Chapter 2

The U.S. Textile and Apparel Industry: Technology and Structural Change

Chapter 2

The U.S. Textile and Apparel Industry: Technology and Structural Change

Chemicals and robots make our clothing, rather than cotton and the sewing machine. Manual labor has been virtually eliminated in the production of textiles and apparel, except in design and equipment maintenance. Few communities are known as "textile towns."

Fiber companies, textile producers, apparel manufacturers, and retailers are tied together through sophisticated communication networks, and react almost instantaneously to market trends. Customers enjoy more products tailored to their specific tastes, and find a greater range of styles and sizes in stock, However, demand for blouses and slacks may not be as great as demand for the textiles and fabrics used in road construction and rocket ships.

A proliferation of export incentives and import protections among nations of the world has made public policy nearly as important as traditional economic forces. "Made in the U.S.A.," when it appears on a label, may not ensure that all stages of production occurred within U.S. borders. The domestic industry is comprised of large multinational corporations and small contract shops. Mid-size firms, the backbone of the industry for two centuries, have all but vanished.

Could this be part of the future of the U.S. textile and apparel industry? While there are certainly exceptions to such a vision of the U.S. industry in the 21st century, most experts predict a vastly altered industrial landscape for the future—one in which the economic, technological, and public policy influences on production are radically changing the industry, much as the forces of the industrial revolution did 200 years ago. The industry is being reshaped by technology, the growth of international trade, changing patterns of demand, and a shifting regulatory environment. These forces affect what is being produced, how it is produced, and who is doing the work. They are changing the structure of both individual businesses and whole business sectors.

The network of industries that deliver apparel, home furnishings, and other woven and knitted products to final markets is extraordinarily complex. The diversity of this system is both an asset and a liability. The system has enjoyed enormous flexibility, and has matched products to markets despite constant changes in styles, tastes, and production technologies.

The industry begins with the production of fiber from either natural or "manmade" (synthetic) materials; typically, manmade fiber companies are large and sophisticated chemical firms. Raw fiber is spun, woven, knitted or otherwise converted into fabric by another set of enterprises–primarily textile mills, which can be very small or very large enterprises. This fabric must be converted into an apparel product or a product for industrial use; the apparel industry is highly fragmented, and typically operates through a complex series of contracts with "jobbers." Finally, the product must be transported, warehoused, transported again, and made available to consumers through retail channels.

Each of these industry segments has a unique business structure and management style, each has a unique history, and each is supported by different kinds of technology. Each is affected by trade in different ways. Perhaps most importantly, each is a virtually independent culture. Taken together, however, the industry segments share a common problem: finding the means to prosper in an increasingly competitive international environment by improving the way that U.S. and world markets can be served by domestic production.

The fragmented structure of the industry presents a barrier to technologies that require standardization and integration. This standardization involves agreed improvements in quality and reliability; sophisticated weaving, for example, requires high-quality yarns. Agreed protocols are needed as well, in order to shorten delivery times and reduce inventories. There is no reason why a diverse group of enterprises could not develop a set of standards and communication protocols that would allow the industry as a whole to benefit from new technology, even without large-scale vertical or horizontal integration—indeed, the industry segments are now developing just such standards. There may also be areas where economies of scale can be enjoyed from greater integration, and a number of mergers have taken place in recent years.

This chapter first examines the nature of the markets served by the combined network of fiber/textile/apparel/retail businesses. Changes in the technology of each industry segment are then described, emphasizing those technologies that must work together to improve the net productivity of the entire system; details on the equipment used in fiber, textiles, and apparel will be provided in chapter 3. This chapter concludes with an examination of the changes in the structure of each industry component made possible—and in some cases made necessary –by new technology and the new challenges of the global marketplace.

U.S. MARKETS FOR TEXTILES AND APPAREL

Increasing domestic and international competition, coupled with relatively slow growth in U.S. markets, have forced U.S. apparel producers and retailers to pay close attention to changes in the market. Even textile firms, which have traditionally not tied sales success to market trends, have been forced to account for changing consumer preferences and the growth of specialty market niches. Such developments have evolved from changes in the structure of demand, which result from increased female employment, greater interest in leisure and sports activities, rising education levels, and aging of the population.

The search for a competitive edge has led to greater concern about the growth of forced markdowns and the impact of "stockouts" on lost sales. In response, a growing number of firms are adopting sophisticated market research activities, including test market programs. New technologies can satisfy rapidly changing consumer needs and tastes, allowing U.S. firms to provide a "quick response" to shifting patterns of expenditure.

Characteristics of the Domestic Marketplace

Domestic markets for apparel can be divided roughly into three categories, each of which present different problems in production and sales:

1. "fashion" products, with a 10-week product life—approximately 35 percent of the market;
2. "seasonal" products, with a 20-week product life—approximately 45 percent of the market; and
3. "basic" products, sold throughout the year—approximately 20 percent of the market.[1]

[1] Estimates based on interviews with industry marketing specialists.

Generally, markets for men's and children's clothing are less subject to change from year to year, and are therefore more suited to large-scale production. Women's garments tend to dominate seasonal sales, which are much more difficult to predict.

While the bulk of the following discussion will concentrate on apparel, it must be recognized that textile markets for products other than apparel are growing rapidly. The home furnishings market—draperies, rugs, sheets, blankets, towels, tablecloths, window shades, wall coverings, and upholstery-is essentially a "basic" market, in that it is both large and relatively predictable; the assembly process is straightforward and highly automated. Many textile companies sell these products directly to retailers.

Textiles are also used for an expanding range of other products, including filters, parachutes, book bindings, fire hoses, adhesive tape, typewriter ribbons, automobile tires, mailbags, electrical insulation conveyor belts, and storage tanks. The safety harness and couch coverings of space crafts are made of textiles. Textiles are used in surgery to replace worn-out body parts, such as blood vessels, and were even part of the first artificial heart. Textiles are instrumental in controlling air and water pollution, in soil conservation, and in flood prevention in the form of inflatable dams. Geotextiles may even be used to help solve the pothole problem.

U.S. producers have remained competitive at the extremes of the domestic market for textiles and apparel. Import penetration is relatively low for basic items like home furnishings, which have an extremely low labor content, and for items like basic men's wear, where styles change slowly and domestic production is highly automated. U.S. producers are also doing well in such industrial products as bile upholstery, where the cost of textiles is a small fraction of the total selling costs and where the risks of dealing with low-cost producers are often not worth the small direct savings. Import penetration is also low in certain "fashion" areas-those in which an extremely short selling life complicates dealings with foreign contractors who may need several months to deliver products, and those in which purchasers are comparatively insensitive to price.

In contrast, foreign penetration is highest in seasonal products, particularly private label products; imports of this type may now constitute over 80 percent of the market. Market uncertainty, and virtually no tradition of concern with production technology, mean that domestic labor productivity in the seasonal product sectors is relatively low. This, of course, has resulted in high labor costs, giving low wage foreign producers a competitive advantage against U.S. firms in selling labor-intensive product lines. It is in precisely these seasonal products that new production systems, mostly in the form of "quick response" technologies and strategies, can have their greatest impact.

Trends in Consumer Purchasing

Overall, textile and apparel demand in the United States in the next decade will likely reflect a stabilization or even a reduction in per-capita consumption growth rates. America's per-capita volume fiber consumption has leveled off, and is now in a slow decline. According to trend estimates by the American Apparel Manufacturers Association (AAMA), apparel consumption is expected to increase in value, but not in unit volume. Consumers are expected to demand more quality in apparel, tending to raise prices while increasing the useful life of the garment. Market analysts portray today's apparel consumer as a comparatively independent shopper with a sophisticated taste level, a high income level, and a high education level. Textile and apparel markets also face the challenging opportunity of the coming of age of the "baby-boomers." With the oldest of the baby-boomers now approaching 40 and the youngest just leaving college, this generation is entering its prime years of earning and spending.

Men and women alike have become more sensitive to the communicative quality of their clothing, and its ability to influence image, career advancement, and self-esteem. By wearing specific clothing, consumers are seeking to convey an image of confidence and attractiveness. Opportunities for individual firms to find successful market niches thus become more significant. There are also indications that mills are learning how to sell—instead of continuing to churn out cloth for a mass market, they are targeting niches not filled by imports.[2]

With consumers placing increasing emphasis on the style and status of clothes, retailers can direct promotion around an image that is "in vogue. " Major retailers see the need not only to increase the number of basic textile and apparel lines offered at any given time, but to offer greater variety in color and style within each line; one of the major areas of retail growth has been the smaller specialized stores, which concentrate on a particular line, design, or brand. This trend has forced major retailers to establish a number of smaller boutique areas, offering products to specific customer groups. At the same time, however, department and specialty stores have lost market share to chain outlets and discounters, as well as to nonapparel stores that sell items such as hosiery.

