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Textile Machinery

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UNITED STATES INTERNATIONAL TRADE COMMISSION

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PREFACE

In 1991 the U.S. International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.

This report on textile machinery and parts covers the period 1988 through 1992 and represents one of approximately 250 to 300 individual reports to be produced in this series during the first half of the 1990s. Listed below are the individual summary reports published to date on the machinery and equipment sector.[1]

USITC publication number	*Publication date*	*Title*
2430	November 1991	Aircraft, spacecraft, and related equipment
2505	April 1992	Construction and mining equipment
2546	August 1992	Agricultural and horticultural machinery
2570	November 1992	Electrical household appliances and certain heating equipment
2633	June 1993	Textile machinery and parts

[1] The information and analysis provided in this report are for the purpose of this report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

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INTRODUCTION

This summary provides industry and trade information on textile machinery for the 1988-92 period. This report is organized in three major sections: U.S. and foreign industry profiles; U.S. and foreign tariff and non-tariff measures; and U.S. industry performance in domestic and foreign markets. In addition, appendixes A-C provide, respectively, information explaining tariff and trade agreement terms, various statistical data in tabular form, and detailed descriptions of the specific machinery covered.

Textile machinery is used to convert cotton, wool, man-made fibers, and other raw textile materials into yarn and finished fabric. Textile machinery and parts can be grouped into four basic categories: yarn-preparing and-producing machinery and parts; weaving and knitting machinery, needles, and parts; finishing machinery and parts; and specialized textile machinery and parts. The following is a brief description of the textile machinery and parts covered by this summary.

Yarn-preparing and -producing Machinery and Parts

The process by which raw materials, including all natural and manmade fibers, are transformed into finished yarn involves a variety of diversified machinery, such as spinnerettes, opening, reeling, carding, combing, drawing, roving, ring and open-end spinning, extruding, texturing, jet spinning, twisting, slashing, felt-making, and winding machines. These machines clean, blend, orient, and align the raw fibers and then twist them into yarn. The newly spun yarn is wound onto bobbins, spindles, caps, or paper tubes.

Weaving and Knitting Machinery, Needles, and Parts

Fabric is generally formed by either weaving or knitting. Weaving machines (looms) produce fabric by interlacing warp yarns, which run lengthwise through woven fabric, with filling yarns, which run crosswise at right angles weaving over and under the yarn. The different types of looms are named according to the type of mechanism used to weave cloth. The major types are projectile/missile looms, air jet looms, water jet looms, rapier looms, and fly shuttle looms.

Knitting machines interloop vertical rows of stitches with horizontal (or crosswise) rows of stitches by use of a needle to form series of connected loops. Knitting machines are generally of four types: circular, full-fashion hosiery, flat, and warp. Flat knitting machines include V-bed and links-and-links machines. Warp-knitting machines include tricot, raschel, milanese, and simplex machines.[1]

[1] According to the *Man-Made Fiber and Textile Dictionary* (Celanese Corporation): tricot, raschel, and milanese knitting is defined as follows: (1) tricot—a run-resistant type of warp knitting in which either single or double sets of yarns are used. Tricot is a generic term referring to the most common type of warp-knit fabric.

Finishing Machinery and Parts

Because of the variety of raw materials used in the manufacture of textiles and the number of different finishes desired, many different types of finishing machines are required. The operations performed by these machines usually are classified as either wet or dry processes, and they range in complexity from rather simple operations to those that completely change the character or appearance of the fabric. Fabric weights and knits also affect the types of machinery used.

Much of the equipment used is nothing more than vats, tanks, troughs, or other containers. They are fitted with simple mechanical features, such as rollers for leading the yarn or fabric or for squeezing out excess liquid, stirring agitators, and similar devices for wet processing. Finishing machinery and parts, include bleaching, dyeing, drying, washing, cleaning, dressing, folding, reeling, and cutting machines and parts.

Specialized Textile Machinery and Parts

Specialized textile machinery is used to manufacture rope, twine, carpet, cord, shoe laces and other braids, as well as ornamental fabrics for net, lace, window curtains, table cloths, handkerchiefs, and embroidered edgings. Specialized textile machinery includes lace- and net-making machines; braiding, lace-braiding, tufting, and embroidery machines; bleaching, mercerizing, and dyeing machines; printing and calendaring machines; and cordage machines and parts.

As presented in figure 1, yarn-preparing and -producing machinery and parts and accessories for textile machinery constituted the two single largest import categories during 1992. Imports of these two categories accounted for 27 and 38 percent, respectively, of the value of total U.S. imports of textile machinery. Specialized textile machinery and parts and accessories for textile machinery, as presented in figure 2, accounted for 41 and 40 percent, respectively, of the value of U.S. shipments during 1992.

U.S. INDUSTRY PROFILE

Industry Structure[2]

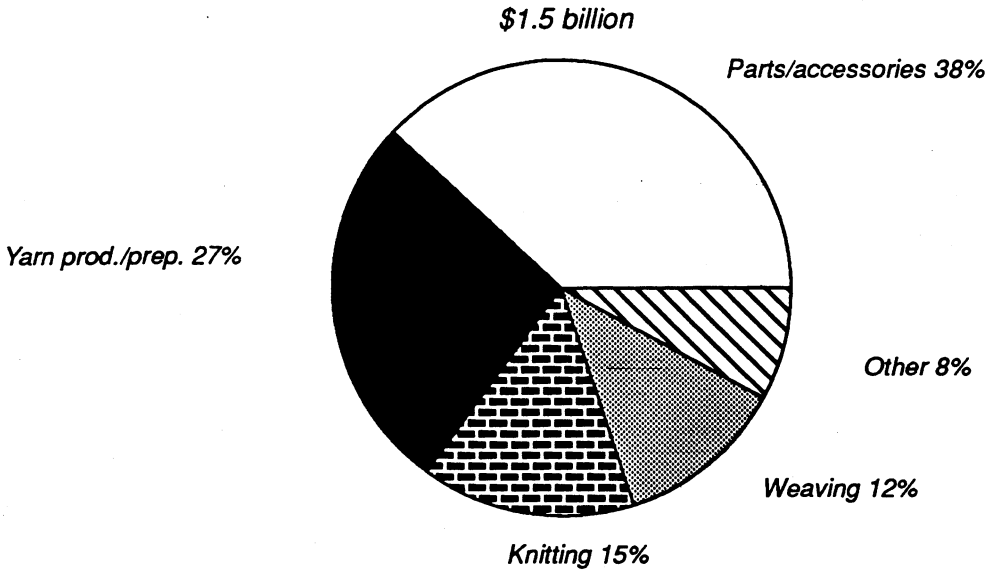
The United States has traditionally been one of the world's leading manufacturers of textile machinery and

[1]—*Continued*

(2) raschel—a versatile type of warp knitting made in plain and jacquard patterns; the latter can be made with intricate eyelet and lacy patterns and is often used for underwear fabrics. Raschel fabrics are coarser than other warp knit fabrics. (3) milanese—a type of run-resistant warp knitting with a diagonal rib effect using several sets of yarns.

