the manufacturing cycle and the intensity of the design in its operations, but also the manufacturing strategy as suggested by Fisher (1997). Companies manufacturing basic products can utilize larger batches and tend to be larger in size. Cost reduction is a priority for these companies. Companies manufacturing fashion products have to live with smaller batches and tend to be smaller in size. Flexibility is the key to success for such companies (Taplin 1997).

Companies' involvement in apparel manufacturing vary. Traditional manufacturers are responsible for all phases of manufacturing. But most of the industry is organized in the form of jobbers and contractors; jobbers being responsible for the design, cutting and marketing and contractors being responsible for the sewing and assembly.

The operations of an apparel manufacturer is aligned with the sales seasons of different apparel items it produces. Fashion products usually have 4-5 seasons in a year, while for seasonal items with more stable year-round demand, there can be only two seasons. For example, Paugal delivers its fashion products in 5 different seasons given below:

Season	Delivery times	to	retailers
Fall 1	July	-	August
Fall 2	September	-	October
Holiday	October	-	mid November
Spring	late January	-	March
Summer	March	-	mid April

At LDS, there are four seasons for women's clothing, but many categories also have special sales seasons such as Christmas.

2.1.1 Design

Design is either completed in-house or commissioned to smaller design companies. The first step in design is analyzing the consumer which the company is targeting. The design process is influenced by the works of other designers presented in collections in cities like Paris, Milan and New York, or trade shows of the earlier seasons. Fashion prediction consultancies and magazines may also be an important input for the design efforts (Bohdanowicz and Clamp 1994). More important is the feedback gained from the sales of the similar products that were developed earlier, which requires a collaboration between the retailers and the manufacturer. Usually, prototype garments are made for internal decision making. These tasks take considerable amount of time. The design process usually starts while the previous year's garments are still retailed. The design process at Sport Obermeyer, a major ski-wear manufacturer, starts as early as 19 months before the season and takes up to 8

months (Hammond and Raman 1994). At Paugal, the design efforts for Fall 1 (2003) merchandise to be delivered to retailers at the end of July 2003 should start as early as early October 2002. At this time, the designers working for Paugal are able to observe any particular trends popular with the consumer in the Fall 1 (2002) season. Design takes place until January 2003 and sample production begins at Paugal's own facilities.

Responsiveness may be greatly enhanced by reducing the time required for design development. Computer-aided design (CAD) systems are recently being used for such reduction efforts. Besides reductions in the actual design time, CAD systems also reduce the time for making the pattern and enable electronic storage of the design which makes later modifications and transmissions easy (Blackburn 1991). Levi Straus & Co., the San Francisco based jeans-wear company, reduced its product development time for its Red Tab line from 53 weeks to 36 weeks through use of such systems (Women Wear Daily 1999b). Recently emerging Product Lifecycle Management (PLM) technologies are targeting to improve communications throughout the supply chain during the product development process. The primary benefit of these new technologies is to shorten lead times which is crucial in the apparel industry where it still takes 12 to 18 months from initial concept to having a design ready for production. It is expected that a PLM systems will lead to 25–30 percent reductions in product development time (Bobbin 2003b).

2.1.2 Production of Samples and Order Collection

The next step after the design in the fashion calendar is the production of samples. At Paugal, the first samples are produced and approved by mid February for Fall 1 season. The samples are shown to the buyers from retailers by market representatives at major trade shows (e.g., Las Vegas Magic Show) or at the retailer sites. Some major customers may be also invited for on-site exhibitions. Paugal, like most small manufacturers, accumulate all of their orders and then proceed with the production. Order quantities from retailers are usually economically feasible. However, even if a particular retailer asks for a non-economic quantity of a particular design, the tendency is to accept the order, considering the long term relationships with the retailers. Fourth week of April is usually the time that Paugal checks to see whether the cumulative orders in each style exceeds minimum production quantities. Rarely, Paugal has to cancel the orders, if the cumulative demand in a particular style is not enough to carry out a cost efficient production. Trading off the cost of such cancellations against the cost of failing to capture enough market share, Paugal has to plan its initial merchandise assortment (samples to be shown to the retailers) very carefully. Note that the customer (and thus the retailer) preferences are highly unpredictable when Paugal decides its assortment and starts to collect its customer orders. This is probably the only stochastic problem

faced by Paugal in its operations.

As a result of capacity constraints in peak periods and recent trend of retailers willing to order much closer to and even during the selling season, some other companies have to commit themselves to some or all of their production volume prior to gathering all their actual orders. For example, Sport Obermeyer's initial production order before any order collection is as much as half of its annual production (Hammond and Raman 1994).

2.1.3 Production

A strategic question for the apparel producers at this point is where to carry out the manufacturing operations. Some companies operate their own facilities for manufacturing. Some others use contractors. The trade-offs for this decision are typical of any manufacturing operation. Some of them are: more control over quality and time, fewer communication problems with in-house production; less capital investment and more flexibility with out-sourcing (Brown and Rice 1998, Page 3). Whether this decision be out-sourcing or in-house production, another important issue is the venue of the production. Now the major trade-off is between the responsiveness and cost efficiency. Increasing number of apparel producers are choosing lower cost off-shore production in Asia and Latin America. Among them are major apparel manufacturers such as V.F. Corporation, Fruit of the Loom and Oxford Industries that plan to produce majority of their garments offshore (US International Trade Commission 1998). Paugal also uses off-shore contractors for manufacturing its apparel. When the collection of orders is complete, cumulative orders in each style is assigned to one of four contractors in China and Bangladesh. The assignment is usually based on the production volume of each style. For all of these factories the production and transportation lead time is about 3 months. The finished merchandise is delivered to retailers at the end of July.

Kurt Salmon Associates reports that some companies are pursuing blended sourcing strategies (Apparel Industry Magazine 1997). Domestic production is used for fashion items, while basic products are produced in off-shore facilities. The report also includes an example of an apparel manufacturer which uses three contractors for the very same product. A low cost high lead time (90 days) Far East contractor, a medium cost medium lead time (21 days) Latin American contractor and a high cost low lead time (3-5 days) domestic contractor.

The new designs are used to make patterns by which the fabric is cut. An efficient layout of the patterns on fabric is crucial in reducing the wasted material. CAD systems may be used for pattern layout and be further integrated to computer-aided cutting systems (Abernathy et al. 1995). The later stages of apparel manufacturing are quite labor intensive as they are not appropriate for any kind of automation. Whether it is in a large or small manufacturing facility, garment is usually

assembled using the progressive bundle system (PBS). In PBS, or batch production with its general name, the work is delivered to individual work stations from the cutting room in bundles. Sewing machine operators then systematically process them in batches. The supervisors direct and balance the line activities and check quality. The result of such a system is of course large work-in-process inventories and minimal flexibility (Taplin 1997). In order to move the apparel faster through the successive sewing operations, some apparel producers began to use Unit Production Systems (UPS) which reduce the buffer sizes between the operations. Another way is to use modular assembly systems which allow a small group of sewing operators to assemble the entire garment (Abernathy et al. 1995, Blackburn 1991).

2.1.4 Distribution

Assembled garments are labeled, packaged and usually shipped to a warehouse. The garments are then shipped to the retailers' warehouses. In an effort to compress the time from placement of the retailer order to the consumer's purchase of the apparel, several practices are gaining popularity. First, there are increased automation and use of electronic processing in the warehouses of both manufacturers and retailers. Manufacturers are assuming responsibility in many functions, once considered to be part of retailers' services. Among them are labeling products with retailer's price tags, preparing them on hangers and shipping them directly to stores.

2.2 Retail Operations

A retailing organization is responsible for the following tasks:

- buying merchandise for sale in stores
- operating stores for the selling of merchandise
- operating warehouses and trucks for receiving, storage and transshipment of merchandise

in addition to the usual tasks such as finance, marketing and personnel management. Most large retailers are organized in a way that these three tasks are separated; a general merchandise manager responsible for buying, a manager of stores responsible for store operations and an operations manager responsible for logistics (Bell 1994). It should be noted that a close contact between the buying and sales organizations is required to better understand the point of view of the customers and merchandise assortments accordingly.