AAMA identifies six trends, both demographic and qualitative, that are likely to influence future trends in apparel purchasing:

1. a major shift to an older population; largest growth in the 35 to 54 age group, who have the most money to spend on apparel—need for greater variety in apparel;
2. more white collar workers—need for more dress apparel;
3. more single people with more money for apparel;
4. shift to more casual and informal wear;
5. shift to better quality and longer life garments; and
6. sportswear and active wear still important—need for more style, higher cost, and more durable items, but not for as many units.[3]

The baby-boom generation is having an enormous influence on markets as it passes through its peak buying years. The number of households with heads

[2]Scott Kilman and Linda Williams, "The New Mill: While Textile Makers Bemoan Imports, They Are Modernizing, Too," *Wall Street Journal*, Sept 14, 1984, p. 1,

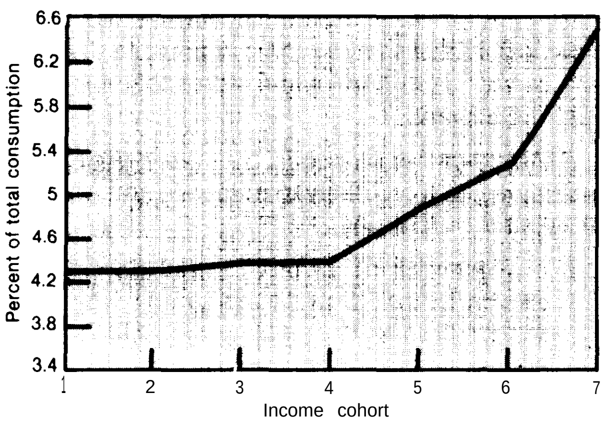
[3]"The U.S. Apparel Market," *Apparel Manufacturing Strategies 1984*, report compiled by American Apparel Manufacturers Association,

aged 35 to 44 is expected to increase 44 percent by 2000, and the household age group 45 to 54 is expected to grow by 71 percent;[4] the U.S. Census Bureau has indicated that households headed by individuals between the ages of 35 and 54 have, on average, the highest household income, and spend more on textiles and apparel as a percentage of total expenditures than either younger or older households. Indeed, OTA analyses show that as household income rises, the portion of household spending that goes to apparel also increases-dramatically, in the highest income groups (see figure 9).[5]

[4]U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 986, *Projections of the Number of Households and Families: 1986 to 2000* (Washington, DC: U.S. Government Printing Office, 1986), table 2, Series B.

[5]OTA, collected from US. Department of Labor, Bureau of Labor Statistics, "Consumer Expenditure Survey, 1982/83," unpublished data, 1986.

Figure 9.—Apparel As Percent of Total Consumption by Income Cohort, 1982



NOTE" Income cohorts divided according to average pre-tax income per person for a "consuming unit," roughly defined as a "household." The figure was calculated, ranked into ascending order, and then split into seven groups with equal numbers of "households" in each group.

SOURCE U S Department of Labor, Bureau of Labor Statistics, "Consumer Expenditure Survey, 1982/83," unpublished data, 1986

In addition, consumers aged 25 to 44 spend up to 45 percent more than other age groups on furniture and home furnishings, and it will be 20 years before the last baby-boomers leave that high spending category. As the baby-boomers age, they will account for an estimated 4-percent increase in furniture sales in the coming years, and will be particularly attracted to high-priced, high-quality furniture. Clearly, significant opportunities exist for individual firms to find successful market niches–another of which could be in children's apparel, since the growing number of baby-boom families has already translated into a larger share of household spending for infant clothing.[6]

On the other hand, the group which has the largest propensity to spend disposable income for apparel (not including textiles)--generally classified as young adults, under 25 years of age—will decline over the same period, According to the Census Bureau, there will be approximately 1 million fewer household heads in this age group by the year 2000, a loss of 22 percent.[7] And all demographic groups—whether they are based on income, age, marital status, or family age structure—spent less on apparel as a percentage of their total consumption in 1983 than in 1973.[8]

[6]Ibid.

[7]Ibid.

[8]OTA, collected from "Consumer Expenditure Survey, 1972/73 and 1982/83," op. cit.

A TECHNOLOGICAL REVOLUTION

"For American manufacturers, the choice is clear: modernize or die. "[9]

Automation of virtually all textile production processes is underway. The entire manufacturing process is utilizing sophisticated microprocessor-controlled monitoring technology. And all manufacturing technologies are being integrated into flexible units with fewer overall steps. Speed and product quality are improving. New technology is increasing productivity while reducing labor content. Future technologies are expected to be more expensive, which will increase demand for new capital expenditures.

[9]Ellison S. McKissick, Jr., president, American Textile Manufacturing Institute, and head of Alice Manufacturing Co. of Easley, SC, cited in Phillip W. Wilson, "Living in a Material World," *World,* March-April 1986, p. 10.

Many experts believe that the U.S. textile and apparel industry must have a technological edge in order to remain competitive in world markets. Maintaining such an edge, however, is increasingly difficult, as technology transfer becomes easier and developing nations make substantial investments in new plant and equipment.

New Production Technologies

Most changes in the technology in place are designed to address three major production issues:

1. reduction of the labor content in the manufacturing process,
2. increase in the quality of products, and
3. flexibility in production.

Since the mid-1960s, process improvements have included the automation of opening rooms, the installation of chute-feeds and high production cards, the partial automation of drawing, the introduction of open-end spinning, the increasing use of shuttleless looms, the use of automatic systems for handling waste, and the nearly universal use of microprocessor-controlled monitoring and reporting of production variables.[10]

In each of the four major processes of cotton textile manufacturing there have been major technological innovations that have substantially increased productivity. The installation of automatic equipment in cotton opening rooms is replacing manual feeding. The use of chute-fed cards eliminates the necessity for manual carding and for most manual cleaning. Open-end spinning is replacing ring spinning for some yarns. In weaving, firms are shifting from shuttle looms to a variety of high-speed shuttleless looms. There have also been major innovations in texturing, new knitting machines, computerized finishing, cutting, and sewing.

Productivity Improvements

Consolidation and modernization have resulted in productivity increases by generating increased output from fewer plants and fewer employees. Productivity growth in the textile mill industry is the highest of all industries in U.S. manufacturing. Between 1975 and 1985, productivity levels in the textile mill industry increased substantially—more than twice that of total manufacturing, or 5.6 percent per year v. 2.4 percent. Even the apparel industry as a whole had higher productivity growth than total manufacturing, at 2.7 percent for the decade (see table 2 and figure 10).

U.S. textile industry productivity also surpasses productivity per employee among the textile industries of the major industrialized nations of the world, according to a 1985 European Economic Community study. The study found that:

> . . . some Western industries—especially the United States' —have achieved considerable gains in productivity thanks to the modernization and automation of their production. In 1980, the U.S. textile industry recorded the highest productivity per employee amongst the major industrialized manufacturing countries, thereby enabling it to achieve the lowest unit production costs amongst the same industrialized countries . . . The labor cost per unit produced in the United States is therefore closer to that of Portugal than that of the major European manufacturers, and closer to the unit cost in Pakistan than to the unit cost in Belgium or Germany. As a result, U.S. producers have been able to achieve price levels approaching those of some "low cost" Asiatic or Mediterranean countries.[11]

Productivity improvements have largely been the result of significantly increased machine speeds and versatility, and improved product quality, energy efficiency, and production efficiency, through both economic and technological consolidation.[12] The major innovations which have increased productivity are high-speed cards, continuous spinning frames, and shuttleless looms. Large- and even some medium-size U.S. companies are well on their way to modernization. On the other hand, many smaller companies may have difficulty making the transition from a highly labor-intensive to a highly capital-intensive production process. Today's U.S. firms face an increasing threat posed by potential acquisitions and mergers. In addition, the number of plant closings has grown in recent years.

[10] D R Buchanan, *Direction of Technology Change in the Fiber, Textile, and Apparel Industries* (Raleigh, NC: North Carolina State University, 1974).