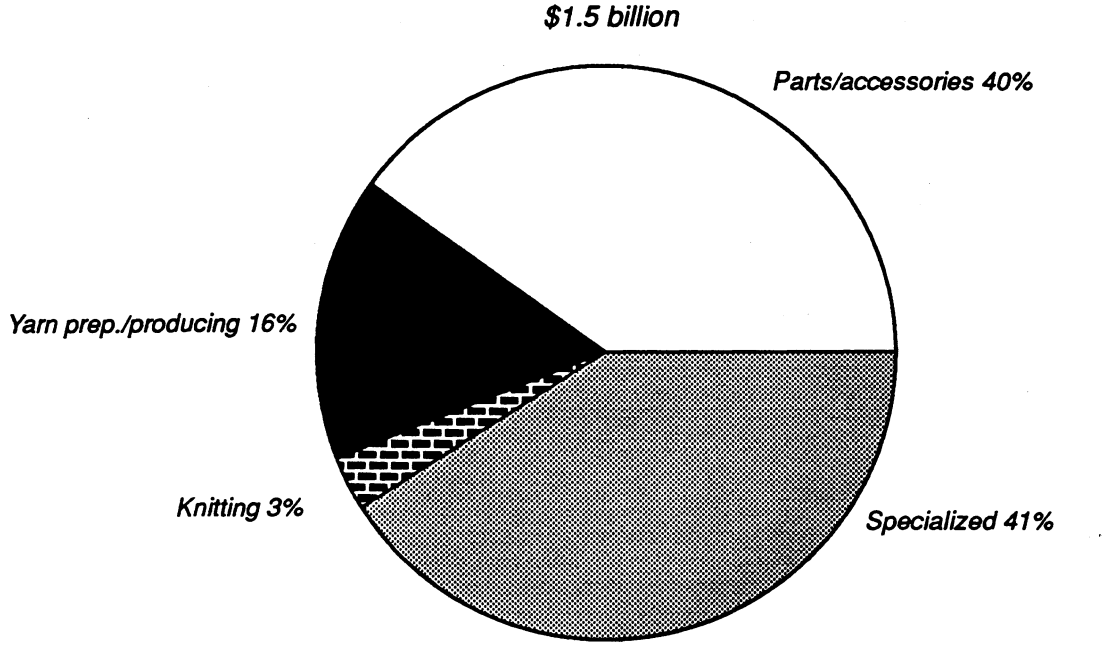
[2] Textile machinery and parts are classified under Standard Industrial Classification (SIC) categories 3552 (Textile Machinery), 3559 (Special Industry Machinery, Not Elsewhere Classified), 3569 (General Industrial Machinery and Equipment, Not Elsewhere Classified), and 3965 (Fasteners, Buttons, Needles, and Pins).

Figure 1
U.S. imports of textile machinery and parts, by major products, 1992



Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 2
U.S. shipments of textile machinery and parts, by major products, 1992



Source: Estimated by the staff of the U.S. International Trade Commission.

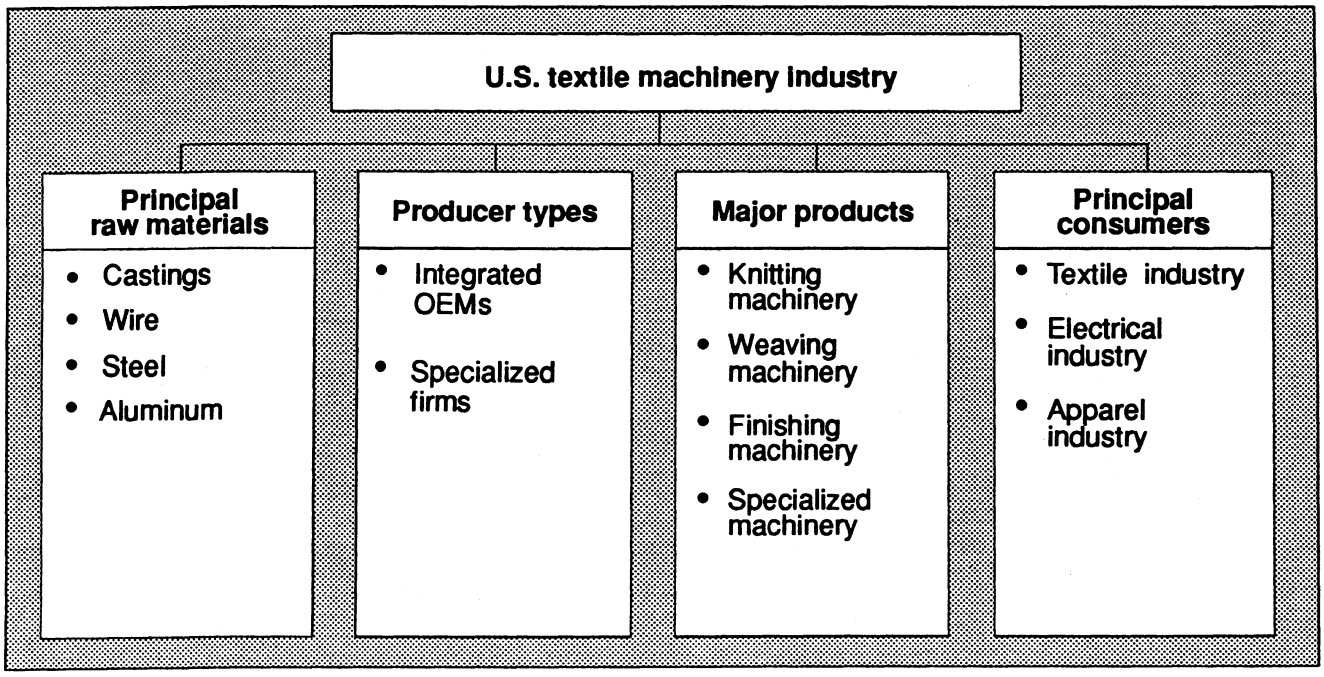
parts. The United States is also the largest single market for textile machinery and one of the three largest textile-manufacturing and parts and textile mills and apparel manufacturers. Secondary markets include wire, and electrical industries. The number of domestic producers of original-equipment machines, parts, and accessories participating in this industry declined from approximately 670 manufacturers in the 1980s to less than 500 in 1992. The industry is made up principally of small-to-medium sized companies employing less than 500 workers. Traditionally, the top 25 percent of the manufacturers of textile machinery account for more than 75 percent of the value of all shipments, with the four largest firms accounting for 35 percent of the total. The principal components, producer types, major products, and principal customers of the U.S. textile machinery, parts, and accessories industry are shown in figure 3.

Approximately 200 companies manufacture complete machines for the manufacture of textiles and apparel. Although a number of textile machinery manufacturers produce a variety of different products, original-equipment manufacturers tend to concentrate production in one or two types of machines. The production of specialized machinery and parts and accessories historically comprises a major proportion of total industry shipments, accounting for over 80 percent of the total value of shipments during 1992 (figure 2). The leading U.S. textile machinery producers in 1989 and their principal applicable products are shown in table 1.

Although textile machinery manufacturing facilities are located in 22 states, they are concentrated primarily in North Carolina, South Carolina, and Georgia. Employment in these states accounts for nearly 70 percent of industry employment. The trend in new plant location is toward the textile-producing states in the South, where the majority of domestic firms manufacturing textiles and apparel were located in 1992. According to U.S. Department of Commerce, total industry employment, as shown in the following tabulation, decreased by 5 percent during the 1988-92, whereas hourly earnings of production workers increased by 8 percent:

Year	Total	Production workers	Average hourly earnings of production workers
	—(1,000 employees)—		
1988	17.1	11.7	$9.87
1989	16.4	11.5	10.26
1990	16.0	11.0	10.85
1991	14.9	10.2	10.60
1992	14.5	10.0	10.70

Figure 3
U.S. textile machinery industry: Principal raw materials, producer types, major products, and principal consumers, 1992



Source: Compiled by the staff of the U.S. International Trade Commission.

Table 1
Textile machinery and parts: Leading U.S. producers, 1989

Company	Location	Machine/Product	1989 Sales	Employment
			Million dollars	*1,000 workers*
John Brown Inc.	West Warwick, RI	Weaving machines	210	2.0
John D. Hollingsworth	Greenville, SC	Carding, textile prep.; accessories	79	0.8
Platt Saco Lowell Corp.	Greenville, SC	Yarn prep. machinery	78	0.7
Steel Heddle Mfg. Co.	Greenville, SC	Weaving accessories	65	0.8
A.B. Carter, Inc.	Gastonia, NC	Yarn prep. machines	65	0.8
Monarch Knitting Machines	Flushing, NY	Knitting machines	50	0.4
	Monroe, NC	Knitting machines	40	0.3
Draper Corp.	Spartanburg, SC	Weaving machines	45	0.7
Gaston Country Dyeing Machine	Stanley, NC	Bleaching, dyeing, washing machines	35	0.5
Morrison Textile Machinery	Fort Lawn, SC	Finishing machines	35	0.2
Leesona Corp.	Burlington, NC	Yarn prep. machines	31	0.4
Precision Screen Machinery	Hawthorne, NJ	Textile machine parts	30	0.2
West Point Foundry	West Point, GA	Textile prep. machinery	22	0.1

Source: *Manufacturers USA*, 2nd ed., Detroit, Gale Research, Inc., p. 1271.