2.2.1 Fashion Buying and Replenishment

Mass merchandisers, department stores and specialty stores are the major outlets for apparel. Merchandizing practices vary depending on the type of outlet and the fashion content of the apparel.

Large organizations manifest different levels of centralization in their buying organizations. Competitive deals with the vendors are possible with consolidated buying. However, a decentralized buying better addresses the different tastes and different size needs of the customers in different geographic areas. Nordstrom, for example, used this strategy to expand its operations in 1970s (Parpia 1995, Spector and McCarthy 1995). However, Nordstrom is recently moving to a hybrid system where it will employ decentralized buying for some items and centralized buying for others (Women Wear Daily 2000a, 2000b). Macy's, on the other hand, has a centralized buying organization for all its stores in the Western U.S. After 100 years of decentralized buying, J.C. Penney also has recently shifted to centralized buying which is proving a financial success (Discount Store News 2003).

At LDS, about 10 buyers cover women's wear for the Western U.S.. Each buyer is responsible for a separate category of apparel items and all merchandise under a buyer's responsibility would potentially generate similar profit margins. This system ensures that the buyers would not only buy those items that are believed to generate more margins as most of their compensation is determined by the total margin of their purchases. Successful buyers are generally among the highest paid employees of the chain, rivaling executives and store managers. The buyers have tremendous power in representing the chain to the vendors and are responsible for a large portion of the chain's profit. Since the buyer's performance evaluation criterion (and his or her bonus) is the total profitability (total margins) of the apparel lines he or she buys (which depends on the purchase cost, the initial selling price, the subsequent mark-downs, and the units sold under each price point), it is in the buyer's interest to ensure that she buys the right items generating the best financial results for the chain as a whole.

Merchandizing activities start as early as the end of a comparable season in the previous year. At LDS, for example, buying decision are made usually 6-9 months before the start of each selling season. The planning process at J.C. Penney starts with the estimation of individual store sales for the next year (Blasberg and Wylie 1998). Initial wholesale purchase quantities are then established by buyers. Fashion direction for the season is developed based on a variety of sources including the past records of the organization, competition, market research, fashion and trade shows and magazines (Bohdanowicz and Clamp 1994, page 95). About nine months before the start of the season, buyers shop at major markets and start developing their merchandise plan. Five months before the season, buyers visit the markets and make their preliminary orders with the vendors. The contact with the vendors often takes place at trade shows. Prior personal contacts and recommendations also play an important role. Most larger retailers have strategic alliances with their vendors and buy a huge variety of products in large quantities (Chain Store Age 1996). Some buyers (e.g., a

Macy's buyer) are only responsible for buying merchandise from one vendor (e.g., Liz Claiborne).

The buyer's decisions are controlled by a budget set by the merchandise managers (or an administrator as it is called at LDS). A buyer's budget is usually updated each season based on his/her performance and consumer trends in the apparel line he/she is buying. The maximum amount of funds the buyer can allocate for new purchases is often called *open-to-buy*. Open-to-buy (OTB) is calculated using the following formula:

$$\begin{aligned}\text{OTB} &= \text{budgeted closing stock} + \text{budgeted sales} \\ &+ \text{budgeted reductions (mark-downs, thefts)} \\ &- \text{opening inventory} - \text{purchases already received} \\ &- \text{purchase orders placed but not yet received}\end{aligned}$$

The budgeted components of OTB are derived before the start of the season from the corporate merchandizing budget (first, demand forecasts are used to determine budgeted sales, which is then used to calculate budgeted closing stock level which will maintain a specific inventory to sales ratio). During the season, the opening inventory is updated by the flow of merchandise that occurred since the start of the season. This updates the OTB figure which drives the new purchases, sales or reductions (Goodwin 1992). The purpose of the system is to control the sales in order to keep the inventory in budgeted levels. Such a system has two potential problems. First, the calculation of OTB (which in effect determines the purchase quantities) uses only the point estimate of demand (i.e., budgeted sales), ignoring the uncertain nature of the apparel industry. Second, most retailers do not update their budgeted sales (thus budgeted closing stocks) during the season. Therefore, especially when the pre-season forecast is conservative, service level deteriorates as new orders are placed only if OTB becomes available. With an empirical study, Goodwin (1992) verifies that OTB system constrains the performance of buyers and suggests that it should incorporate the updates in demand forecasts. Goodwin also suggests that mark-downs should be based on sales activity rather than budgeted prior to season.

At the start of the season, some buyers choose to spend all of their OTB. Some others choose to hold back some of their OTB for opportunistic buys after they know more about the popular styles, colors and fabrics of the current season. For example, suit buyers spend 80 percent up-front and keep the remaining 20 percent for on-season buys (Daily News Record 1993). A traditional practice is to receive all bought merchandise before the season. However, recently, more and more retailers are using different windows of delivery through the season. This helps to maintain a fresh look of the store over the entire season. Suit retailers, for example, typically use two or three delivery windows (Daily News Record 1993).

For J.C. Penney, preliminary orders constitute 50% to 75% of the anticipated total orders. The selections are reviewed by the stores and the merchandise commitment is finalized after collect-

ing individual store orders 2.5 months prior to the season. Above merchandizing cycle is typical for nationally branded apparel. For companies that are marketing their own private labels, the merchandizing activities are more complicated and may involve the coordination of manufacturing activities such as design and fabric sourcing. For such companies, buyers and merchandise managers have to work closely with brand managers responsible for the private label apparel, in order to maintain a profitable mix of branded-private label merchandise in their assortments.

Throughout a selling season, merchandise display on the store floor is periodically updated, with two or three apparel groups marked as new arrivals at one time. There can be 8-10 apparel groups in total within a selling season. Arrangements are made, especially with domestic suppliers, to have the merchandise delivered to the stores (or the retail chain's distribution center) monthly. Such a staggered schedule has two major effects: (1) smoothing out production for the vendors; and (2) keeping the retail store constantly refreshed in merchandise display with new items. This is done to capture shoppers' attention who are usually attracted to newly arrived items being put on prominent display; a shopper who sees the same few items on display would assume that the store has nothing new to offer and would therefore quickly lose interest in the store.

While this merchandizing cycle is repeated for each season for fashion apparel, basic items are subject to longer life cycles and are mostly on automatic replenishment plans. EDI (Electronic Data Interchange) systems enabling these plans are gaining popularity as the vendors are compressing their cycle times by Quick Response systems. These plans are usually based on strategic alliances and are taking over the responsibilities of buyers. One such system is Liz Claiborne's LizRim which has been a success for both retailers and the company itself (Blasberg 1997).

Ideally, past sales data should be a major factor in buying and re-ordering decisions. Recent advances make enormous amount of point-of-sales data available to buyers. However, this is not quite the fact, as the CEO of Federated's Logistics and Operations division states "Where we have made little progress, ..., is in changing the way our buyers go to market and buy. I don't see them using this data nearly as much as I expected." In some departments, buyers are far away from efficient use of sales data in their merchandise selections, ending up with inventory turns less than once per year. The result is a huge number of SKUs, most of them moving fairly slowly. Macy's Herald Square store carries 5.5 million SKUs (Apparel Industry Magazine 1998). Quite recently, major retailers started improving their forecasting and fulfillment through the use of massive software solutions. Dillard's, for example, started using i2 Technology's Demand Planner and Replenishment Planner solutions to create replenishment orders for 2.9 million SKUs every week. Dillard's inventory turnover rate was 3.7 while the industry average was 4.9 in 1998 before implementing i2's solution. Dillard's was able to increase its inventory turnover rate to 5.2, slightly

above the industry average, through the use of the solution and is planning to roll it off to 15 million SKUs that it is currently merchandizing (Baseline 2003).