[11] J F Belaud, "Textiles: EEC Policies and international Competition," *European News Agency*, 1985, p. 37.

[12] The next several paragraphs are based largely on Ruth Ruttenberg, "Compliance With the OSHA Cotton Dust Rule The Role of Productivity Improving Technology," contract report for the Office of Technology Assessment, March 1983, pp 92-97.

Table 2.—New Capital Expenditures and Productivity

	New capital expenditures					Productivity Indexes (1977 = 100)		
Period	Manufacturing industries	Nondurable goods (millions of dollars)	Textile mill products	Chemical & allied products		Total manufacturing	Textile mill products	Apparel products
1974	52,480	25,710	1,060	6,180				
1975	53,660	28,280	860	7,120		92.9	72.6	96.0
1976	58,530	31,030	980	7,370		97.1	82.1	95.8
1977	67,480	34,710	1,180	7,350		100,1	100.0	100,0
1978	78,580	39,130	1,310	7,760		101,5	99.4	103,7
1979	95,920	47,420	1,420	9,810		101,4	104.9	1069
1980	112,330	56,960	1,540	11,630		101,4	110.2	112,6
1981	126,540	66,730	1,660	13,110		103,6	113,0	114,4
1982	120,680	65,330	1,460	12,660		105,9	122.8	117.9
1983	116,200	63,120	1,550	12,960		112,9	129,5	118,0
1984:	138,820	72,580	1,920	15,320		118.5	129.5	121 4
1st	129,910	68,680	1,870	14,950				
2nd Q	135,960	71,930	1,990	14,850				
3rd Q	142,440	74,180	2,020	15,360				
4th Q	146,960	75,530	1,810	16,120				
1985:	153,150	80,010	1,780	16,450		1218	129.1	121.0
1St Q	145,650	75,780	2,010	16,430				
2nd Q	154,330	80,360	1,860	16,900				
3rd Q	154,040	81,190	1,740	16,280	Growth rates			
4th Q	158,570	82,700	1,500	16,190	per year (%)			
1986:[a]	149,170	77,090	1,700	17,160	1975–1 985	2.4	5.6	2.7
1st Q	143,060	75,320	1,520	16,020				
2nd Q	148,010	75,800	1,770	16,820				
3rd Q	148,470	77,040	1,770	17,270				
4th Q	157,160	80,190	1,760	18,520				

[a]Estimates based on planned expenditures reported by business in late April and May 1986 Quarterly data are seasonally adjusted annual rates

SOURCE American Textile Manufacturers Institute (ATMI) collected from U S Department of Commerce Bureau of Economic Analysis Index for Manufacturing. U S Department of Labor Bureau of Labor Statistics Index for others ATMI I Real GNP per payroll hour) Growth Rates ATM I (least squares of natural logarithms of indexes). Washington DC 1986

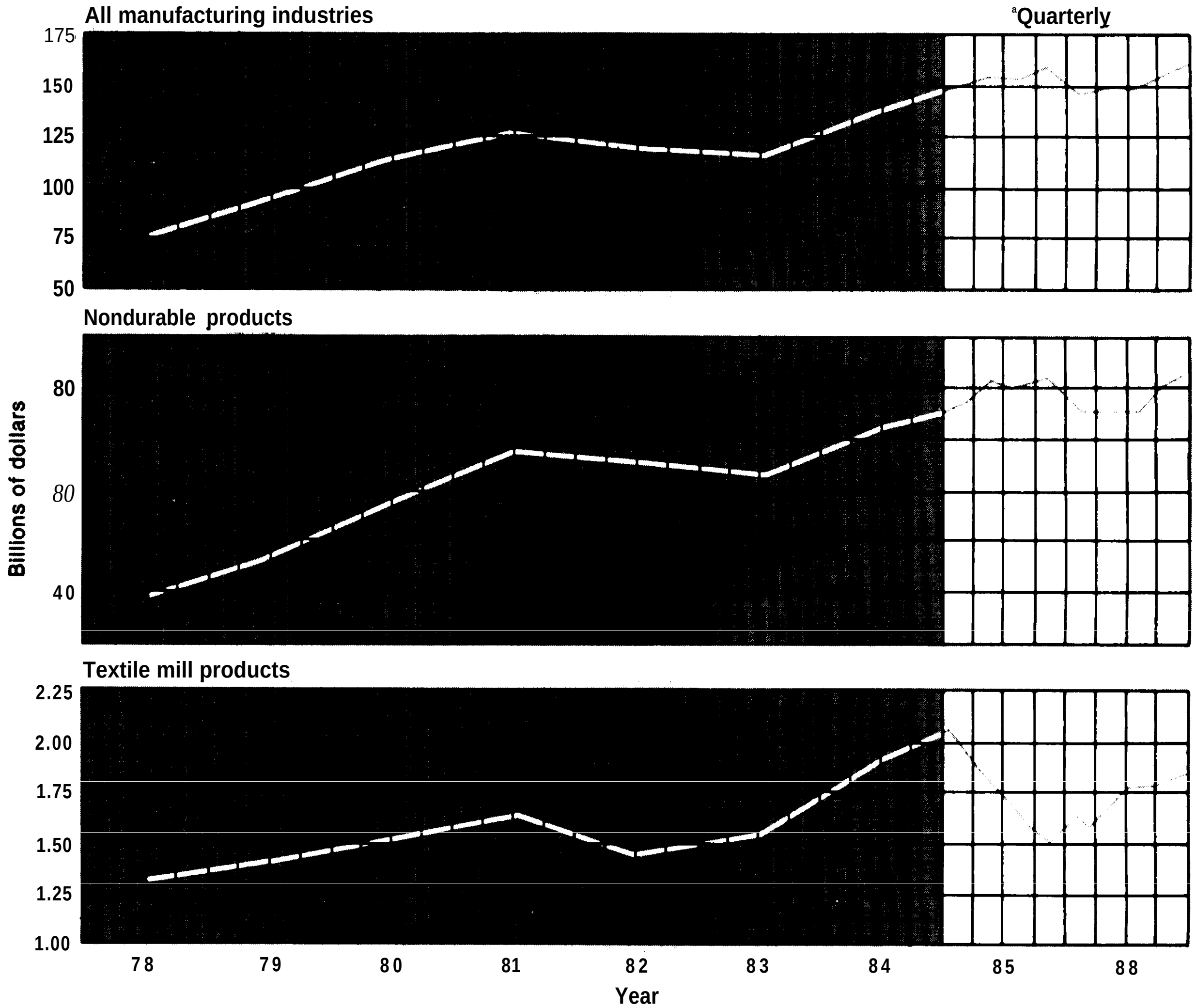
The means of modernization vary widely, and are the product of a broad range of new technologies. Older, slower cards, for example, are being replaced by high-speed cards. Chute-feed systems eliminate doffing, racking, manual transport to the card room, and hanging the lap. Open-end spinning eliminates drawing and roving. Conventional shuttle looms are being replaced by high-speed shuttleless looms, some of them 10 times more productive than the equipment they replace. Slower manual cleaning of equipment is being replaced by faster automated cleaning equipment. The production process is becoming more efficient.

Energy savings have also been a benefit of new textile machinery. From 1972 to 1980 alone, the textile industry improved its per unit energy efficiency by over 17 percent through the use of known technology and energy management programs.[13] The air-jet loom is especially energy efficient. Reduced air consumption can be achieved by a new heat and water recovery process. And in addition to saving energy and water, there is also a reduction in the quantity of polluted effluent—thus assisting companies with their EPA compliance efforts. Sizing equipment, weaving machines, and new carding technology also improve energy efficiency.

Another productivity improvement has been the reduction in needed floor space, as the production process has been consolidated and some steps have been eliminated. In addition, some new machines are more compact. Such space saving translates into reduced costs when building new facilities, as well as less costly expansion in older mills, The chute-feeding system saves floor space by eliminating both the picker floor area and the lap storage and lap conveyer systems. The Platt-Saco-Lowell sizing system is designed to use less floor space. Sulzer claims that the compact design of its PS weaving machine, particularly with the warp beam as far inside the ma-

[13]American Textile Machinery Association, "Assessment of Energy Conservation Potential at ATME-I 80 Textile Machinery Show in Greenville, SC, Phase l," report for the US. Department of Energy, December 1980, p. 7.