The degree of competitiveness among textile machinery manufacturers varies according to the particular machine category. Foreign manufacturers have been able to surpass domestic producers in terms of technological sophistication in several machinery areas. Foreign firms presently supply the bulk of all weaving and knitting, finishing, yarn-preparing, texturing, fiber production, and printing machines purchased by U.S. textile mills and apparel manufacturers. However, domestic textile mills still rely on U.S. machine manufacturers for dyeing and buffing machines, parts, and auxiliary equipment.

In recent years, various segments of this industry have upgraded the technological sophistication of their machinery by increasing operating speeds, versatility and precision, and by incorporating the latest advances in computerized systems and high-technology process controls. Firms producing warp-preparing, dyeing, tufting, and finishing machines were able to maintain their domestic market share and increase exports because of the modernization efforts. Overall, however, the industry reported that the majority of machinery producers failed to keep pace with the technological developments made by their foreign competitors. Domestic manufacturers have also increased funding for research and development, moving toward producing special machinery for niche markets where imports are not dominant, and adopted such programs as just-in-time manufacturing to reduce their production costs. Capital equipment expenditures in the industry range between 2.4 and 2.7 percent of shipments during 1987-90 (latest information available).

On January 30, 1992, HR 1461, the Textile Machinery Modernization Act of 1992, was introduced in the U.S. House of Representatives. This legislation would establish a fund administered by the Secretary of Commerce in conjunction with industry representatives to finance and promote research and the modernization of the U.S. textile machinery industry. The Textile Machinery Modernization Act of 1992 was introduced because the availability of research and development funds is crucial to the future viability of this industry in the United States. Funding for this program would be derived from import duties levied on imports of textile machinery. The fund would be limited to 10 percent, or $10 million of total textile machinery import duties, and would be raised without increasing import duties or restricting imports of textile machinery. The session ended before the enactment of this legislation.

The high cost of capital, raw materials (principally steel), and labor during the late 1980s placed U.S. manufacturers at a significant cost disadvantage compared with foreign suppliers. Throughout the 1980s, U.S. manufacturers of textile machinery maintained that major foreign competitors, especially those in Japan, had access to less expensive capital. The cost of capital[3] in the United States, during this

[3] The Federal Reserve Board defines the cost of capital as "the minimum before-tax rate of return that an investment project must generate in order to pay its financing costs after tax liabilities." See "Explaining International Difference in the Cost of Capital," *Federal Reserve Bank of New York Quarterly Review*, Summer 1989, pp. 7-27.

period, was far higher than in any other industrialized country. The after-tax cost of capital (the discount rate[4]) in the United States during 1987 was approximately 6 percent compared with 2.5 percent in Japan, 3.5 percent in the United Kingdom, and 2.5 percent in West Germany.[5] The differential in rates, according to U.S. industry officials, enabled Japanese and Western European firms to invest in projects that offered either negative or substantially lower rates of return than were possible in the United States. But, since that time, the discount rate (figure 4) in both Japan and Germany has risen, exceeding the levels in the United States and effectively eroding their one-time advantage. By the end of 1990, the discount rate in both Germany and Japan rose to nearly 6 percent, approaching the levels in the United States. One year later, the advantage completely reversed itself as the discount rate in the United States had dropped to 3.5 percent as opposed to 4.5 percent in Japan and 8 percent in Germany.

[4] The prime rate is a more appropriate interest rate for comparing capital costs in the United States with those in other countries. However, other countries, especially Japan, do not publish similar rates. Consequently, the discount rate offered by the central bank was used to measure differences in the level of interest rates in the United States, Japan, and Germany.

[5] "How Capital Costs Cripple America," *Fortune*, Aug. 14, 1989, pp. 50-53.

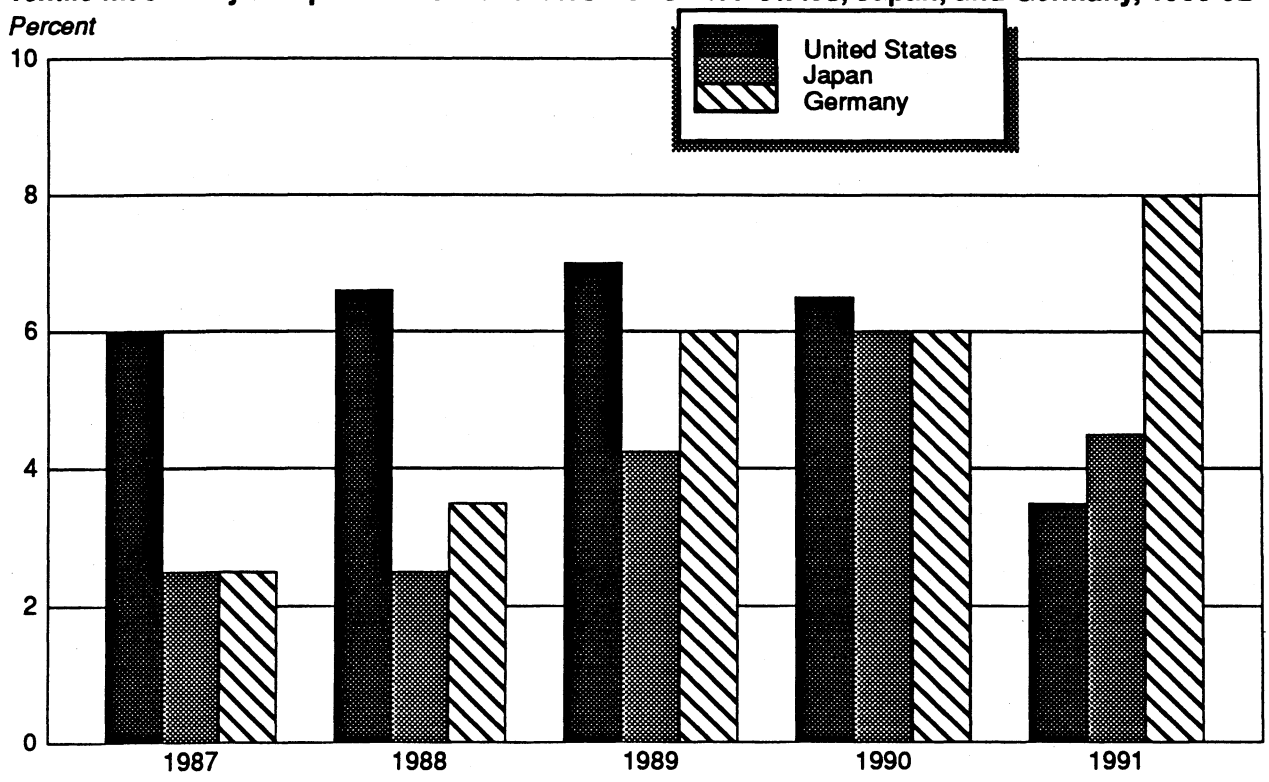
Marketing Methods

Direct sales presentations, including trade show promotions, are used by textile machinery and parts manufacturers as the primary method of marketing their products. Local, regional, and international trade shows are utilized by foreign and domestic manufacturers to present their latest lines of equipment, and orders are frequently taken in such fora. The vast majority of all textile machinery and parts are sold directly to the end user (the textile mill). Both U.S. and foreign machinery manufacturers will deliver, install, and service their products. Although most original-equipment manufacturers stock spare parts for their machinery, many use distributors to market these products. Sales agents are employed by textile machinery manufacturers to sell their products in foreign markets. Sales agents often have the exclusive right to sell the products of their principal manufacturers and often set the terms of sale and the selling price to potential customers.

Consumer Characteristics and Factors Affecting Demand

Textile mills and apparel manufacturers are the primary market for textile machinery and parts. Although the U.S. textile and apparel industries are located nationwide, they are concentrated primarily in

Figure 4
Textile machinery and parts: Discount rates[1] for United States, Japan, and Germany, 1988-92



[1] Rate represents end 4th quarter rate.
Source: International Monetary Fund 1992.

the South Atlantic States of Georgia, North Carolina, and South Carolina. Price is one of the primary factors affecting demand for textile machinery. Nonprice factors that influence purchasing decisions by textile mills and apparel manufacturers include: quality, performance, versatility, distribution channels, reliability, technology (automation), the availability of parts, brand loyalty, operating and maintenance costs, and after-sales service and assistance.