For many companies like LDS, a buyer is responsible for many stores in a particular sales region (like Western United States). When a buyer decides on what to buy and how much to buy, the buyer is deciding for all the stores in aggregate. A “planner” works closely with the buyer to distribute the assortment and purchasing quantities across different stores, accounting for differences in store locations such as area income level or demography. The “allocations” across stores are generally not even; a store may not “get” any allocation of a particular item at all.

When a vendor delivers a batch of garments, the shipment can go to a central warehouse or distribution center first and then be broken down and re-shipped to individual stores. Alternatively, the shipment can go directly to individual stores without ever entering a central warehouse or distribution center (this is called drop-ship); in this mode, the vendor’s garments must be “floor ready” (complete with the proper labels and price tags and hangers).

A buyer sometimes moves an item from one store to another store; when this occurs, a direct transshipment between the two stores may not always occur. At LDS, a transfer between two stores has to go to a distribution center, for it was found that the potential costs of miscounts and mishandling of goods in direct transshipment between two stores can offset the additional transportation cost of moving merchandise through the DC.

2.2.2 Pricing

Apparel retailers usually employ cost based pricing techniques for the initial prices for their merchandise. Typically, the initial price is the cost of the product plus a percentage mark-on. This mark-on percentage is such that the revenue obtained from the sales will be adequate to cover all expenses incurred in the business plus a reasonable profit. Rather than detailed item specific pricing based on expected sales activity, most retailers choose to follow company specific simple rules, or other retailers in the same category (i.e., department store, discount store and specialty store) offering similar merchandise. At LDS, the buyer sets the initial price, but more or less based on a company-wide price schedule. Corporate management uses pricing guides and schedules to achieve control and uniformity of items bought by different buyers. Small stores sometimes multiply their cost by 2 or 2.2 as a general rule in setting prices. Mark-on percentages may also depend on the volume of the sales. As an example, custom printed and embroidered sporting merchandise are called to mark-on 100-150 percent for quantities of under two dozen pieces and 80-100 percent for quantities two to six dozen (Sporting Goods Business 1998). Also as a general rule, fashion items with higher risks and items with small volume command higher mark-ons (Bohdanowicz and Clamp

1994, page 110). Some retailers (usually discounters) try to group different styles around different prices and charge the same price for the styles in the same group (*price lining*). Some retailers such as One Price Clothing Stores (Discount Merchandiser 1997) go as far as charging a single price for all of its merchandise (*singular pricing*). Overall, initial pricing is a part of retailer's marketing strategy rather than micro-managed at the product level. In fact, retailers in the same category tend to follow similar pricing strategies (in the case of discount stores, price alone is the reason for categorization). Department stores have been known to charge high initial prices and offer deep mark-downs later in the season. This is contrary to apparel specialty stores, offering medium prices throughout the season. According to W. J. Salmon, professor of retailing at the Harvard Business School, pricing policies of department stores which he refers to as "usurious prices followed by illegitimate sales", is one of the major reasons for department stores' declining performance in early 1990s (Discount Merchandiser 1994). Realizing this, Dillard's Department Stores began to practice every day low pricing or every day fair pricing (EDLP/EDFP) (Chain Store Age 1994).

Most retailers change the prices of their merchandise during the season usually by offering discounts. Several factors distinguish apparel industry from other industries in pricing decisions. First, value of fashion merchandise deteriorates in an enormous speed. Left-over merchandise would have little or no value at the end of the season. Second, there is a considerable amount of uncertainty involved in consumer taste, hence in demand for a particular fashion merchandise. Part or all of this uncertainty can be resolved as the retailer starts to observe the sales after the start of season. Finally, retail space is highly competitive in fashion industry. Ideally, retailer should consider all of these factors in its sales decisions, maximizing its revenues over the entire season, preferably selling all inventory by the end of the season to allocate the entire retail space for fresh merchandise of the new season.

The sales fall into three categories: pre-season sales, within-season promotional sales and end-of-season clearance sales (Pashigian 1995). In some merchandise categories, retailers charge introductory low prices for a short period of time before the start of season. For example, at LDS, the pre-season sale for the Winter season is held in late August, and each garment is marked 25 % of regular price, or comes with two price tags: one with the regular in-season price, another with a 25 % marked down price with a purchase date limitation. Resulting increased store traffic allows the retailer to gather information about the popular colors, styles and garments early enough for appropriate replenishments within season. Within-season promotional sales, on the other hand, use discounts on particular merchandise to increase store traffic for improving sales not only on discounted items, but also on other slow moving items. These temporary point-of-sales discounts are usually applied at the cash register, and price tags are not physically changed to reflect the

temporary price.

The most common form of sales is end-of-season clearance sales aimed to liquidate all stocks before the end of season. Clearance sales are comparatively more tactical in nature and should be based on detailed analysis of individual item's sales activity. The timing and depth of these mark-downs are crucial decisions as early and deep mark-downs may result in revenue losses, and late and not sufficiently deep mark-downs may result in obsolete inventory at the end of the season. Factors such as customers substituting regular priced items by marked down items (cannibalization) should also be considered. Despite the importance of this difficult problem, mark-down decisions in practice do not follow any scientific rule. This is again in spite of the fact that required point-of-sales data is easily available to decision makers. Mark-downs are usually subject to buyer's budget, limiting the responsiveness of these decisions to sales activity (Chain Store Age 1999, Goodwin 1992, Women Wear Daily 1999a). For some companies, mark-downs are completely sales driven and automated. At Filene's Basement Store, all merchandise not sold within 14 days is marked down by 25 percent; remaining merchandise after 21 days is marked down by additional 25 percent and remaining merchandise after 28 days is marked down by another additional 25 percent. Finally, if there are still left-over merchandise after 35 days, it is given to the charity (Stores 1994). While this policy is easy to implement, it is questionable that it gives the maximum profit across all merchandise categories. A more rigorous analysis should include a probabilistic treatment of demand and allow dynamic pricing based on remaining inventory and time before the end of the season.

At LDS, there are company-wide guidelines as to when and how much to mark-down. There are a few pre-set mark-down levels: 25%, 30%, 50% and 60%. The first mark-down occurs in approximately the sixth week. Once an item is marked down, its shelf space is consolidated (for example from two shelves to one shelf) or it is moved to a less prominent display area. For "hard" mark-downs like 50% or 60% off, the garments are moved to special racks organized by garment size so that a shopper can go directly to the right rack to find all styles of her size. Since two new groups arrive every two weeks throughout the same season, the stores can constantly refresh its display and inventory.

Almost never will the stores mark the price up, no matter how hot an item is selling. We can conjecture that if the retailers had practiced mark-ups during the season, the initial prices would not be this high, a problem well-known in department stores. The "no-mark-up" rule applies also to vendors. If a vendor has a "hit" item and the buyer screams for more of it, the vendor will usually charge the same price, but may bundle the item with some less popular items or attach some other sales conditions.

While mark-downs are quite frequent, store-wide sales are relatively infrequent as it is feared that consumers may act strategic and “wait for the sales”. Store-wide sales are twice a year at LDS, one of them after Christmas. At those events, the whole store space is organized for the sales (whereas for smaller sales, the items marked down are put in special corners or back space). Sales also tend to occur before annual or semi-annual inventory counts, so that the store personnel have fewer items to count.

Recently, fashion industry has seen some efforts to implement analytical methods for mark-down decisions. In one of the earliest efforts, Mantrala and Tandon developed a model which assists the department store buyer in selecting the optimal price from a set of permissible price levels for each period of the season (Stores 1994, Mantrala and Rao 2001). The probabilistic periodic pricing model is implemented via a computer program called MARK. Since 1994, there has been increasing number of retailers that implemented commercial software to optimize their mark-down decisions. The increased use of analytical models could be easily associated with the availability of point of sales data and reduced cost of switching prices enabled through advances in information technology and e-commerce. Substantial commercial success of revenue management applications in airline industry was a major factor for convincing retail executives for investing in pricing solutions (sometimes called *Retail Revenue Management (RRM)*).