Figure 10.— New Capital Expenditures and Productivity



ªSeasonally adjusted.

SOURCE American Textile Manufacturers Institute, collected from U.S. Department of Commerce, Bureau of Economic Analysis, Index for Manufacturing, U S Department of Labor, Bureau of Labor Statistics, Washington, DC, 1986

chine as possible, not only saves space but reduces vibration as well.

Productivity in the textile industry is the dominant factor in competition among U.S. producers; however, this may not be the case for global competition, since exchange rates, labor costs, and noneconomic barriers are so significant. Domestically, even small productivity advantages can mean a competitive edge, because most of the industry competes on a cost basis. Productivity advantages over competitors can only be achieved through constant upgrading of machinery, and capital cycles are short; for example, 5 years for spinning machinery. As a result, only the financially strong will be able to upgrade their production technologies without assistance. But excellent productivity does not always result in excellent financial operating results.

Improvements in Product Quality

New textile machinery has the potential to increase production speeds while also improving product quality. In most cases, yarns are stronger, cleaner, and more uniform. Cloth is of higher overall quality. New looms are faster and can produce wider cloth, giving the manufacturer improved options on sales, further processing, and the increased amount of fabric produced at one time.

Quality improvements begin with new equipment for opening and picking. Because of carousels and automatic feeders, picking can be from a larger number of bales, thus achieving a better blend of cotton. The Bale-O-Matic of the U.S.-owned Automatic Handling Co. claims improved yarn quality due to "consistent hopper feedings [and] controlled cotton mix. "

New carding technology also adds to quality. Settings on new and rebuilt cards can be improved, and roller bearings on cylinder supports allow closer settings. Also, because the clothing is more even and metallic clothing allows tighter settings, one can achieve a better integration of fibers. This produces a more uniform and stronger piece of yarn. There are also fewer broken threads. The U.S. Department of Commerce, in studying the chute-feeding system, found that quality improvements came from eliminating thick lap joints and also from less reliance on judgment and more on automation.[14] Martha Mills in Thomaston, Georgia, claims that its chute system —"Levelfeed, CMC''—improves yarn quality by contributing to reduced weight variation.[15]

New spinning technology improves yarn quality. New self-cleaning mechanisms in open-end spinning keep small rollers from becoming dirty quickly, which increases yarn quality, Springs Industries claims that "modernization of yarn manufacturing machinery resulted in better quality yarn . . . and a higher percentage of first quality cloth."[16] An Italian fiber manufacturer that uses robots in its spinning systems claims increased yarn quality due to less handling.[17]

New weaving technology also improves product quality. In 1982, Textile *Industries* published an analysis of shuttleless looms, with findings of substantial quality improvements over conventional shuttle looms:

> A comparison of quality with similar fabrics woven on fly-shuttle looms shows shuttleless weaving to be superior in all categories. Improved quality results in dramatic increase in first-quality, woven cut lengths, generally providing lengths which are more than double those obtained from fly-shuttle weaving.[18]

Draper's air-jet conversion loom claims higher quality cloth, due to a mechanism that removes bad picks and thus minimizes the defects in the cloth. Dornier's rapier weaving machine, as well as other shuttleless weaving systems, has special motions to ensure perfectly woven closed selvedges. This machine also has reverse motion capability, which allows it to repair broken picks at any phase without starting marks. Sulzer boasts of the high-quality selvedges of its PS and PU weaving machines. Because of repair of broken threads, the proportion of first-quality cloth is increased; uniform weft tension adds to quality as well.

Consistency, Standardization, and Quality

The Production System

The network that converts fiber into a retail product involves a number of independent enterprises tied together by contract. The consumer sees only the price and the quality of the final product, factors that depend on the combined performance of the entire system. While the performance of each enterprise within this network is clearly important, the efficiency of how the pieces work together is also critical. Recent evidence suggests that the performance of the fiber-to-end use system is far from optimal, in part because of poor communication between fiber, textile, apparel, and retail enterprises.

Better information flows can improve the integrated performance of the system in three ways:

1. they can ensure that cost-reducing techniques used at one stage of production—such as those that produce fiber or yarns of uneven quality—do not block the use of cost-reducing techniques later in the production chain—such as the use

[14] U.S. Department of Commerce, "Opportunities and Strategies for U.S. Textile Machinery Manufacturers To Improve Their Competitive Positions in Domestic and Foreign Textile Markets, 1980- 1985," September 1980, p. II-57,

[15] " Chutes: An Integral Part of a Totally New Program," *Textile World*, September 1981, p. 81

[16] Springs Industries, Annual Report, 1981.

[17] "Italian Robot Proves Its Cost Advantage in Doffing, Donning Heavy POY Bobbins," *Textile Week,* May *3, 1982,* p. 5,

[18] Leon Seidel "Projectile Weaving Machines: A Post-Transitional View, " *Textile Industries*, May *1982,* p *59*

of high efficiency looms that require quality and consistency in fibers;

2. agreed standards and communication protocols can help eliminate redundant counting and sorting of deliveries, and can simplify paperwork for billing, invoicing, and inventory control; and
3. improved communication links, coupled with new batch production strategies, can allow retailers to keep a wide range of styles and sizes in stock, while reducing inventories throughout the textile and apparel network.

Quality Standards

In addition to inherent limits that exist in the operating speed of equipment, rapid production throughout the fiber-to-end use chain is limited by defects and poor quality in the materials used. Maximum speeds are limited by the weakest part of the chain—typically the quality of fiber or yarn. As suggested above, the challenge for the industry is to optimize the manner in which the system works as an integrated whole. Costs may be reduced by increasing the speed of winding machines, for example, but the resulting increase in the number of broken ends limits the productivity of equipment that converts the yarn into fabric.

Contrastingly, the high capital costs required to produce clean, high-quality, long-staple cotton fiber may reduce net costs by allowing greater productivity throughout the system. Fiber cleaning may be more efficient; intermediate steps in yarn production may be reduced; fewer broken ends in yarns may improve the efficiency of such follow-on steps as weaving and knitting; and better yarn may result in fewer end-breaks and less machinery downtime.

The key to improving the net performance of the system is to ensure that information about material requirements passes rapidly and accurately between the contributing industries. The lack of materials standards presents special problems. The characteristics required of yarn used in knitting differ from those required of yarn used in weaving; weaving itself can require a variety of yarn types, It seems certain that significant improvements in system-wide productivity can be made simply by improving the language with which these different needs are communicated throughout the system.

Coordination and "Quick Response"

New Technologies

Growing uncertainty about the nature of future markets, and competition from foreign producers, have placed increased pressure on the domestic apparel industry to find ways of reducing costs. Effective management techniques, however, combined with new communication and information processing technology and new production technology, can give domestic producers a significant advantage in many market areas now dominated by foreign production. While foreign producers will always be able to capture certain niches, such as silk blouses or other products requiring an extremely large amount of hand labor, the family of "Quick Response" technologies described below could make domestic production profitable in a wide range of seasonal products.

The key to Quick Response is holding inventories low and avoiding overstocking, while still ensuring that retailers stock what customers want to buy. Accomplishing this will require revolutionary changes in how information flows between the different components of the fiber-textile-apparel-retail chain, and an associated revolution in the style of production. In many ways, the institutional difficulties that must be confronted in implementing such a system pose a greater barrier than the technical problems involved. A basic change in the structure of industry suppliers will be required:

> The reorganization of the system that will result from the adoption of Quick Response systems will therefore lead to further consolidation of the textile and apparel industries as retailers and apparel manufacturers will both seek to develop stronger relationships with a smaller number of suppliers, each offering the capability to produce a wider range of products than is ususally the case today."[19]

Kurt Salmon Associates points to a similar trend in the automobile industry, where the Big Three automakers are reducing the number of their suppliers, and are selecting their suppliers based on quality, service, flexibility, technological expertise, and product development skills as much as on price.

[19]Peter W. Harding, Manager of Textile Industry Services, Kurt Salmon Associates Inc., "Quick Response in the Soft Goods Pipeline," synopsis of speech to the Knitted Textile Association Retail Relations Workshop, Dec 6, 1985, p. 12

There are major "hard" and "soft" technological requirements of Quick Response, for textile mill manufacturers, apparel manufacturers, and retailers (see figure 1 1):

For textile mill manufacturers, hard technology includes flexibility for shortrun weaving, shortrun dyeing and finishing, computerized defect mapping with shading information, computerized fabric design, and faster samples. Soft technology includes putups for faster handling by cutter, rolls pre-sorted by width, shipping information by computer, and sequential truck loading.