U.S. Subsidiaries of Foreign Firms

During the 1980s, many foreign manufacturers, responding to the high shipping costs, established sales, distribution, and service centers, and wholly owned manufacturing facilities in the United States. Swiss and German manufacturers, such as Sulzer, Maschinenfabrik Rieter, Barmag Barmer, and Treutzschler, have taken the lead in establishing production and assembly facilities in the United States. These firms tend to concentrate in the production of weaving, knitting, and spinning machinery. These facilities produce machinery for the U.S. market and for export to Central and South America.

FOREIGN INDUSTRY PROFILE

Traditionally, Germany, Switzerland, Italy, and Japan have been the world's major producers of textile machinery and parts outside the United States. These countries manufacture textile machines for their own markets and for export. Textile machinery manufactured in the European Community (EC) (particularly in Germany and Italy), Switzerland, and Japan are among the world's most technically sophisticated equipment, employing the latest technological advances. Leading German, Japanese, Italian, and Swiss textile machinery manufacturing firms are listed in the tabulation:

Leading foreign manufacturers	Product
Germany:	
Schlafhorst[1]	Spinning/winding
Karl Mayer	Warp knitting
Lindauer Dornier	Weaving
Karl Mayer	Knitting
Switzerland:	
Sulzer Rudi	Weaving machines
Rieter	Spinning/winding
Jacob Muller	Weaving
Zellweger Uster	Textile electronics
Saurer	Weaving
Japan:	
Murata	Spinning/winding
Nissan	Weaving
Toyota	Spinning/weaving
Tsudakoma	Weaving
Shima Seiki	Knitting
Italy:	
Somet	Weaving
Vamatex	Weaving
Pignin	Weaving
Savio Group	Knitting

[1] In July of 1990, the Swiss Saurer Group purchased Schlafhorst AG based in Monchengladback, Germany. The purchase of Schlafhorst AG, the world's leading producer of spinning and winding machinery, also included Zinger Textilmaschinen and American Schlafhorst (Charlotte, NC).

Western Europe[6]

During 1989, there were approximately 1,100 firms producing textile machinery and parts in the EC.[7] Textile machinery production in the EC is dominated by Germany and Italy. These two nations accounted for the largest concentration of manufacturing firms, nearly 78 percent of the value of the EC's total shipments of textile machinery and parts during 1989 (figure 5).

As shown in the following tabulation, the value of total EC shipments of textile machinery and parts increased from $8.5 billion (7.4 billion ECU) in 1987 to $10.4 billion (8.6 billion ECU) in 1989 (million dollars):

Item	1987	1988	1989
Shipments	8,540	9,398	10,400
Apparent consumption	5,140	5,765	NA
Net exports	3,378	3,633	NA
Exports extra-EC	4,844	5,265	NA
Imports extra-EC	1,542	1,733	NA
Imports intra-EC	2,534	2,787	NA

[6] Leading European textile machinery manufacturers include Switzerland, Germany, and Italy. Discussion in this section will be limited to EC countries principally because comparable data for Switzerland are not available.

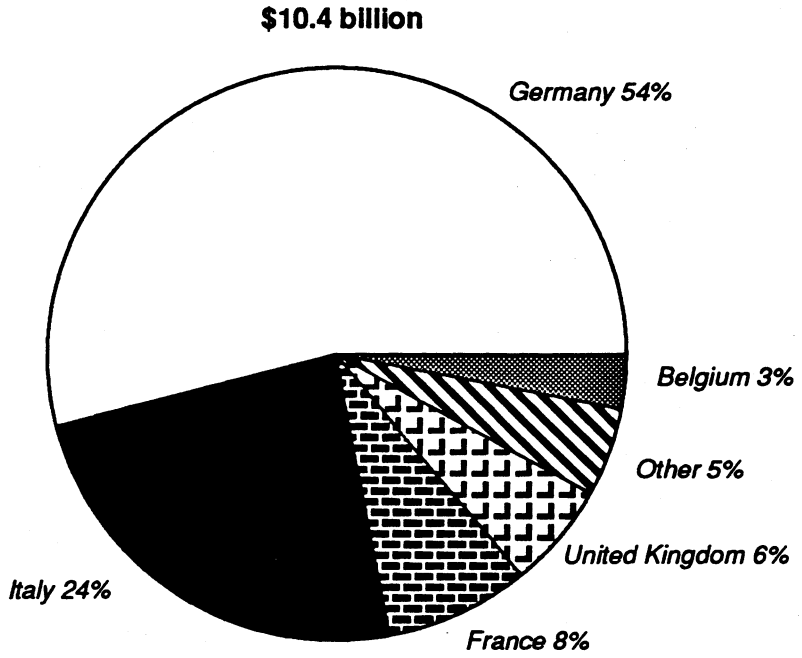
[7] Commission of the European Communities, *Panorama of EC Industries 1990*, p. 10-26.

EC imports and net exports totaled $1.7 billion and $3.6 billion, respectively, during 1988. Switzerland and the United States are the principal sources of imports.

The textile machinery industry is one of the EC's most export oriented industrial sectors. EC manufacturers produced approximately 70 percent of their machinery for export during 1986. In 1989, the EC accounted for approximately 55 percent of the world's total exports. Important foreign markets for EC textile machinery manufacturers include the United States, newly industrialized nations, and certain developing countries. Leading Swiss and EC manufacturers have established wholly-owned production facilities or joint ventures in the United States to serve the North American and Latin American markets. In recent years, these same European manufacturers have also entered into similar arrangements in the Far East to better serve that market. Expansion efforts in the Far Eastern and newly industrialized markets have been frustrated by exchange rate fluctuations and by the emergence of competing local textile machinery manufacturers.

Germany and Italy are the EC's leading textile machinery manufacturing countries. In 1990, the German textile machinery industry consisted of 400 manufacturers employing approximately 46,000 workers. German textile machinery shipments totalled $4.1 billion (DM7.6 billion) in 1989 and $5.1 billion (DM8.3 billion) in 1990. German manufacturers

Figure 5
EC textile machinery shipments, 1989



Source: Panarama of EC industries.

specialized in the production of spinning, weaving and knitting, and dyeing and finishing machinery. Exports accounted for approximately 87 percent (DM7.3 billion) of Germany's shipments in 1990. Germany exported textile machinery to over 130 nations during 1990. However, leading export markets included the United States (13 percent), the EC (17 percent), Turkey (6 percent), and Indonesia (5 percent). The following tabulation presents an estimate of Germany's exports of textile machines during 1990 (million dollars):

Product	1990
Spinning machines	1,195
Weaving machines	658
Hosiery and knitting machines	599
Dyeing & finishing machines	845
Accessories, parts, other machinery	1,221
Total	4,518

Italy's shipments of textile machinery increased from $2.1 billion (1.6 billion ECU) in 1987 to $2.4 billion (2 billion ECU) in 1989. Italy's textile machinery industry consisted of approximately 350 highly labor-intensive manufacturers, producing a wide variety of machinery. During 1990, Italy shipped approximately 28 percent of its textile machinery exports to the EC, 24 percent to Asia and Australia, 12 percent to Eastern Europe, and 12 percent to North America. The following tabulation presents an estimate of Italy's exports of textile machines during 1987-90 (million dollars):

Product	1987	1988	1989	1990
Spinning machines	439	503	583	615
Weaving machines	312	416	419	442
Knitting machines	333	370	457	485
Finishing machines	333	333	286	369
Other machinery	NA	NA	31	59
Total	1,417	1,622	1,776	1,970

The large German, Italian, and Swiss firms tend to be vertically integrated, performing the complete production process internally. Machinery producers in these countries, in contrast to U.S. producers, tend to manufacture a broad line of machinery. In recent years, there has been a significant degree of restructuring. In Germany, for instance, there has been a trend toward consolidation, with small companies merging with larger firms to gain size and economies of scale.