ProfitLogic (formerly known as Technology Strategy Inc.), a software and consulting firm in Cambridge, Massachusetts, developed several software solutions to assist apparel retailers in their mark-down decisions (Stores 1998, The Boston Globe 1998). ProfitLogic’s mark-down solution uses massive historical data to determine the timing and amount of mark-downs which maximize gross profit. ProfitLogic’s current customers include J.C. Penney, Casual Male, Old Navy, Marshall Fields and Bloomingdale’s (Stores 2003, Bobbin 2002c, Girard 2003).

Dayton Hudson, the company that owns retailers Dayton’s, Hudson’s, Target and Mervyn’s California, worked with Santa Clara University researchers to come up with a mark-down strategy for their fashion items (Chain Store Age 1999, Women Wear Daily 1999). Given the time of mark-down, the new system determines the depth of mark-down so that the merchandise stock is cleared by a specific date. The system plans for a single mark-down as Dale Achabal, Santa Clara University professor argues: “there is no combination of two mark-downs that is more profitable than one mark-down”. These recent efforts are pioneers in apparel industry as a business consultant working for Dayton Hudson states: “For many of our merchants, this is the first exposure they’ve had to intelligent systems”. These efforts have been incorporated into software solutions available from Cincinnati-based company called Spotlight Solutions (Stores 2001c). Spotlight’s current customers include ShopKo, Saks Inc. and Dillard’s (Stores 2002, The New York Times 2002a).

Other niche software companies in RRM market include KhiMetrics, DemandTec and 4R Systems (Stores 2003). While markdown optimization is the most mature segment of the RRM market (Girard 2003), these software companies are also offering solutions to initial price optimization and promotion optimization (Achabal 2003).

There have been reports of companies achieving significant success using these software tools. ProfitLogic reports that its customers saved \$ 160 million in the first quarter of 2003 alone (Girard 2003). ShopKo reports 24 percent increase in gross margin on clearance items using the software solution from Spotlight Solutions. Despite these reports, adaptation of price optimization tools in retail has been slow. Major reasons include retailers' doubt about the maturity of the software providers in RRM, significant software license fees, and integration issues with other software and business processes (Stores 2003). Major Supply Chain Management (SCM) and Customer Relationship Management (CRM) software vendors such as i2, Manugistics and SAP are now offering pricing optimization tools emphasizing the importance of integration (CRMDaily.com 2002). Even though the adaptation has been slow, AMR Research predicts that the market for RRM software to grow to \$ 500 million in 2005 from \$ 75 million in 2002 (Girard 2002). Many software vendors are trying to grab a share in the growing RRM market. A recent study by Bobbin reports that in addition to 8 vendors above, 14 additional vendors are also offering price optimization/markdown management systems (Bobbin 2002a). The reader is referred to Elmaghraby and Keskinocak (2003) for a general review of pricing research and current practices in dynamic pricing.

3. Trends in Apparel Manufacture and Retail

3.1 Retail Consolidation, Vertical Integration and Emerge of Private Labels

The retailing space per capita increased from 8 square feet to 19 square feet in the last 20 years reflecting the increased demand created by baby boomers. However, aging of the same population, changing consumer priorities and introduction of non-traditional retailing outlets decreased the consumer interest in many sub-sectors of the U.S. retailing industry. The over-stored U.S. retailing industry in general has faced considerable number of bankruptcies and acquisitions in the recent years. As a result, the total U.S. retail sales are concentrated in a few major retail companies. The top three retailers, Wal-Mart, Home Depot and Kroger account for \$ 323 billion annual sales in 2001, about 10.2 % of all sales in the industry, while top 100 retailers account for 37.2 % (U.S. Census Bureau 2003, Chain Store Age 2002b). The scene is not very different for apparel retailing. The apparel sales are far away from sustaining a productive use of retail space as a result of consumers

preference for comfort over fashion and a casual work place. As a result, apparel and accessory stores have experienced very high failure rates, highest among all retail sub-sectors (Standard and Poors 1998). In 2000, the number of firms in men's clothing retailing and women's clothing retailing went down to 5706 and 15296, respectively, from 5902 and 15977, respectively in 1999; two of the sharpest declines in the retailing sector in the U.S. In department stores, a major channel for apparel sales, the number of firms declined to 103 from 141; the sharpest decline in 2000 (U.S. Census Bureau 1999b and U.S. Census Bureau 2000). Domestic apparel market is dominated by 12 major retail groups, representing almost two thirds of the sales (U.S. Department of Commerce 1999).

Retail consolidation shifted the industry power from apparel manufacturers to large and powerful retailers. Fewer and stronger retail firms are in a position to mandate favorable terms in their contracts with manufacturers involving price, service, delivery and product diversification and differentiation (U.S. International Trade Commission 1995). Mass retailers are willing to order closer to the actual sales and shrink their inventories by continuous supplier replenishment throughout their selling seasons. The result is higher inventory risk assumed by manufacturers. Several services once considered to be part of retailer operations, such as, pre-ticketing the retailer's price tags and storing the apparel on hangers are now part of manufacturers' operations (U.S. International Trade Commission 1998). The financial penalties in case of errors and failure to meet vendor compliance standards further increase the costs of manufacturers. As an example of these standards, since 1994, Sears expects all of its vendors to use EDI and bar-code shipping labels; ship merchandise as close to floor ready as possible meeting the company's Floor Ready Product (FRP) standards (Apparel Industry Magazine 1998). These and other requirements are difficult to satisfy for small and medium sized companies.

Paugal also struggled with the restructuring and increased import penetration in the apparel industry. The company's production volume decreased substantially. Pierre Levy, the chairman of the company, explains that the retailers now are the price setters in the industry. Before even arranging an appointment with a large retailer, Paugal has to show the proof of its financial stability, its costs and sources. Pierre Levy says that these are the kind of information he would never reveal ten years ago. Using these crucial information, some retailers now began to remove the intermediaries between them and the contractors. Mr Levy explains that a major retailer initiated a direct business with a factory he put a lot of effort to find in Mexico, after a year of business with Paugal. Increased pressures to decrease costs force Paugal to use contractors in China, Bangladesh and Mexico. Moreover, the company has to focus on sweaters, where a great deal of expertise is required for production and dresses for large size women where the consumers are still price insensitive.

Consolidation also helped the retailers to reach the economies of scale for participating in manufacturing activities. Mass merchandisers, department stores, specialty retailers and up-scale retailers are now offering private labels with competitive prices. For example, Sears sells casual apparel under its private label, Canyon Rivers Blues, as well as national branded apparel such as Levi's and Wrangler. Besides cost reductions through the elimination of intermediaries, retailers with manufacturing operations are able to respond quicker to changes in consumer demand and have a better control on the quality of products that they sell. Uniqueness of private-label apparel also helped to attract consumers who have been complaining about the sameness of the merchandise in different retail outlets. Retailers can also exploit their closeness to the consumers in the design and marketing of their private labels. Private labels especially helped department stores to regain the market share they lost over the past several years. Most of the retailers with private labels are likely to source their private-label apparel overseas, eliminating the need for U.S. agents to develop marketing expertise in foreign markets and to improve their responsiveness to consumer demands. Imports of private-label apparel accounts for 15 percent of U.S. apparel market in 1997 (US International Trade Commission 1998). The retailers continue to invest in private-labels. May Department Stores is planning to expand its private-label sales from 17 % to 25 % in the long term and has added to major labels in 2002. J.C. Penney which already has 40-45 % of its sales on private-labels such as Arizona and Stafford, is still expanding its private-label offerings with new brands such as Bisou Bisou (Apparel Magazine 2003b). Analysts identify private-label development as a major means to improve profitability and expect that increase in private-label will lead to further consolidation in retail (Apparel Magazine 2003a).