For apparel manufacturers, hard technology includes computer assisted design, automatic marking and cutting, flexible sewing with microprocessor, robotic handling, and unit production systems. Soft technology includes shop floor controls, logistics, supplier-cutter linkage, retailer-cutter linkage with merchandise control, and implementation.

For retailers, hard technology includes electronic data interchange from point-of-sale to vendor, point-of-sale data capture with bar coding, and sortation systems in distribution center. Soft technology includes merchandise planning and control systems, automatic markdown information, pre-marking by vendors, and pre-distribution by vendor.[20]

Efficient transportation also plays a key role. Textile suppliers are now able to communicate with large apparel companies with such precision that apparel firms have reliable information about the time and size of delivery, as well as the color and location of fabric within a truck. This permits apparel producers to closely integrate deliveries into their plans, and allows them to avoid costly and lengthy inventories of materials delivered. The Levi Co. estimates that their new communication system, by itself, saves as much as 10 cents per square yard of material.

[20]Peter N. Butenhoff and R.E. Cotton, Du Pent, "U.S. Apparel Competitiveness," May 28, 1986.

Figure 11 .—The Apparel Pipeline at a Glance: Present System v. Quick-Response Strategies

	Textile mill	Apparel manufacturer	Retailer
Present inefficient practices	• Requires long runs - 3 months' in-process time • Minimum fabric versatility • High inventory • Produces against tentative sales	• Inefficient, high-cost operations • Limited fabric selection; large orders required • High inventory • Markdowns • 1-month in-process time • Produces against tentative sales	• High markdowns • High Inventory • Stockouts
Quick Response solutions	• Better sales forecasting using: — computer-aided design — electronic data interchange • Rapid sample capability • Increased greige inventory • Shorter weaving and finishing runs • Quality guarantee • Timely delivery	• Sales forecasting closer to season using: — computer-aided design — style testing • Engineered plant • Reorder capability: — electronic data interchange — rapid throughput (UPS) — flexible output • Preticketing • Timely delivery • Quality guarantee • Supplier retailer cooperation	• Sales forecasting closer to season • Reorder capability via electronic data interchange • Revised open-to-buy policy (keep more money in reserve for reorders) • Rapid delivery to store shelf via reliable suppliers
Quick Response benefits	• Accurate production schedule • Increased sales • Lower inventory • Improved financial performance	• Accurate production schedule • Competitive advantage over imports via cost reduction, lower inventory, lower markdowns • Higher fixed investment offset by lower inventory • Wholesale price competitive with direct retail imports • Improved financial performance	• Increased sales: — lower stockouts • Higher margins: — fewer markdowns • Lower cost: — fixed — inventory • Improved financial performance

Quick Response potential (savings. *in* $billions)	Textile mill	Apparel manufacturer	Retailer	Total system savings
Forced Markdowns	0 3	2 0	5.0	7.3
Stockouts	—	0 2	1.7	1.9
Inventory	0 5	13	1.5	3.3
Total	0 8	3 5	8.2	12.5

SOURCE: Peter N. Butenhoff, "U.S. Apparel Competitiveness, " paper presented to OTA by El. du Pent de Nemours, & Co., June 1988,

The Philadelphia College of Textiles and Science has a computer-assisted design (CAD) laboratory equipped with 10 design stations. Above, a student works on a fashion illustration.

Efficient transportation networks are also required between apparel producers and retail outlets. As one observer puts it:

> [f you can process a style in four hours, but it then waits three days for the next truck to your distribution center, and then it takes another couple of weeks to go through your distribution center to get on to the retail shelf for presentation to the customer, you cannot capitalize on the potential for quick response. [23]

It can take up to **2** months for a product to get from an apparel plant to the sales floor. The initial experiments with Quick Response have shortened this time span considerably, using United Parcel Service for rapid deliveries.

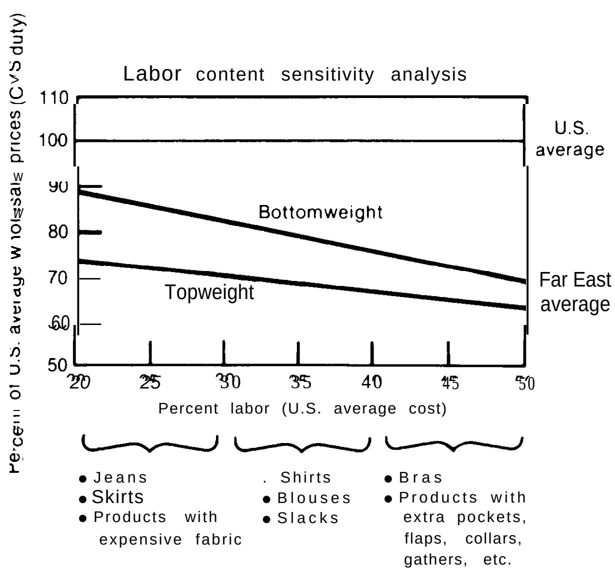
A Quick Response pilot program, organized by the Crafted with Pride in U.S.A. Council, Inc.; Wal-Mart Stores of Bentonville, Arkansas; Seminole Manufacturing Co. of Columbus, Mississippi; and Milliken & Company of Spartanburg, South Carolina, has shown substantial success.[22] Basic improvements, which *were* clear after only 3 months, include:

- increasing the frequency of replenishment orders from monthly to biweekly, thus enabling stockouts to be avoided or detected earlier and reducing the size of reorder shipments;
- cutting reorder cycle time, from counting inventory on the selling floor to receipt of the replenishment order, by 33 percent;
- shortening the cut authorization-to-finished goods availability by 30 percent through changing from monthly to weekly planning; and
- reducing the color assortment-to-shipment time by 50 percent.

Quick Response and U.S. Competitiveness

Figure 12 indicates the large gap that now exists between the wholesale price of garments imported from the Far East and garments available from domestic producers; the size of the gap depends on the type of fabric used and the percent of the wholesale cost due to labor. Overseas producers have a comparative advantage in products using relatively labor-intensive fabric, or "topweights," because foreign topweight fabrics may cost **35** percent less than equivalent domestic fabrics, while fabric costs may only be 15 percent lower for the less labor-intensive, "bottomweight" fabrics. Most U.S. apparel producers, however, clearly must find a way to shave between 10 and 35 percent off their costs in order to compete directly with many foreign suppliers.

Figure 12.— Retailers' Sourcing Cost Comparison: United States v. Far East



SOURCE: Peter N Butenhoff, "Quick Response Technlogy —Needs and Justification, " E I du Pent de Nemours & Co , January 1987

[21] Robert M Frazier, "Quick Response, " presentation made at DUPAATCH, Sept 13, 1985

[22] Kurt Salmon Associates, Inc , "Crafted With Pride in U S A Council, Inc , Quick Response Program Report, " June 11, 1986.

63-978 0 - 87 - 2

Photo credit: Copyright (©) 1986, 1987 by Bobbin International, *Inc. All rights reserved*

Computers used to track the flow of finished goods into the warehouse can help to improve communication between apparel manufacturers and retailers. In addition to reducing overhead costs, computer-based monitoring can facilitate inventory control, and thus can increase the efficiency of the system that brings a product to the consumer.

Quick Response systems can close this cost gap in several ways. First, the enormous inventories carried by textile mills, apparel manufacturers, and retailers can be reduced. On average, it takes roughly 65 weeks for fiber to move from a manufacturing plant to the customer's hand. The material is in processing for only 15 out of these 65 weeks; the remaining 50 weeks are spent sitting in inventory .23 The cost of this inventory alone represents 6.4 percent of retail sales. With good management, it should be possible to reduce this by 25 to 50 percent.[24] Proper inventory control can increase sales per square foot, ensuring that the assortment on the selling floor matches proven market demand for styles, colors, and sizes.