Japan

There are approximately 103 companies manufacturing textile machinery and parts and accessories in Japan. The majority of these firms are small-to medium-sized companies employing less than 300 employees. Japanese manufacturers specialize in such areas as textile and yarn preparatory machinery; spinning machinery; weaving and knitting machinery; dyeing and finishing machinery; and parts and accessories. Like their major EC competitors, Japanese manufacturers also produce principally for export. More than 82 percent of Japanese shipments were exported during 1989.[8] Major export markets for Japanese textile machinery during 1988 were Asia (58 percent), Western Europe (14 percent), North America (12 percent), and the former Communist Bloc (10 percent). Japanese export shipments to North America consisted principally of spinning machines, preparatory machines, knitting machines, and parts and accessories. Japanese shipments, imports, and exports of textile machinery and parts and accessories are presented in the table 2.

Japanese producers have moved to the use of computer controls, factory automation (FA), computer-aided design (CAD), computer-aided manufacturing (CAM), intelligent manufacturing systems (IMS), and other technologies to reduce labor costs, streamline the production process, and to increase product speed, reliability, and precision.[9] The

[8] Various issues of *Digest of Japanese Industry & Technology.*

[9] "Trends of the Textile Machinery Industry in Japan," *Digest of Japanese Industry & Technology*, No. 256/1990, p. 3-11.

Table 2
Japanese textile machinery and parts: Japanese production, imports, and exports, 1989

Product	Production	Imports	Exports
	(Million dollars)		
Chemical fiber machinery	196.7	11.8	101.4
Spinning machinery	596.4	29.2	488.8
Preparatory machinery	744.9	11.8	474.9
Weaving machinery	587.0	48.2	386.5
Knitting machinery	419.2	34.8	466.0
Dyeing/finishing machines	311.2	46.0	192.3
Miscellaneous machinery	32.1	43.2	23.6
Parts and accessories	106.2	118.9	328.0
Total	2,993.7	343.9	2,461.5

Source: Data derived from various issues of *Digest of Japanese Industry & Technology.*

traditional Japanese emphasis on less sophisticated machinery has given way in recent years to an emphasis on quality and high value-added. Japanese manufacturers also have developed a reputation in foreign markets for working closely with foreign customers to tailor their machinery to the exact specifications of each textile mill. During the 1986-89 period, the number of production workers employed by this industry in Japan declined from 11,710 to 11,245.

U.S. TRADE MEASURES

The appropriate provisions of the *Harmonized Tariff Schedule of the United States* (HTS) applicable to textile machinery and parts are shown in B-4. Table B-4 provides the 1993 column 1 rates of duty, preferential rates of duty, and U.S. exports and imports for 1992 for each 8-digit HTS subheading covering textile machinery and parts. The aggregate trade-weighted-average rate of duty for these products, based on 1992 data, was 4.2 percent ad valorem, including U.S. imports entering duty-free under preferential tariff programs. In 1993, the most-favored-nation (MFN) rates of duty for textile machinery and parts range from free to 10 percent ad valorem.

Approximately 20 percent of U.S. imports of textile machinery and parts entered the United States duty-free in 1992. The preponderance (99 percent) of duty-free imports entered under temporary duty-free provisions provided for in subchapter II of Chapter 99 of the HTS.[10] Governed by this provision, column 1 general duty rates were suspended on a temporary basis, at the request of the U.S. Congress because these products were not produced in the United States. The remainder entered duty-free under the Generalized System of Preferences (GSP) and Caribbean Basin Economic Recovery Act (CBERA), and at reduced rates under tariff item 9802.00.80 and the United States-Canada Free-Trade Agreement. There are no significant nontariff barriers to U.S. imports of textile machines and parts.

FOREIGN TRADE MEASURES

Tariff Measures

Foreign manufacturers are subject to lower tariff rates on machinery shipped to the United States than those faced by U.S. producers exporting textile machinery to many parts of the world, especially to Western Europe. Foreign manufacturers face an average U.S. tariff rate of 4.2 percent ad valorem compared with an average rate of 12.5 percent for EC countries, 10 percent for Mexico, and 5 percent for Brazil. Textile machinery and parts and accessories can presently enter Japan duty free. Most of the items covered by this summary enter Canada from the United States duty free as part of the United States-Canada Free-Trade Agreement.

[10] See table B-4.

In third world nations, tariffs can be as high as 200 percent. However, many third world nations reduced tariff rates on certain imported items during the late 1980s to promote more internationally competitive industries at home. High tariffs and taxes were the principal elements limiting access of U.S. textile machinery exports to many South American countries. However, during 1989-92, many of these nations began to liberalize their trade regimes permitting the importation of newer, more advanced machinery.

As an example, until 1990, local manufacturers in Brazil possessed a virtual monopoly in the Brazilian market because of legislation banning imports. Imports were restricted by the "Law of Similars" that prohibited the importation of merchandise similar to that produced in Brazil. Effective January 30, 1990, the Brazilian Government (Executive Secretary of the Brazilian Customs Policy Commission) reduced import duties on certain categories of textile machinery (including parts and computerized machinery) from an average of 40 percent ad valorem to only 5 percent ad valorem. The announced duty reduction covered 30 different types of machines and their parts including: carding, combing, spinning, twisting, knitting, weaving, dyeing, cutting, reeling, piling, and industrial sewing machines. The tariff reduction applied only to those machines and parts not produced in Brazil and includes a number of automated and advanced-technology equipment. Duties on equipment not included under the January 1990 tariff-reduction measure have recently been reduced from 40 percent to 20-25 percent.

In contrast to Brazil, the Government of Argentina recently raised import duties on textile machinery. In October 1992, the Argentine Government issued Resolution 432/91 that increased the top tariff rate on imported capital goods from 22 to 35 percent ad valorem for machinery similar to that produced domestically, and from free to 5 percent for machinery not produced in Argentina. In 1989, under Resolution 324, the Argentine Government eliminated the import duties on certain textile machinery not produced in Argentina. At the same time, the Government also waived duties under Decrees 571 and 515 on certain machinery imported for Government-sponsored projects.[11]

Nontariff Measures

Historically, many third world nations initiated policies to reduce their reliance on imports, including textile machinery, and to develop domestic industries to conserve foreign exchange reserves. Import restrictions have been placed on almost all nonessential imports. These governments generally would require mandatory import licenses for all imported goods and maintain prohibited imports lists, import quotas, import performance requirements, and domestic content requirements as means of curbing imports. In recent years, however, many governments have embarked on programs to modernize and revive their economies by

[11] U.S. Department of Commerce, U.S. Embassy, Buenos Aires, *Argentina-Commercial Activities Report '90*, 1992.

opening markets to limited foreign investment and imports. Many of these nations have announced new industrial policies terminating programs shielding domestic industries from import competition.

U.S. MARKET

Consumption

Apparent U.S. consumption of textile machinery and parts declined from approximately $2.45 billion in 1988 to $2.35 billion in 1992, representing a decrease of less than 5 percent (table 3). The U.S. textile and apparel industries, the primary consumers of textile machines, enjoyed record levels of production and sales during 1986-89. Consequently, demand for new and replacement machinery also increased. The increase in apparent consumption during 1990-92 can also be related to more aggressive marketing by U.S. manufacturers and to efforts by U.S. machinery manufacturers to produce technologically competitive machinery. The ratio of U.S. imports to consumption remained high during 1988-92, ranging from 60 percent to 66 percent. Foreign suppliers dominate the U.S. market for spinning, weaving, and knitting machinery.

According to major foreign machinery producers, demand for new textile machinery in the United States began to decline during 1990. Responding to recessionary pressures and declines in consumer demand for textiles and apparel, the U.S. textile industry suffered its worst decline in over 15 years.[12] During 1990-91, domestic consumption consisted principally of replacement machinery and upgrades of existing machinery instead of expansion.

Shipments

The value of U.S. shipments of textile machinery and parts increased by only 1 percent, from $1.49 billion in 1988 to $1.51 billion in 1992 (figure 6). The bulk of U.S. shipments during this period consisted of parts, accessories, and specialized machinery. Trends in domestic shipments of textile machinery tend to parallel the output of the U.S. textile and apparel industry and the demand from major export markets.

Although the value of U.S. shipments increased during 1988-92, the value of domestic shipments (shipments minus exports) actually declined during 1988-92 from $985 million to $846 million. Whereas U.S. shipments of textile machinery were partially aided by a surge in sales output by domestic textile and apparel producers during 1987-89, most of the growth in the value of total U.S. shipments can be attributed directly to an increase in exports. In 1989, both the U.S. textile machinery and the U.S. textile and apparel industries recorded peak levels of sales and output.