The industry also experiences a forward vertical integration of large manufacturers. In an effort to increase efficiency, eliminate intermediary and better understand the consumer needs, increasing number of textile mills and apparel firms are involved in retailing. Some of these companies only operate factory outlets where they dispose their excess or second-quality merchandise without damaging their brand image with merchandise sold in the off-price retailers.

3.2 Import Penetration and Production Sharing

Limited capital requirements and labor intensity of the apparel and other textile products manufacturing have made the industry a primary industry in low waged underdeveloped and developing countries starting early 1960s. Changes in trade regulations, advances in transportation and communication helped to increase the global trade in apparel. As a result, increasing portion of apparel production is moving to less developed countries and apparel industries in developed countries are experiencing increasing import penetration in almost all apparel categories. The trend is similar

and substantial amount of restructuring is taking place in almost all developed countries including U.K., Japan, Germany and Italy (Taplin and Winterton 1997).

U.S. apparel industry was not immune to such globalization. Apparel imports reached \$64.0 billion in 2001, up from \$27.7 billion in 1991. The imported apparel now constitutes more than half of the \$ 100 billion industry (U.S. Department of Commerce 1999 and U.S. International Trade Commission 2002). With reduced trade regulation with the North American Trade Agreement and progressive phase-out of Multi-Fiber Agreement, we expect to see the same increasing trend in all apparel categories. Traditional suppliers of imported material to the U.S.: Taiwan, Hong Kong and Korea are losing their market share in the U.S. market since the beginning of 1990s, as the companies are seeking even lower cost production in countries such as China, India and Bangladesh. It is expected that apparel for the U.S. market will also be imported from other Third World countries after 2005, when all textiles and clothing quota restrictions will be eliminated.

A relatively new trend is production sharing in the Central and South American countries. Chapter 98 of the Harmonized Tariff Schedule of the United States (formerly item 807 of the tariff schedule) permits cut fabric to be shipped to low waged countries and returned back to the United States with duty applied only to the value added part of the production. Imports under production sharing account for \$12.3 billion in 2001 or 19.2 percent of all apparel imports in 2001, up from 9 percent in 1990. Under the NAFTA agreement, there are no duties for apparel cut in the U.S. and assembled in Mexico. This and proximity to the U.S. markets further advantaged Mexico (12.7 % of all imports) making it the second largest supplier of U.S. imports following China (13.9 % of all imports)(U.S. International Trade Commission 2002).

Generally, U.S. apparel imports concentrate on basic styles and fabrics for which design changes are minimal from one season to the other. Market share of imported apparel is especially high for all men's and boy's clothing, knit-wear, and women's coats and jackets (U.S. Census Bureau 1999). U.S. apparel imports under Chapter 98 of HTSUS from Central and South American countries are concentrated in fewer products, with high, but unskilled labor content. The major apparel categories that are manufactured through production sharing operations include trousers and shorts, shirts and blouses, foundation garments, underwear, and coat and jackets (US International Trade Commission 1995). While U.S. manufacturers are mostly importing from Central and South American countries through production sharing operations, U.S. retailers tend to import the full package from Asian countries since they do not have the expertise to coordinate manufacturing processes (US International Trade Commission 1998).

Retailers and manufacturers are still restructuring themselves to increase their foreign sourcing. For example, V.F. Corporation, producer of Wrangler and Lee jeans, Vanity Fair intimate apparel,

sourced 50 percent of its sales globally in 1998 (US International Trade Commission 1998). This ratio increased dramatically to 70 percent in 2000. Now, V.F. sources 94 percent of its apparel from overseas: 56 percent from Mexico and the Caribbean and 38 percent from the rest of the world (Women Wear Daily 2003). Ashworth Inc., a golf apparel company, sources almost all of its production off-shore now, a quick shift from 1999, when it was sourcing 100 percent from the U.S. (Bobbin 2003a).

3.3 Quick Response Systems

Consolidation, vertical integration and low cost imports in the apparel industry began to eliminate the weaker players in the apparel manufacturing industry. Although there are no significant barriers to enter and expand in the industry with low capital requirements and use of contractors, remaining competitive is becoming extremely difficult. The failure rate for apparel and other textile manufacturing businesses was 136 out of 10,000 in 1997, the highest rate among all other manufacturing sub-sectors. 364 businesses that failed in 1997 had about \$ 1 billion of liabilities (The Dun and Bradstreet Corp 1999). The total number of employees in apparel manufacturing dropped to 316,900 in 2003, down from 892,900 in 1997 (U.S. Department of Labor 2003).

In order to compete with foreign manufacturers that are able to meet the increasing demands of big and powerful retailers, the industry initiated a series of technological innovations and business practices called Quick Response in 1985 (Hammond and Kelly 1991). Quick Response intends to tie the apparel and textile manufacturing and retailing operations to provide the flexibility to quickly respond to consumer needs in a volatile industry. In 1986, Kurt Salmon Associates estimated that the inefficiencies in the supply chain cost the industry about 24% of net retail apparel sales annually or \$ 25 billion in the form of forced mark-downs, excess inventory and stock-outs (Frazier 1986). As a result of various process changes that link the retailing and manufacturing operations, responsiveness can be used to effectively substitute for fashion sense, forecasting ability and/or inventory required for operating under uncertainty (Richardson 1996). Ideally, a quick response system would enable the manufacturer to adjust the production of different styles, colors and sizes in response to retail sales during the season. The immediate objective is to reduce the cycle times and be able to produce as close to the consumer need as possible decreasing risks and inventories at each stage of manufacturing and retailing operations.

A number of technologies are used to help to reduce the cycle times in manufacturing and retailing. CAD/CAM equipment are used to reduce the cycle time from design to production. Point-of-sale (POS) scanners at the checkout counters read the bar code attached to each item and record the merchandise sales by its price, style, color and size. Electronic Data Interchange (EDI)

systems then can be used to transfer this real time information to different stages of the supply chain facilitating automatic reordering or even allowing the manufacturer to manage its retailers' inventories. A successful quick response implementation also depends on substantial information sharing and coordination between the manufacturer and the retailer.

In addition to information technologies mentioned above, a number of business practices are required for an ideal Quick Response system. In the logistics arena, Just-in-time shipping policies with frequent and small lots, pre-ticketing and drop shipments are necessary. On the manufacturing side, flexible, short-run and high speed processing, automated material handling and modular production concepts are commonly practiced by Quick Response manufacturers (Hunter 1990).

Abernathy et al. (1995) reports that a Quick Response retailer should be able meet the following standards

- Track sales in individual styles, colors and sizes on a store-level and real-time basis.
- Replenish products at the store quickly.
- Hold minimal excess inventories at the store level beyond what is on the sales floor.
- Provide logistical support for the above practices.
- Create manufacturer performance standards for replenishable products, specifying standards for order-to-replenishment lead times, shipment accuracy, and delivery information, and setting out penalties for noncompliance.

These standards will then establish the following standards for the Quick Response manufacturers

- Label units, track sales, and respond in real time to product orders at specified style, color and size levels.
- Exchange electronic information concerning current sales and related information with retailers.
- Provide goods to retailer distribution centers in ways that allow goods to be moved efficiently to stores for distribution (for example, boxes marked with computer-scannable symbols concerning contents; shipments of products ready for display in retail stores.

While these standards are currently met mostly by increased inventory levels of finished goods, further manufacturing responsiveness may be achieved by establishing or improving the following internal practices at the manufacturer level

- The ability to forecast and plan future production needs based on sales data provided by the retailer.
- Distribution centers capable of providing logistical support to efficiently process shipments to multiple retailers.

- Manufacturing practices adapted to producing a variety of styles, sizes, and colors under shorter lead-time requirements.
- Agreement with key suppliers to provide shorter procurement lead times and smaller minimum orders for textiles and other suppliers to accommodate changing demand requirements.