Second, it should be possible to reduce incidence of forced markdowns that result from orders of goods that fail to sell as expected, Forced markdowns have grown by 50 percent during the past decade, and the National Mass Retail Institute estimates that total losses may be as high as 15 percent of retail sales.[25] Forecasting failures are due in large part to the long planning cycle that is now typical in the industry-most initial orders for seasonal products must be placed more than a year before the products are sold. With Quick Response, it may be possible to reduce initial order times to 2 or 3 months, and reorder cycle times to a few weeks. Accordingly, the need for long range, imprecise forecasting is greatly reduced:

> If the manufacturing cycle can be reduced through the use of more flexible manufacturing technology, then the time horizons for forecasting may also be reduced with resulting improvements in accuracy. Better collection of data from point of sale terminals, better systems to analyze this data and electronic communications will ensure that better and more timely information will be available on which to base forecasts. This will also encourage the use of better forecasting tools, which are often not used today because the quality and quantity of data available does not justify their use.
>
> Computers and electronic data interchange provide us with the tools we need to both process and to communicate the information that our partners in the system require.[26]

The third area where Quick Response can result in cost savings involves "stock outs, " or situations where business is lost because a customer cannot find apparel in the desired style or size because it is out of stock. Quick Response systems permit smaller initial orders, allowing stores to reorder more of a product that proves to be popular. The product can then be in stock at full price during the selling season.

Estimating the magnitude of "stock out" losses is a difficult task, since many consumers who don't find what they want simply leave a retail store without

[23] Sig Scheier "QR to Consumer Demand Vital, Hinerfeld Warns, " *Daily News Record,* Oct. 9, 1985, p. 11.

[24] Frazier, op. cit.

[25] Ibid.

[26] *Harding, op. Cit.,* pp *11-12.*

registering their disappointment. Industry estimates suggest that losses from stockouts are about 8 percent of apparel sales.[27] Field experiments with Quick Response systems suggest that this may bean underestimate. The Wal-Mart experiment, cited earlier, found that using Quick Response reordering systems for sales of basic men's slacks increased inventory turnover at the astonishing rate of 30 percent, with a comparable increase on gross margins on inventory.[28] A stock count indicated that while 29 percent of items checked were out of stock before the program, only 17 percent were out of stock after the Quick Reponse system was initiated. Retail stores can offer a greater variety of products without a significant increase in inventory through the ability to replenish stocks quickly. Overall, the Wal-Mart experiment claims to have yielded year-to-date sales increases of 47 percent, and 31 percent on a same store basis.[29]

Quick Response systems can also reduce costs and paperwork associated with such overhead operations as billing, invoicing, and inventory controls. Improved information flows and standardized reporting systems can greatly reduce handling and processing costs, like quality control audits, hanging and premarking of merchandise, and time spent handling and counting deliveries. Perhaps most importantly, four networks that link different parts of the fiber-to-finished product chain more effectively have been created within the last year:

- **The Fabric and Supplier Linkage Council (FASLINC):** Having commenced operations only in January of 1987, FASLINC is designed to improve and facilitate communication between fabric producers and their suppliers.
- **The Textile and Apparel Linkage Council (TALC):** Begun in the spring of 1986, TALC works between textile mill firms and apparel manufacturers.
- The **Sundries and Apparel Findings Council (SAFLINC):** This network, established in March of 1987, ties apparel manufacturers with a diverse group of suppliers, ranging from button makers and lacers to packagers and labelers.
- **The Voluntary Interindustry Communications Standards (WCS):** This final link in the chain connects the apparel manufacturer with the retailer.

Increased communication and standardization between different sectors within the textile and apparel industry complex will quicken the process by which the final product is brought to the consumer, leading to further reductions in overhead costs and bringing production even closer to the marketplace.

Finally, productivity gains can be realized within the apparel production facility through the use of off-the-shelf equipment, and better management practices can facilitate integration with the overall Quick Response system. Many of these techniques have been discussed in earlier sections of this report. Moving away from the "progressive bundle" system—a process driven by repetition of standardized tasks, which may have been cost-effective in an environment where response time and inventory control was not critical—to a modern unit production system can reduce processing times of 4 to 6 weeks to 1 or 2 days.[30] Computer-controlled cutting techniques can reduce material losses by 2 to 3 percent and can take 1 to 2 weeks out of planning, while reducing the number of parts that are cut simultaneously by 30 to 50 percent.[31] Taken together, these innovations could reduce average apparel assembly costs by at least 7 percent; the new generation of $(TC)^2$ technologies could, of course, lead to even greater time savings.

A conservative estimate of the savings that can be realized from a relatively' straightforward implementation of Quick Response technologies indicates that the industry could have saved $12.5 billion in 1984 (again see figure 11). These savings are realized by the entire system acting as a whole, and may not be recognizable in a study that focuses on only a single part of the system. Indeed, the use of small batches can actually increase the cost of material, while the most efficient "progressive bundle" apparel assembly system may cost 7 percent less than the most efficient Quick Response system. Also, small batch shipping requirements may increase freight

[27] Frazier, op. cit.

[28] "Quick Response Pilot Program Update," *Crafted With Pride*, January 1987.

[29] Ibid.

[30] R. E Cotton, "QR's Bottom Line," *Apparel Industrv Magazine*, Ju l! *1986*, pp 2[3-:31

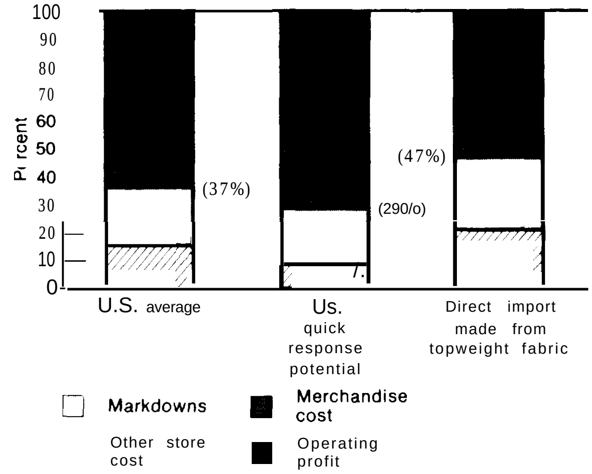
[31] Frazier, 01) (it

The Gerbermover GM-100 “unit production” system (above), installed in Mary Fashions in late 1986, reduces manufacturing time significantly from the “progressive bundle” system (bottom). Note that in unit production, the fabric moves between sewing stations by automation rather than by hand. In the progressive bundle system, hand transfer means time spent not only in the actual movement of fabric, but in tying and untying bundles and pressing wrinkles out of folded pieces.

charges. Such cost penalties, however, appear to be more than offset by the system-wide gains that Quick Response will bring.

Quick Response systems could reduce overall costs to the point where purchases from domestic suppliers will be competitive with imports. Figure 13 indicates

Figure 13.—Breakdown of Original Retail Price (Mass Merchant . Private Label Seasonal Product)



SOURCE: E.I du Pent de Nemours & Co , “Quick Response Technology, ” paper presented at North Carolina State University, January 1987

the breakdown of costs for retail sale of a “private label” seasonal product made from topweight fabric; conservative assumptions about the gains from “stock outs” are used. The figure includes the cost savings that are potentially achievable from Quick Response systems, as well as the “hidden costs” of imports—increased communication and travel expenses, and inefficiencies due to uncertainties and delays. Accordingly, retailer profit margins using Quick Response can be as high as those achievable from sales imports. Competition with foreign suppliers, of course, still depends on the 10 to 30 percent advantage realized from tariffs paid by importers, and on higher shipping costs.

One obvious question brought by the implementation of Quick Response is whether other exporting nations can participate in such a system. Benetton, the Italian apparel manufacturer and retailer, has established a production facility in North Carolina, as part of an overall strategy to move closer to U.S. demand; Benetton’s flexible production capacity has already allowed this firm to successfully target U.S. market niches. The more sophisticated Asia producers, like those in Korea, Taiwan, and Hong Kong, could certainly enter into a Quick Response network by using air freight for delivery, although the additional costs of the freight could reduce the range of products in which they are competitive.

On the other hand, because they have reached their quota limits, these nations do not represent a majority of U.S. imports. Many of the nations that have increased exports to the United States in the past few years will face great difficulties in building the communication and transportation infrastructure needed to participate in a Quick Response network.