In 1990, domestic demand for textile machinery lagged even further as textile and apparel mills cut back on their purchases of new machinery in response to high levels of debt associated with leveraged buyouts in the textile and apparel industry and with a recession that reduced the demand for apparel and textiles.[13] In 1990, the U.S. textile industry reported its lowest after tax profit margin in the last 50 years at 0.8 percent.

Although textile machinery is a commodity product that competes principally on price and technological sophistication, certain special-application machinery can be expensive to develop and produce. Therefore, a slight decline in price can shift purchases away from one source to another. To remain competitive in U.S. and foreign markets, many U.S. producers have become more aggressive in marketing their products. To become more price competitive with imports, domestic manufacturers have also increased funding for research and development, moved toward producing machinery for special niches where imports are not dominant, adopted such programs as just-in-time manufacturing, and increased productivity and efficiency while reducing production costs.

U.S. Imports

Since the late 1970s, imports have accounted for 50 to 66 percent of the value of apparent U.S. consumption of the U.S. market for textile machinery. U.S. producers indicate that cost disadvantages and lags in the development and incorporation of new technologies have made it difficult for domestic manufacturers to compete effectively with European

[12] "West German machine-builder reports," *Textile Asia*, Oct. 1990, p. 183.

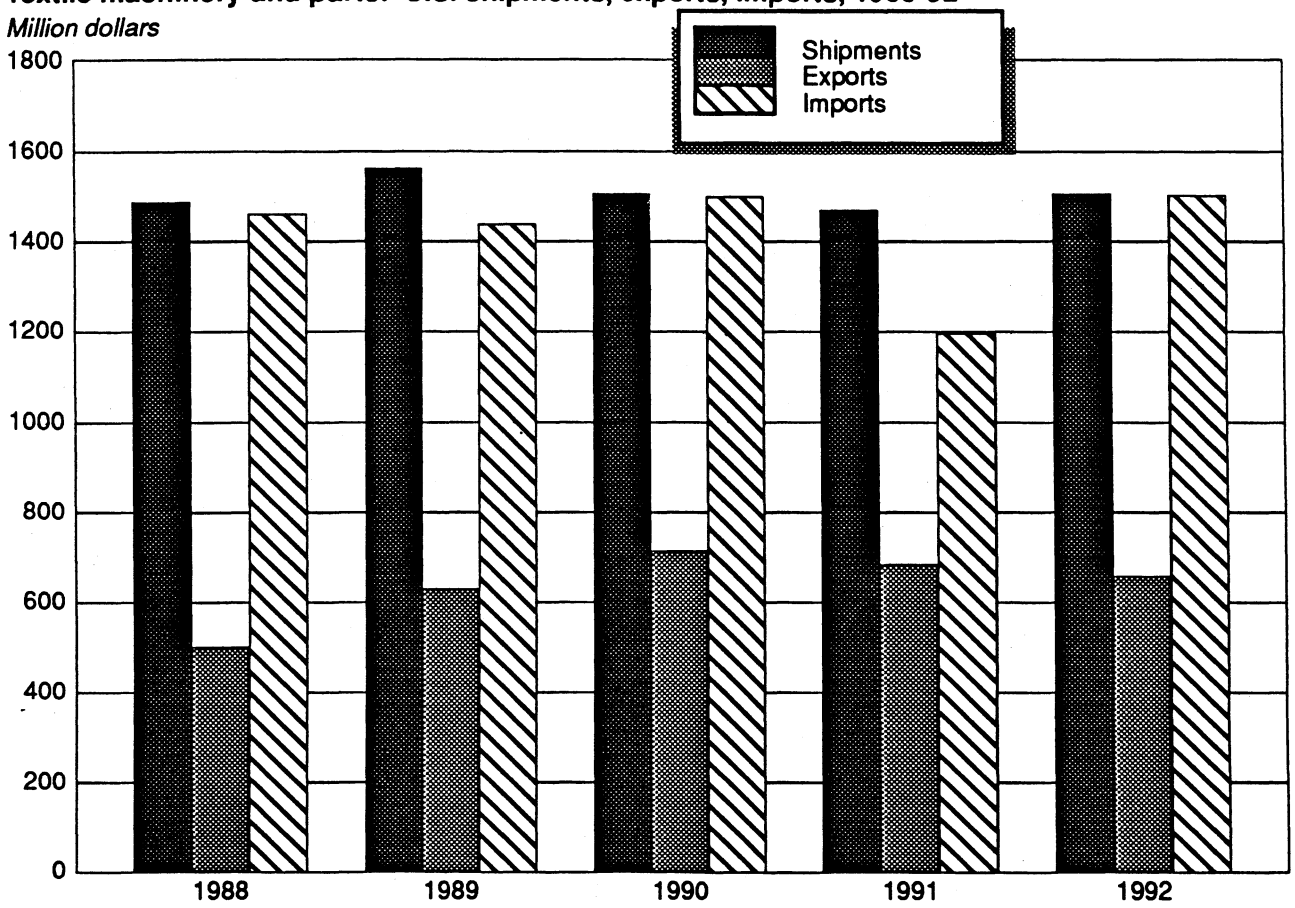
[13] "The textile industry is looking threadbare," *Business Week*, Sept. 16, 1992, p. 114.

Table 3
Textile machinery and parts: U.S. shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1988-92

Year	U.S. shipments	U.S. exports	U.S. imports	Apparent U.S. consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1988	1,487	502	1,461	2,446	59.7
1989	1,561	630	1,439	2,370	60.7
1990	1,505	716	1,499	2,288	65.5
1991	1,470	685	1,196	1,981	60.4
1992	1,505	659	1,502	2,348	64.0

Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 6
Textile machinery and parts: U.S. shipments, exports, imports, 1988-92



Source: Compiled from official statistics of the U.S. Department of Commerce.

and Japanese textile machine manufacturers.[14] Consequently, foreign manufacturers have been able to supplant U.S. producers in several important machinery categories. Foreign manufacturers now provide the bulk of all weaving, knitting, finishing, yarn-preparing, texturing, fiber producing, and printing machines consumed in the U.S. market. As presented in figure 1, yarn-preparing and producing machines and textile machinery parts and accessories constituted the two single largest import categories in 1992. Imports of these two groupings accounted for 27 and 38 percent, respectively, of the value of total U.S. textile machinery imports.

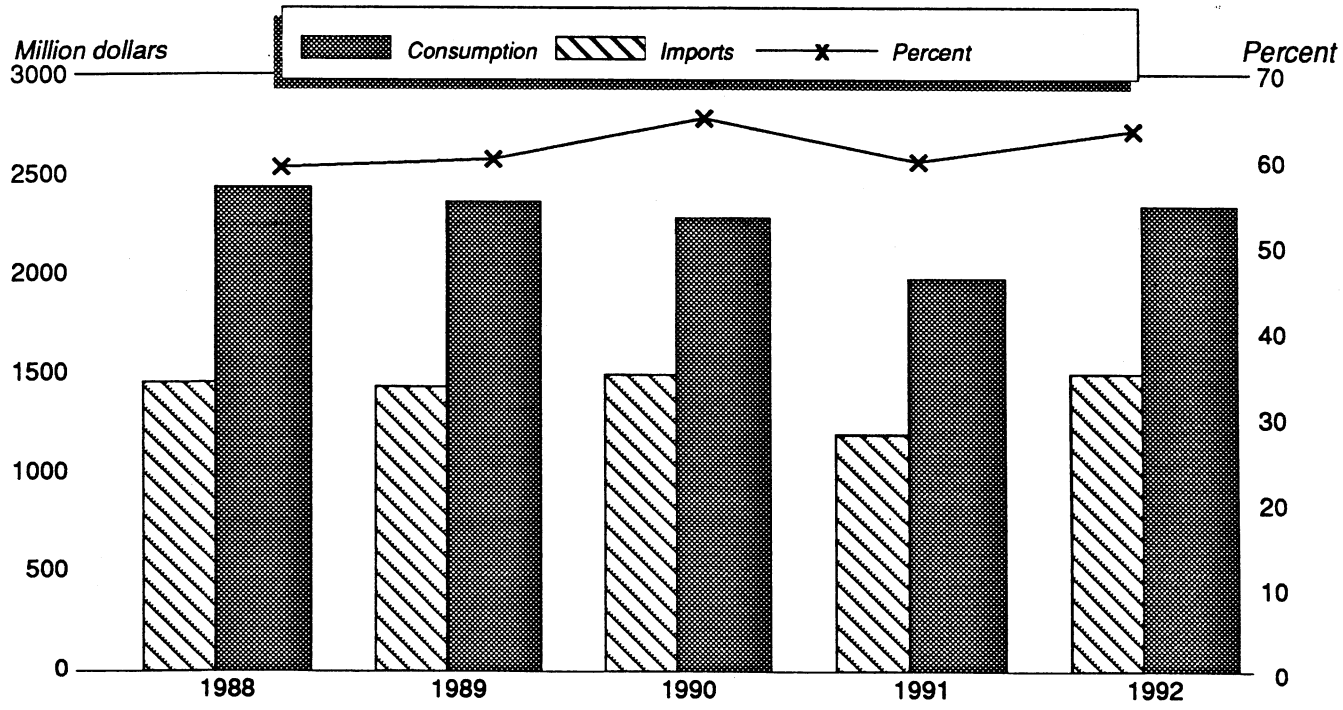
U.S. imports of textile machines and parts increased from $1.46 billion in 1988 to $1.50 billion in 1992, or by less than 3 percent (figure 7). The decline in the value of the U.S. dollar, relative to the value of currencies of major competitors, resulted in more expensive imports and in the creation of more price competitive U.S. products. As a result, imports as a percentage of apparent consumption declined from 66 percent in 1990 to 64 percent in 1992.