Abernathy et al. (1995) reports that between 1988 and 1992 there is a substantial growth in the number of retailers requiring suppliers to meet their Quick Response related standards such as bar-coding, EDI and automated distribution centers. More and more manufacturers are now changing their internal practices related to manufacturing and performing activities such as bar-coding, preparing the merchandise for selling and distribution to retail outlets that are not once considered the responsibilities of manufacturers. Kurt Salmon Associates notes the 10 years of Quick Response implementation a major success saving \$13 billion through a combination of removing excess stocks from the system and enabling wider and more accurate assortments (Bobbin 1997b). Quick response systems are still in use as retailers are demanding more responsiveness from their manufacturers. Liz Claiborne, for example, uses two Quick Response programs, Liz Quick and Liz Chase, to react faster to changes in consumer demand (Bobbin 2003a).

3.4 Supplier selection: off-shore versus domestic sourcing

Retailers and manufacturers consider a number of factors when deciding where to supply their merchandise. First group of factors includes the production or purchase costs, inventory storage costs and transportation costs. These are related to the efficiency of the supply chain. Fisher (1997) classifies them to be the *physical* costs of the supply chain. The other group is related to the responsiveness of the supply chain; how accurate and fast supply is able to match demand. If supply exceeds demand, the merchandise has to be marked down, and sold at a price possibly less than the cost. If supply is less than demand, the company loses sales opportunities and dissatisfies its customers. Fisher calls resulting costs *market mediation* costs. For products that satisfy basic needs, with long life cycles, and thus stable demand, (*functional* products as called by Fisher) physical costs should be the focus. For products with high fashion content, short life cycles and thus hard to predict demand (*innovative* products as called by Fisher), companies should rather try to minimize market mediation costs.

Apparel market consists of many products with varying levels of fashion content (innovation or functionality). Fashion content not only defines the season length, but also affects where retailers or manufacturers source their merchandise. Basic apparel merchandise generally have longer selling seasons and physical costs are likely to represent a major part of potential total costs. Like most

labor intensive-low technology industries in U.S., a natural choice of production venue for basic products is developing or underdeveloped countries where wages are substantially lower. Fashion products, on the other hand, have generally shorter life cycles and market mediation costs play a major role. For fashion products, apparel retailers seek responsiveness when making their sourcing decisions. A few factors define responsiveness. First of all, order lead times play a major role. If the order lead times are long, apparel retailers need to order much in advance of the start of the season, when their knowledge of consumer demand is limited. Long lead times also prohibit the replenishment opportunities within the season. According to a study by Prudential Securities Inc., delivery lead times for leading branded women's apparel firms for imports from Asia are as high as 35 weeks, as compared to 35 days for imports from Mexico and the Caribbean (U.S. International Trade Commission 1999). According to survey of U.S. and U.K. consumer goods retailers, the average lead time for orders from Asian and Central American vendors is as much as 48–60 weeks and 24–36 weeks, respectively, while the average lead time for orders from North American vendors is 12–24 weeks (Lowson 2001). According to the same study, 61 % and 53 % of the retailers are able to change the mix and volume of their orders, respectively, if they source from North American vendors. Corresponding percentages are only 30 % and 14 % for Asian vendors and 48 % and 37 % for Central American vendors. North American vendors are also providing more flexibility over their Asian and Central American counterparts for excess stocks. 76 % of the retailers say that their North American vendors agree to returns or discounts for surplus goods, while corresponding percentages are only 50 % and 27 % for Asian and Central American vendors, respectively. It is clear that it is primarily domestic manufacturing which can provide the responsiveness demanded by apparel retailers. An individual retailer's choice may be to source its particular merchandise from overseas or from a manufacturer in U.S., whichever minimizes its total costs (physical and market mediation). For a particular merchandise category, these individual decisions may be aggregated in one statistic: market share of imports. Table 1 lists the market share of imports and import/domestic costs for selected apparel categories in 2002.

In all categories, imports capture more than half of the market share as imports are providing significant cost benefits. For example, the import cost for men's sweaters is approximately 32 % less than the domestic cost, which leads to 98.3 % import penetration. It should be noted that cost alone is not the only factor for sourcing decisions for apparel retailers. Imported men's suits cost 37 % less than the suits manufactured domestically which leads to 74 % import penetration. In women's dresses, which is a comparable category in women's apparel, import cost is 55 % less than half of the domestic cost. However, import penetration in women's dresses is only 64 %. The low market share of imports for women's apparel categories reflects the importance of fashion in

Table 1: Market Share and Cost of Imports in Apparel in 2002

	Market Share of Imports ^a	Average Domestic Price ^b	Average Import Price ^c
Men's			
Sweaters	98.3	15.27	10.42
Swimwear	100.0 ^c	12.93	4.52
Suits	74.0	100.64	62.71
Women's			
Sweaters	86.1	12.24	9.69
Swimwear	70.8	13.61	6.10
Dresses	64.0	20.10	9.08

Data compiled from U.S. Census Bureau 2002.

a Derived by dividing imports for consumption to apparent consumption in the U.S. market.

b Average cost (\$) per unit for manufacturers' shipments.

c Average cost (\$) (cost+insurance+freight) per unit from imports for consumption.

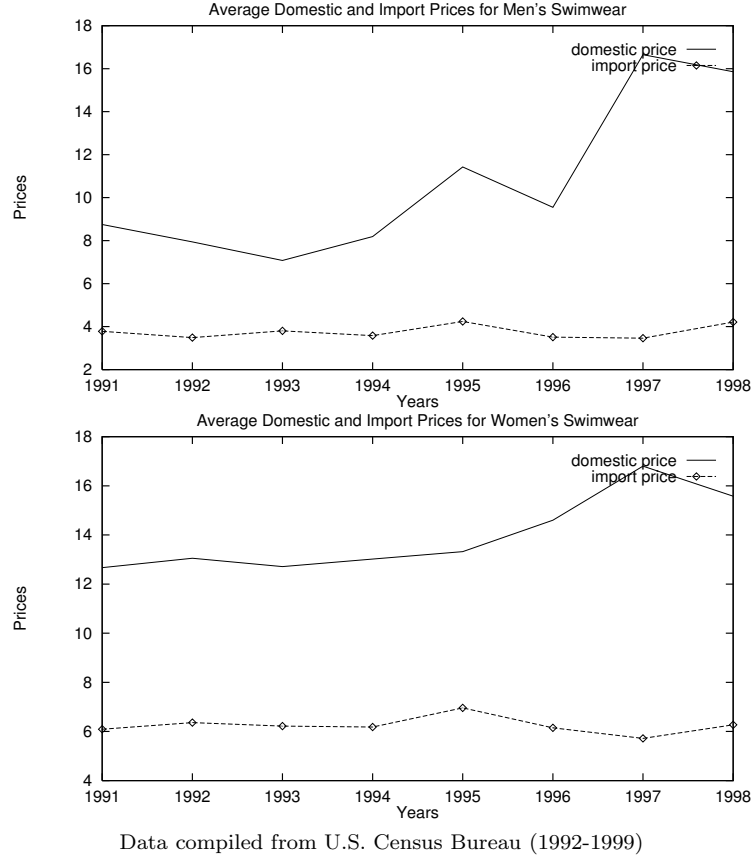
d Missing quantity data for 2002 imports is estimated using data from 2001.

women's apparel. Apparel retailers need a higher level of responsiveness for women's apparel and domestic sourcing provides the responsiveness they need through shorter lead times.

Figure 1 shows the import and domestic unit prices for men's and women's swim-wear over the years 1991-1998. For both categories, imports have a substantial cost advantage over domestic production. In both categories, domestic prices increased gradually, while imports maintain a steady average price. Figure 2 shows the domestic production, imports and domestic market for men's and women's swim-wear over the years 1991-1998 (domestic market is derived by subtracting exports from the sum of domestic production and imports). The market share of domestic production in men's swim-wear is virtually disappeared. While expanding market in women's swim-wear is exploited predominantly by imports, domestic manufacturers were able to maintain their production volume in spite of considerable increases in their prices.