Quick Response, by attempting to change some of the dynamics of competition between domestic and imported goods, and by fostering cooperation between U.S. manufacturers and retailers, is clearly a critical part of efforts to increase domestic production. Because the United States probably has enough retail square footage to serve almost twice as many consumers as are now in its market, and because there is much sameness in merchandise and service, price has been considered the best way to attract and keep a customer. But according to Kurt Salmon Associates, Inc., it may be possible to revise this assumption through Quick Response:

> The great majority of retailers have accepted it [price] as the only competitive weapon left to them. This induced an acceleration of private label import programs as stores moved to protect their margins and market shares while offering something unique to their customers.
>
> In the process, of course, direct importing by retailers created havoc among domestic apparel makers and their textile suppliers. Faced with under-utilization of their assets, squeezed margins, and uncertain sales outlooks, manufacturers widened their distribution. Nationally advertised brands and designer labels, tightly controlled only a decade ago, were now available at varying prices in almost everr type of retail outlet .
>
> As markdowns increase on both domestic branded merchandise and off-shore private label purchases, the retailer has become increasingly demanding of his resources. The latter fight back by widening their distribution and developing their own sources overseas . . In the meantime, the consumer is being ignored .
>
> A more integrated and efficient soft goods chain, dedicated to responding to consumer wants quickly, will benefit everyone.[32]

Of course, in order for Quick Response to become a reality, a serious commitment from industry to reorganize production facilities will be needed—a move that many U.S. apparel firms are reluctant to make. As one expert on industry productivity and organization writes, "to move into Quick Response means a willingness to take some risks and to make changes in the way you do business."[33]

[32]Kurt Salmon Associates, Inc., "Quick Response for Retail ing, " *The KSA Perspective*, January 1 986, p. 3

[33]Emanuel Weintraub, "Buzzwords With No Deeds Don't Make it. " Bobbin *Magazine*, September 1986, p 50

INDUSTRIAL STRUCTURE

Background

Changes in the technology of each step in the fiber-to-end use production chain, and how these steps are integrated by strategies like Quick Response, bear a direct relationship to changes in the business structure of textile and apparel enterprises. Textiles and apparel are, of course, distinct industries, and each faces unique problems.[34] Both are relatively fragmented by modern standards, but textile manufacturers have generally been larger and more capital-intensive than smaller, more labor-intensive apparel firms.

The entire textile and apparel industry includes enterprises in at least 66 four-digit standard industrial classification (SIC) codes. Because of the growing technological diversity of the industry, some textile production may be included in other SIC codes as well (see table 3). In addition, there are several nonmanufacturing sectors totally dependent on textile manufacturing—most notably retail trade for textile products.

The various sectors of the industry complex compete in a variety of markets, ranging from the trade of cotton on exchange markets to the retail distribution of apparel goods. All of these markets have become global in nature. Some, such as textile mill products, are being increasingly integrated. Others, primarily apparel, are still fundamentally a sector of small employers with limited production variety.

Traditionally, the industry has been horizontally structured, with the manufacture of cloth and the

[34]Bruce Stokes, "(;~tt) ng Competitive' *National Journal*, June 7.1986, p 1 362

Table 3.—SIC Codes for Textiles and Apparel

SIC 22 Textile Mill Products	
1.2211	Broad woven fabric mills, cotton
2.2221	Broad woven fabric mills, man-made fiber & silk
3.2231	Broad woven fabric mills (including dyeing & finishing)
4.2241	Narrow fabrics & other smallwares mills: cotton, wool, silk, and man-made fiber
5.2251	Women's full length & knee length hosiery
6.2252	Hosiery, except women's full length & knee length hosiery
7.2253	Knit outerwear mills
8.2254	Knit underwear mills
9.2257	Circular knit fabric mills
10.2258	Warp knit fabric mills
11.2259	Knitting mills, not elsewhere classified
12.2261	Finishers of broad woven fabrics of cotton
13.2262	Finishers of broad woven fabrics of man-made fiber & silk
14.2269	Finishers of textiles, not elsewhere classified
15.2271	Woven carpets & rugs
16.2272	Tufted carpets & rugs
17.2279	Carpets & rugs, not elsewhere classified
18.2281	Yarn spinning mills: cotton, man-made fibers & silk
19.2282	Yarn texturizing, throwing, twisting & winding mills: cotton, man-made fibers & silk
20.2283	Yarn mills, wool, including carpet & rug yarn
21.2284	Thread mills
22.2291	Felt goods, except woven felts & hats
23.2292	Lace goods
24.2293	Paddings & upholstery filling
25.2294	Processed waste & recovered fibers & flock
26.2295	Coated fabrics, not rubberized
27.2296	Tire cord & fabric
28.2297	Nonwoven fabrics
29.2298	Cordage & twine
30.2299	Textile goods, not elsewhere classified
SIC 23 **Apparel& Other Finished Products Made *From Fabrics & Similar Materials***	
31.2311	Men's, youths', & boys' suits, coats, & overcoats
32.2321	Men's, youths', & boys' shirts (except work shirts) & nightwear
33.2322	Men's, youths', & boys' underwear
34.2323	Men's, youths', & boys' neckwear
35.2327	Men's, youths', & boys' separate trousers
36.2328	Men's, youths', & boys' work clothing
37.2329	Men's, youths', & boys' clothing, not elsewhere classified
38.2331	Women's, misses', & juniors' blouses, waists & shirts
39.2335	Women's, misses', & juniors' dresses
40.2337	Women's, misses', & juniors' suits, skirts, & coats
41.2339	Women's, misses', & juniors' outerwear, not elsewhere classified
42.2341	Women's, misses, children's, & infants' underwear & nightwear
43.2342	Brassieres, girdles, & allied garments
44.2351	Millinery
45.2352	Hats & caps, except millinery
46.2361	Girls', children's, & infants' dresses, blouses, waists, & shirts
47.2363	Girls', children's, & infants' coats & suits
48.2369	Girls', children's, & infants' outerwear, not elsewhere classified
49.2371	Fur goods
50.2381	Dress & work gloves, except knit & all-leather
51.2384	Robes & dressing gowns
52.2385	Raincoats & other waterproof outer garments
53.2386	Leather & sheep lined clothing
54.2387	Apparel belts
55.2389	Apparel & accessories, not elsewhere classified
56.2391	Curtains & draperies
57.2392	Housefurnishings, except curtains & draperies
58.2393	Textile bags
59.2394	Canvas & related products
60.2395	Pleating, decorative & novelty stitching, & tucking for the trade
61.2396	Automotive trimmings, apparel findings, & related products
62.2397	Schiffli machine embroideries
63.2399	Fabricated textile products, not elsewhere classified
Others	
64.2823	Synthetic fibers
65.2824	Organic fibers, noncellulosic
66.3552	Textile machinery

SOURCE U S Executive Off Ice of the President, Office of Management and Budget, *Standard Industrial C/ass/f /cation Manual, 1972*

manufacture of clothing fairly separate. Fiber producers supplied raw material to yarn manufacturing plants, which in turn sold yarn to weaving or knitting facilities. Manufactured fabric was sold or commissioned to a fabric finisher, and then sold to the garment manufacturer. Textile converters and jobbers helped oversee the movement of products from one processor to another, supplying a finished product to cutters or retailers and maintaining product supplies for spot markets. Clearly, a great deal of time is involved with this flow sequence, making creative and rapid response to market needs very difficult. Having many intermediate companies handling the product has made quality control a particular problem, increasing the levels of product waste.

More emphasis on continuous flow and vertical integration, spurred on by growing interest in Quick Response, is changing the industry's structure. While much of the apparel industry is still quite decentralized, especially the contractor portion, there is more integration than disintegration.

In the early 1950s the leaders of the textile industry, particularly Burlington Industries and Milliken, responded to the need for restructuring of material flow. More vertical and market-oriented organizations were established to handle the textile product from fiber to finishing. Research and development became a part of many of the larger, more diversified companies, where previously it was mostly in the domain of fiber producers. Vertically structured companies seemed better able to respond to some market requirements and to supply versatility in their products. In addition, staff functions such as financial planning, product development, industrial engineering, marketing, and cost accounting could often be more fully supported by vertically structured companies. However, there is controversy in some textile sectors over trade-offs between economies of scale from integration and the loss of flexibility that producers of small lots can provide, especially to fashion-oriented parts of the apparel industry.