The top four suppliers of U.S. imports of textile machinery and parts are Germany, Japan, Italy, and Switzerland (figure 8).[15] These countries accounted for 82 percent of the value of total U.S. imports during 1992. Although there were no significant changes in the top suppliers during 1988-92, the order of importance of the top four did change slightly. Germany has traditionally been the chief source of U.S. imports, accounting for 38 percent of total U.S. imports in 1988 and 41 percent in 1992. Imports from Germany consisted principally of spinning, twisting, reeling and winding, weaving, and fabric preparatory machines, and parts for fabric and yarn preparatory machines. The principal importers of textile machinery are U.S. textile machinery manufacturers looking to supplement their product lines, U.S. based subsidiaries of foreign producers, sales agents, and privately held importing companies.

[14] American Textile Machinery Association, *Toward Equity in International Trade*, 1987.

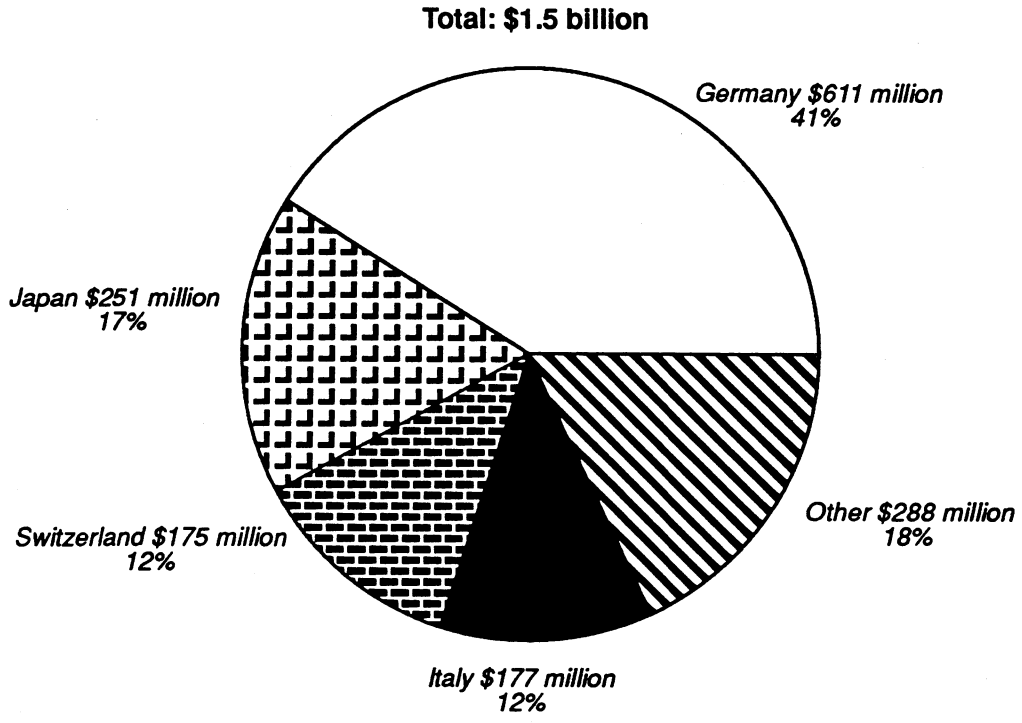
[15] See table B-3.

Figure 7
Textile machinery and parts: Trends in U.S. imports and apparent consumption, 1988-92



Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 8
Textile machinery and parts: U.S. imports, by sources, 1992



Source: Compiled from official statistics of the U.S. Department of Commerce.

FOREIGN MARKETS

Foreign Market Profile

Although U.S. textile machinery manufacturers export to all regions of the globe, Europe and Asia have traditionally been the largest regional markets. In recent years, the Asian market has become the world's most important market for textile machines. As exhibited in the following tabulation, the Asian market accounted for approximately 49 percent of cumulative world shipments of weaving and spinning machines during the 1981-90 period:

Region	Weaving machines	Percent of total
	(1,000 units)	
Africa	21	3
North America	49	8
South America	18	3
Western Europe	108	17
Asia	356	57
All other	75	12
Total	627	100

Region	Spinning machines	Percent of total
	(1,000 units)	
Africa	2,021	5
North America	2,482	7
South America	2,183	6
Western Europe	5,831	15
Asia	19,072	49
All other	7,040	18
Total	38,629	100

The textile and apparel industries in many Asian nations are the leading earners of foreign exchange. In China, the textile and apparel industry earned more than $6 billion in 1990 and $9 billion in 1992 from exports. Yet, much of the equipment in China's textile and apparel mills is considered to be antiquated and outdated. Industry experts estimate that nearly 200,000 of China's 800,000 weaving machines are obsolete and need to be replaced by newer and more technologically sophisticated machinery. In 1992, the Chinese Government announced that it would allocate nearly $1.2 billion to improve Chinese production techniques and purchase technologically sophisticated foreign-made machinery.

Conversely, Indonesia's textile and apparel mills, driven by expanding level of disposable incomes by its consumers, introduced a program in late 1988 to modernize its textile machinery through imports. Since that time, Indonesia has established itself as one of the world's leading manufacturers of polyester filament fibers. Indonesia continues to welcome both domestic and foreign investment in its textile industry. During the first 6 months of 1990, Indonesia imported approximately $190 million in textile machinery from Japan.[16] Indonesia was expected to import approximately 5,000 weaving machines and 1.2 million spindles in 1992. The Asian market, particularly China and Indonesia, has also become important to U.S. textile machinery manufacturers. U.S. exports of textile machinery to the Asian market grew by nearly 48 percent during the 1987-90 period, accounting for 31 percent of total U.S. textile machinery exports in 1990.