An individual company's sourcing decision is a result of the performance measure it uses in evaluating different supplier alternatives. A traditional measure has been the gross margin to sales ratio which has put the focus on low cost imports. However, this measure totally ignores the costs associated with holding inventory. Advocates of Quick Response systems suggest the use of *gross margin return on investment* (GMROI) as a performance measure, which is basically the gross margin to average inventory ratio (Bobbin 1995). Frequent replenishments advantage domestic manufacturing over imports in this measure especially when seasons are long. These two measures only capture physical costs of the supply chain. Measures capturing the market mediation costs include *service level*: percentage of times a customer finds his or her first-choice SKU; *lost sales*: percent of customers finding none of their SKU preferences; *sell-through*: proportion of a season's

Figure 1: Average domestic and import prices for men's and women's swim-wear (1992-1999)



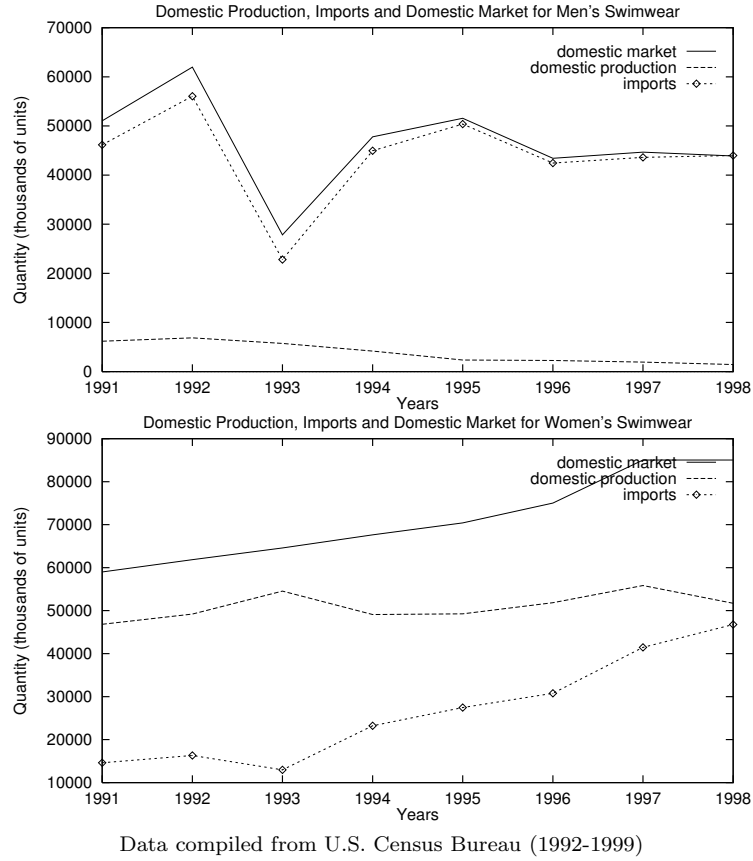
merchandise that sells at first price; and *jobbed-off*: percentage of units remaining at the end of season which must be disposed off. A computer simulation model developed at North Carolina State University concludes that Quick Response strategy outperforms offshore sourcing strategy in these four measures and GMROI, but falls short of generating higher gross margin to sales ratio in all the scenarios created (Bobbin 1997a). The same results are also reported in Hunter et al. (1996).

3.5 Electronic commerce

With the emergence of the Internet and the advancement of information technologies, many companies in the apparel supply chain began to conduct their business online. Electronic commerce is divided into two categories. Exchange of information, services and goods from business to consumer is called business-to-consumer (B2C) and from one business to another is called business-to-business (B2B).

At the B2C front, on line sales of apparel started in the mid 1990s. In 1995, Eddie Bauer and Lands' End became the first major firms that started internet operations (Gernter and Stillman

Figure 2: Market share of domestic and import men's and women's swim-wear (1992-1999)



2001). Apparel has been one of the favorite type of products sold over the internet. According to a research done by National Retail Federation and Forrester Research Inc. in conjunction with Greenfield Online, apparel was the leading category in small ticket items purchased on-line by the U.S. consumers during a 12 months period starting in July 2000. During this period, on-line apparel purchases were estimated at \$ 3.179 billion (Table 2). On line apparel sales are mostly dominated by retailers that initially have bricks-and-mortar operations. Early pure players (those only have internet operations) had difficulty in competing with on-line operations of established brands in apparel (DSN Retailing Today 2000, Chain Store Age 2002c). E-commerce pioneer Amazon.com has started its on-line apparel sales only at the end of 2002 and had to partner with other retailers such as Nordstrom and Old Navy (Chain Store Age 2002c). Dominance of established bricks-and-mortar companies in on-line apparel sales shows the importance of *multi-channel retailing*, i.e., integrating three channels: bricks-and-mortar stores, websites and catalog. Multi-channel retailers use their websites to increase the number of trips to their stores and vice versa. According to a survey, 22 of the 23 major retailers achieved higher store traffic among shoppers who also visited the company's retail website (Stores 2001a). Multi-channel retailers further advantaged themselves over pure players by leveraging from their bricks-and-mortar stores for fulfillment and reverse logistics.

Table 2: NRF/Forrester Survey of On-line Purchases by U.S. Consumers July 2000-June 2001 (\$ 000)

<i>Small-ticket items</i>		<i>Big-ticket items</i>	
Software	1,755,111	Computer hardware	4,551,178
Books	2,330,058	Consumer electronics	2,720,637
Music	1,693,095	Appliances	343,861
Videos	1,198,249	Furniture	602,040
Office supplies	1,491,623	Food/beverages	1,845,678
Apparel	3,179,390	Airline tickets	8,294,776
Footwear	740,453	Car rental	2,110,420
Jewelry	1,065,516	Hotel reservations	4,214,100
Flowers	723,359	Other	4,358,608
Linens/home decor	921,731		
Health and beauty	1,587,717		
Small appliances	707,839		
Toys/videogames	2,470,225		
Sporting goods	938,811		
Tools and hardware	570,452		
Garden supplies	344,429		
Total small-ticket items	21,718,058	Total big-ticket items	29,041,298

Source: National Retail Federation and Forrester Research, Inc. in conjunction with Greenfield Online available at <http://www.retailindustry.about.com>

According to a study by Forrester research, out of 63 multi-channel retailers, 52 accept in-store returns of items purchased online, 13 allow store pickup of online orders. Companies like GAP are using their online stores exclusively to sell slow moving items and to test new products (The Wall Street Journal 2003).

While multi-channel retailing is vital for success in apparel retailing, many companies are finding it difficult to integrate multiple channels and offer consistency in pricing, quality and customer experience across different channels (Chain Store Age 2001). Federated Department Stores, for example, scaled down its internet business on the bloomingdales.com and macys.com websites (Bobbin 2002b). Some bricks-and-mortar retailers also find it difficult to handle fulfillment of online orders. Catalog retailers, such as Lands' End and L. L. Bean, are utilizing their experience and existing infrastructure in order fulfillment and have been very profitable in their internet operations (The Wall Street Journal 2001). Sears has recently acquired Lands' End to leverage its strengths in multi-channel retailing including excellence in order fulfillment. As a result of the merger, Lands' End customers are able to order apparel online or by phone and pick them up at the local Sears store (Time Magazine 2002).

Despite an enormous potential, online apparel sales are only a small fraction of total apparel sales. According to a study by NPD Group, Inc., online apparel sales were \$ 5.873 billion in 2000,

only 3.2 percent of total apparel sales (Table 3). However online sales of apparel are growing significantly each year (online sales were only 1.6 percent of total sales in 1999) and are expected to grow even faster, especially as more women are getting used to shop online (The New York Times 2002b).