Textile companies are restructuring far more than material flows. Mergers and takeovers are abundant. Most of these moves have increased horizontal integration; some have increased vertical integration. Stevens recently bought Burlington's sheet and towel division, and is trying to sell its clothing businesses while enlarging its household and industrial textiles divisions. Springs bought Lowenstein, becoming the second largest U.S. cloth producer. Fieldcrest acquired Cannon. These three actions alone consolidated the sheeting market significantly, with the three firms together holding half of that market. In other moves, West Point-Pepperell, enhancing its vertical integration, has bought Cluett Peabody, a shirtmaker best known for its Arrow brand. United Merchants & Manufacturing Inc. bought Jonathan Logan. Cone Mills, Dan River, Levi Strauss, and Blue Bell have reverted to private ownership to protect themselves against takeover bidders.[35]

At the same time that companies are consolidating, there is movement afoot to expand the importance of small contract shops in apparel. While the number of contractors in the United States has diminished by more than 50 percent in the last 15 years,[36] today's emphasis on proximity to the marketplace, on speed of response to retailers' private label programs with local retail stores, and on direct dealing with retailers that eliminates the "middleman" manufacturer, may open new opportunities for those contractors who remain. Reliance on contractors, however, could draw resources away from needed investment in other areas, such as technologies that can help apparel manufacturers to adapt directly to changes in consumer preferences—and over the long term, the willingness to innovate may determine whether U.S. apparel firms will be able to compete in world markets.

Structural Changes

In this analysis, "industry structure" refers to the number and sizes of firms in a given industry and the type of competition that exists among them. In the past, the textile industry complex has consisted of a very large number of small- and medium-sized firms, and a high degree of competition. The future industry may be characterized differently. As many firms integrate and as they become part of large and diversified corporate entities, the traditional buyers and sellers and the links among them may change.

Traditionally, the textile and apparel industry structure consisted of an agricultural producer of cotton or wool fiber selling to a fabric manufacturer, who in turn would sell to a producer of apparel; finally, apparel would be sold to retail stores for sale to the consumer. The majority of textile shipments proceeded along this chain. This is no longer the case. Agricultural producers are being replaced by chemical companies who manufacture synthetic fibers. The apparel segment, while still the largest of the end uses, is no longer the largest purchaser of fabric. Home furnishings and industrial uses are, together, larger. In some cases the fabric process represents an end product, as in the tufting of carpets or the weaving of towels and bedding. As a result, new relationships and new alliances become a necessity. The pressure for vertical integration means that traditional links in the chain are more susceptible to either backward or forward integration efforts. While some markets, such as those for cotton blouses, may remain quite similar to their traditional structure, the structure will be new in a growing number of product lines.

With the exception of apparel, the era of a textile industry dominated by small, family-owned and -operated companies is a thing of the past. As the fiber-fabric-apparel-retail set of links has weakened,

[35] "America's Textile Industry Holding Its Salvation in Its Own Hands," *The Economist*, Apr. 5, 1986, p. 80.
[36] Joyce Santora, "Contractors Move to Bring Production Back," *Bobbin Magazine*, April 1986, p. 52.

so too has the industry structure which supported small companies providing limited numbers and types of products for limited geographical markets. Concentration varies from segment to segment, but vertical integration and the growth of multinationals is a reality, especially in fibers and fabrics. With the exception of apparel, where concentration ratios are mostly quite low, the most heavily concentrated segments are also the largest employers. The two segments which represented the largest share of capital expenditures and of gross fixed assets—cotton weaving and manmade fiber weaving—had respective concentration ratios of 42 and 39 percent in 1977, in contrast to ratios of 39 and 31 percent 5 years earlier.

Concentration ratios by market segment measure horizontal integration. Vertical integration, on the other hand, by which one segment acquires capacity in other industry segments, represents another form of concentration. This is usually accomplished by integrating either backwards or forwards to merge production processes that occur in sequence. For example, fabric producers might integrate backwards to acquire a yarn manufacturing firm. Or an apparel segment, such as knitting outerwear, might integrate forward into the retail area. As more and more multinational firms with diversified production capacities enter the market, vertical integration can be expected to increase.

Trends in Investment and Disinvestment

Many observers bemoan the plant closings and disinvestment that are occurring throughout the textile industry. Between 1977 and 1982 alone, the number of textile plants and firms declined 10 percent.[37] From 1983 through mid-1985, nearly 1 million spindles and 15,500 looms were eliminated. The geographic impact of these disinvestments was dramatic—more than 85 percent of the spindles were eliminated in the three States of South Carolina, North Carolina, and Georgia. More than 95 percent of all looms were shut down in these States; 63 percent of the impact was in South Carolina alone (see table 4). A February 1985 survey by the American Textile Manufacturers Institute of its own membership estimated that 44 plants had closed in 1981, 100 in 1982, 49 in 1983, and 38 in 1984. The impact on individuals who lose their jobs and the communities that lose a critical economic base has been severe, especially since so many of the affected plants have been in small communities with few other employers.

Table 4.—Permanent Plant Closings in the U.S. Textile Industry, 1983-June 1985

Location	Number of spindles eliminated	Number of looms shut down
Georgia	175,012	2,602
North Carolina . . .	266,956	2,188
South Carolina . . .	390,564	9,750
Alabama	56,816	—
Virginia	77,060	499
Connecticut	2,100	—
Texas	—	—
California	5,280	—
Massachusetts. . .	3,120	—
Total	976,908	15,489

SOURCE" American Textile Manufacturers Institute, Washington, DC, 1986

Nonetheless, disinvestment has not been the only trend. Substantial new investments have been made by many companies, and even by some of the very companies that are also disinfesting. Stevens Corp., for example, in the early 1980s made plans to close three or four plants, in addition to four closings or phase-outs that had already been announced .38 But at the same time, Stevens was planning for $500 million in new plant and machinery investments over the next several years, including 450 new air-jet looms.[39] Dan River, while committed to an aggressive modernization-through-investment program, sold off a plant in Simpsonville, South Carolina, and closed its texturing operation in Mebane, North Carolina. Burlington closed its Madison, North Carolina, yarn plant during 1986, but is spending several million dollars through 1987 to improve technology at its Twintex and Mayodan texturing plants.[40]

Basic elements of supply and demand for textiles have changed in the last decade, and promise to change still more in the decades ahead. The market for textiles is increasingly a global market, demand-

[37] Centaur Associates, Inc., "Technical and Economic Analysis of Regulating occupational Exposure to Cotton Dust, " vol. I, prepared for the occupational Safety and Health Administration (OSHA), January 1983, p. I-2

[38] "Textile Week Hears . . .," *Textile Week*, June 22, 1981

[39] Ruttenberg, op. cit., p. 89.

[40] *Daily News Record*, June 5, 1986, p. 8.

ing specialization and identification of competitive market niches. An industry of many small firms is giving way to oligopolistic markets, or at least to monopolistic competition. A large number of firms engaging in price competition with similar if not identical markets is a fading economic possibility for the U.S.-based industry. Fewer corporate entities are supplying textile products for sale. More and more corporate entities within the fiber-fabric-apparel-end use-retail chain are "selling" products to themselves, or transferring products from one division or subsidiary of the company to another to eliminate price competition altogether. The products being demanded are thus often purchased by internal corporate entities. And the products being demanded are more often for end uses other than apparel, such as home furnishings or industrial purposes.

Not only must the industry adapt to changes in basic supply and demand. It must meet intense challenges to traditional ways of making decisions about trade, research and development, capital investment, employment, and marketing.

Into the Future

The textile industry of the 21st century will be more capital-intensive, more horizontally and vertically integrated, and more internationally linked than ever before. Within the United States, there will be both plant closings and company expansions; markets will increasingly be more carefully identified and targeted; production will be geared to identified market niches. Synthetic rather than natural fibers will represent growth in fiber markets. Nonwoven rather than woven fabrics will represent growth in textile markets. Industrial and home furnishings, as well as apparel, will have some promising product areas in which to identify market niches for end uses. The traditional segmentation of markets—into individual production processes, separate geographic regions, and/or single technologies—will not be the predominant organizing feature of most industry sectors. Instead, there is likely to be increased horizontal and vertical integration, greater participation by chemical and paper producers and by multinational corporations, more capital intensity, and a continuing shift to a global market.

The major exception is likely to be apparel, but this sector could integrate by way of major technological breakthroughs. It is more likely, however, at least in the short to medium term, that apparel will continue to be an industry structure of small firms. Of the more than 200 apparel companies in the United States, less than 1 percent have sales over $100 million per year.[41] Without stricter enforcement of wage and hour regulations, there may be further growth in "underground assembly," through employment of illegal aliens at subminimum wages. The critical problem to overcome is the current high level of import penetration.

[41] Wilson, op cit , p 9