Table 3: 2000 U.S. Apparel Sales by Channel

<i>Category</i>	<i>Sales (\$ billion)</i>	<i>Market Share (%)</i>
Brick-and-mortar	169.256	92.9
Catalog	7.177	3.9
Online/Internet	5,873	3.2
Total	182.306	100.00

Source: NPD Group, Inc. available at <http://www.retailindustry.about.com>

Like any other industry, apparel industry was also greatly influenced by the B2B marketplaces starting in the late 1990s. Firms across the apparel supply chain perform a variety of activities using the internet including sourcing direct and indirect material, bidding and negotiation, forecast collaboration, design collaboration, inventory and order tracking and selling off excess stock (for an overview of B2B marketplaces and why they are efficient see U.S. Federal Trade Commission 2000).

B2B exchanges came to existence during the dot-com boom at the end of 90s. According to an estimate by Kurt Salmon Associates, there were more than 80 B2B exchanges that focus on the apparel industry in 2000 (Apparel Industry Magazine 2000), however most of these exchanges have since gone out of business (Bobbin 2002e). Surviving exchanges are those with powerful retailer members. GlobalNetXchange (GNX) and WorldWide Retail Exchange (WWRE) are two such exchanges. These are public exchanges, i.e., they are independently owned and companies may participate through a subscription or a membership process. GNX's members include Sears, Federated Department Stores and Carrefour. WWRE's members include Target, Kmart, J.C. Penney and Gap (Bobbin 2002e). Initial focus of the public exchanges was auctions and reverse auctions. GNX conducted 2550 auctions in the first half of 2002 for a transaction volume of \$ 1.6 billion. Apparel/soft goods transactions accounted for 16 percent or \$ 256 million performed by 11 members (out of 35 total members) of the GNX. GNX states that the exchange derived savings of \$ 270 million out of a transaction volume of \$2.1 billion (Chain Store Age 2002a). Private exchanges are usually run by a single firm and members are that firm's suppliers and partners. This model of B2B is appropriate for giant retailers that do not want to share their buying power with other retailers. An example is Wal-Mart (Stores 2001b, InformationWeek 2001). B2B marketplaces are also used for liquidating excess inventory by apparel retailers and manufacturers. RetailExchange.com,

Liquidation.com and closeout.com are among the electronic marketplaces that allow excess apparel items to be sold through auctions (DSN Retailing Today 2001, Retail Merchandiser 2002).

In 2000 many analysts were predicting that the B2B exchanges would dominate the economy in a short period of time. Jupiter Communications for example was predicting that the total U.S. B2B market would reach to more than \$ 6 trillion in 2005 or about 60 percent of the total non-service market (Dembeck 2000). Despite all the heat, the growth in B2B has been rather slow and apparel industry was not an exception. According to a survey by the U.S. Census Bureau, 13.54 percent of the wholesale trade in apparel (NAICS code 4223) was through e-commerce in 2001 (“The Census Bureaus e-commerce measures report the value of goods and services sold online whether over open networks such as the Internet, or over proprietary networks running systems such as Electronic Data Interchange (EDI).”). Without EDI, e-commerce constitutes an insignificant 1.68 percent of the total wholesale trade in 2001 (Table 4). B2B commerce in apparel is growing although not with the enormous speed that was initially predicted.

Table 4: 2000 & 2001 U.S. Wholesale Trade in Apparel

	2000		2001	
	\$ billion	%	\$ billion	%
Total	88.922	100.00	87.362	100.00
Total E-Commerce	10.284	11.56	11.828	13.54
EDI	9.312	10.47	10.364	11.86
Internet and other	0.972	1.09	1.464	1.68

Source: U.S. Census Bureau available at <http://www.census.gov/estats>

B2B applications are not only limited to trading online. Companies are also looking for ways to collaborate with their supply chain partners over the internet. For example, i2 Technologies develops software that allows sharing forecast information among different members of the apparel supply chain. V.F. Corporation use this software for collaborating with its fabrics suppliers. WWRE also uses this technology from i2 Technologies to enable its members collaborate over the exchange (Transportation & Distribution 2003). Recently emerging Product Lifecycle Management (PLM) applications allow supply chain partners collaborate on product design over the internet. Three companies: Gerber, Lectra and Freeborders have developed web-based PLM applications specifically for the apparel industry (Bobbin 2003b). Liz Claiborne Inc., for example, uses solutions from FreeBorders to communicate designs of 44,000 items to its upstream suppliers (Bobbin 2002d). Among the public exchanges, WWRE is currently offering a solution called World Wide Design, Planning and Management (WDP&M) which allows sharing of the design data between designers and vendors; and GNX is considering a collaborative product development solution for the apparel

industry (Bobbin 2003c).

4. Conclusion

U.S. apparel industry has been in a transition over the last 20 years. Imports from lower wage countries and retail consolidation forced U.S. manufacturers to look for other ways to remain competitive: quality and flexibility. Physical proximity and advances in information and manufacturing technologies enabled U.S. manufacturers to accept retailer orders closer to the season and replenish their stocks frequently during the season. However, retailers continue to source more and more of their merchandise from overseas with the cost of having to make risky inventory decisions.

Advances in information technology also made an enormous amount of point-of-sales data available to decision makers in retailing. Decision makers (mostly buyers) are able to learn more about consumer preferences over styles and colors, their size distribution and the dynamics of sales. However, re-quoting the CEO of Federated: “Where we have made little progress, ..., is in changing the way our buyers go to market and buy. I don’t see them using this data nearly as much as I expected”, this had little effect on their ordering and pricing decision. These decisions are still considered as a form of art. While most of retailers are still foreign to quantitative models, some have only recently started to explore such models. Again quoting a business consultant working on an apparel pricing implementation: “For many of our merchants, this is the first exposure they’ve had to intelligent systems”. The result of such ignorance is obviously not impressive. Inventory turnovers in some departments are less than once a year. While we expect that point-of-sales data would have the easier impact on figuring out the size choices of the customer base given the geographical area, we continue to see only excessively small or large sizes on clearance racks. There is an apparent and urgent need for practical quantitative models that effectively use the data that is already available in the apparel industry.

Several problems are worthy to note for future research. Dynamic pricing of apparel items has been recently popular in practice after significant success revenue management applications in service industries. Advances in information technology also helped companies gather the customer demand information that they will need for analytical pricing solutions. Dynamic pricing has also received considerable attention in academia in the last decade. Three aspects of pricing needs further attention. First, almost all of the models in the academic literature assumes that the customers are myopic, i.e., their buying decisions are based on current prices only without considering future prices. However, we know that consumers of apparel items are increasingly aware of the pricing practices of apparel retailers (see for example Wall Street Journal 2002) and they may act strategically and hold

back their purchases in anticipation of declines in prices. The only study with strategic consumers that we are aware of is Elmaghraby et al. (2002) where the retailers use a pre-announced price schedule (which is not very common in apparel retailing). We are also not aware of any software solutions that model strategic consumer behavior. Another important aspect is the multi-item nature of pricing decisions in apparel industry. Price of one apparel item in an apparel retailer may easily impact the demand of another apparel item through several factors including increased store traffic, substitution and bundling. Moreover, apparel retailers usually change the prices for a group of items or all items in the store at the same time. Therefore, dynamic pricing decisions of different items in a store should be synchronized. Most academic research in dynamic pricing ignores the dependencies among different items. Finally, game theoretical models can be used to enrich the dynamic pricing solutions. As the consolidation in the apparel retail leaves a few number of major retailers in the market, game theoretical models that model price competition even at the tactical level will have significant impact. Besides dynamic pricing, a number of other problems need further attention from academia: the impact of secondary markets: how would replenishment and pricing decisions would vary in the existence of secondary markets (off-price stores such as Marshalls and Ross or B2B marketplaces for excess stock); how and why multi-channel retailers are advantaging themselves over pure players (bricks-and-mortar only or internet only retailers); sourcing decisions for the apparel retail; and contrasting public and private exchanges for apparel B2B marketplaces.

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