U.S. exports

During the 1960s and 1970s, most U.S. producers manufactured textile machinery and parts principally for the U.S. market, the world's largest single market for textile machines. Today, however, U.S. manufacturers are exploring foreign markets more aggressively than at any other time in their history. U.S. exports have grown from 34 percent of the value of total U.S. shipments in 1988 to 44 percent in 1992, and Asia has become the most important foreign market for U.S. textile machinery suppliers, as the following tabulation shows (in percent):

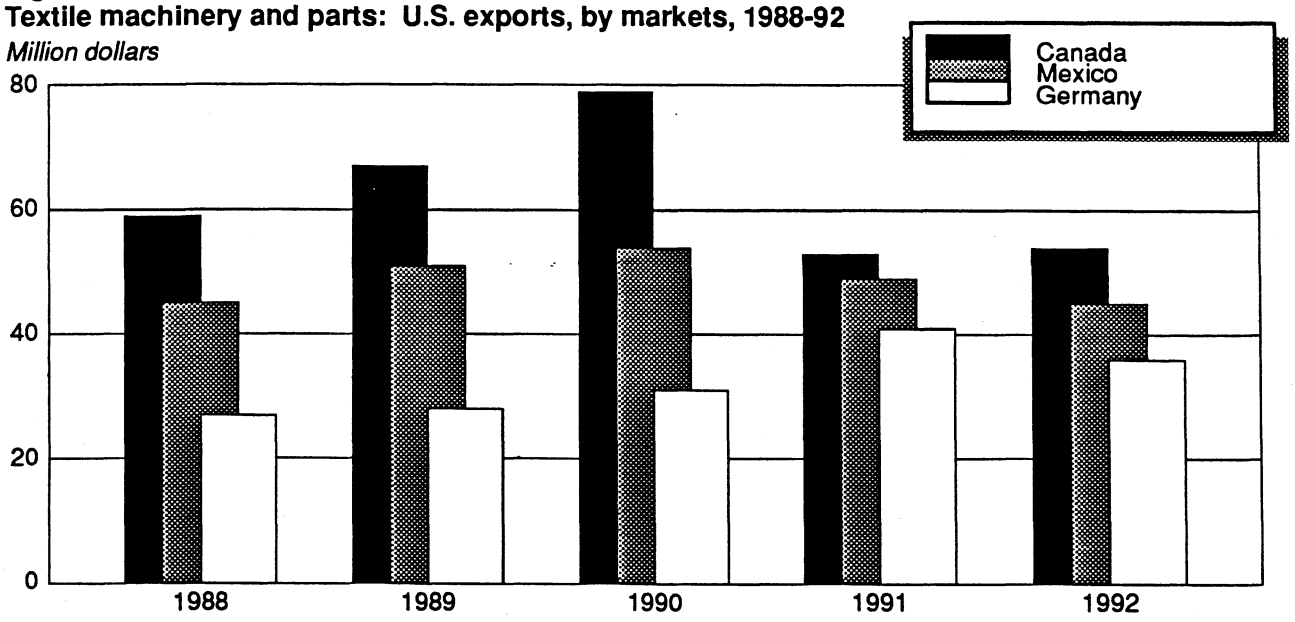
Region	1988	1992
Africa - Middle East	4.0	6.4
Latin America - Caribbean	18.2	12.9
Asia	21.3	31.2
Europe	32.5	30.1
North America	18.0	15.4
All other	6.0	4.0
Total	100.0	100.0

U.S. exports of textile machines and parts increased from $502 million in 1988 to $659 million in 1992, an increase of 31 percent (table B-2). The largest single category of U.S. exports consisted of yarn preparatory and producing machinery that accounted for 33 percent of total U.S. textile machinery exports during 1992. The leading foreign markets for U.S. exports of textile machines and parts in 1992 were Canada, Mexico, Japan, and Germany (figure 9). Historically, Canada has been the leading foreign market for U.S. exports of textile machines and parts. Canada's share of total U.S. exports of textile machines and parts declined from 11 percent of the total in 1989 to 8 percent in 1992. As Canada's dominance declined, Argentina and other third world countries emerged as important export markets.

The principal factors affecting U.S. export demand and competitiveness in these markets are the improvement in the technological sophistication of certain U.S. exports; exchange rate fluctuations that made U.S. machinery more price competitive; the continued ability of domestic producers of specialized machines, parts, and accessories to produce competitive products; and a general global expansion in demand for textile machinery.

[16] "Indonesian textile industry", *Japan Textile News*, June 1992, p. 108.

Figure 9
Textile machinery and parts: U.S. exports, by markets, 1988-92

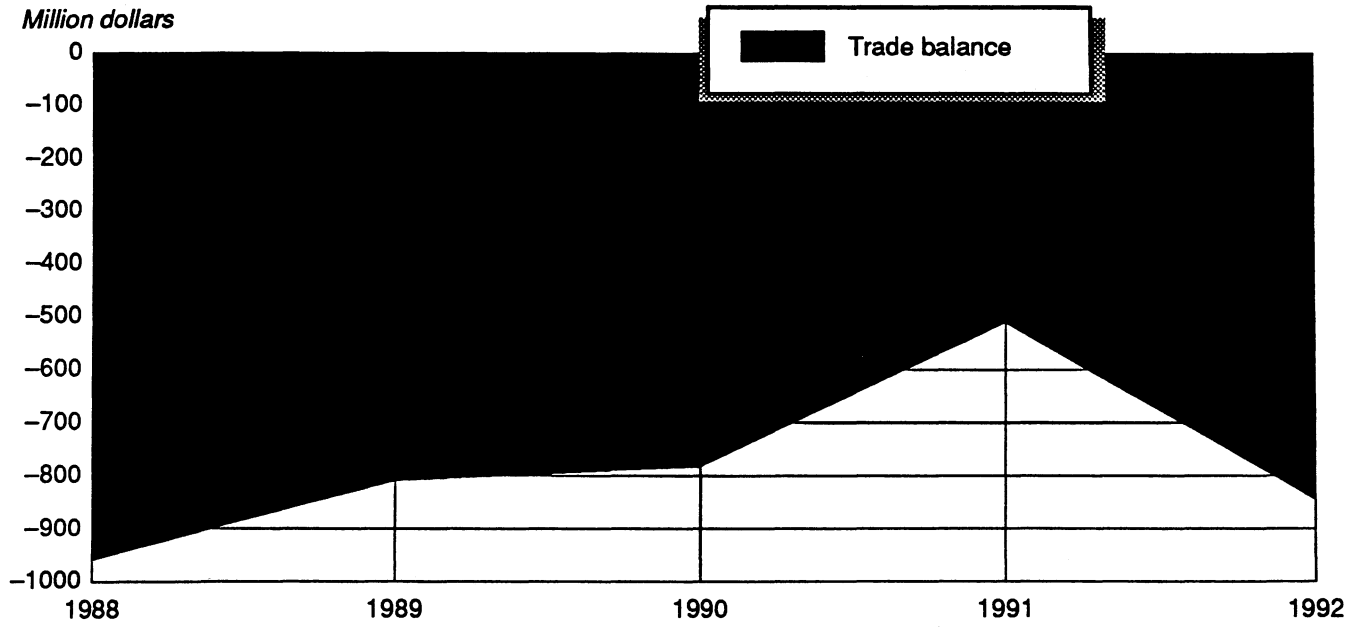


Source: Compiled from official statistics of the U.S. Department of Commerce.

U.S. TRADE BALANCE

Although the United States experienced a trade deficit in textile machinery over the 1988-92 period, the negative trade balance improved markedly during 1988-91 because of efforts by U.S. manufacturers to aggressively market their products in foreign markets and because of a more favorable dollar exchange rate that made imports more expensive (figure 10). However, foreign manufacturers offering technically sophisticated machinery at competitive prices have been able to supplant domestic producers in many important machinery categories. During 1988-91, the trade deficit decreased from $959 million to $511 million, but then increased to $843 million in 1992 (table B-3). The trade deficit has remained high because of large shipments from Germany, Japan, Italy, and Switzerland of products not produced in the United States.

Figure 10
Textile machinery and parts: U.S. trade balance, 1988-92



Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX A
EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

TARIFF AND TRADE AGREEMENT TERMS

The ***Harmonized Tariff Schedule of the United States*** (HTS) replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989. Chapters 1 through 97 are based upon the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description, with additional U.S. product subdivisions at the 8-digit level. Chapters 98 and 99 contain special U.S. classification provisions and temporary rate provisions, respectively.

Rates of duty in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates; for the most part, they represent the final concession rate from the Tokyo Round of Multilateral Trade Negotiations. Column 1-general duty rates are applicable to imported goods from all countries except those enumerated in general note 3(b) to the HTS, whose products are dutied at the rates set forth in ***column 2***. Goods from Armenia, Bulgaria, the People's Republic of China, Czechoslovakia, Estonia, Hungary, Kyrgyzstan, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, the Ukraine and Yugoslavia are currently eligible for MFN treatment. Among articles dutiable at column 1-general rates, particular products of enumerated countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS column 1. Where eligibility for special tariff treatment is not claimed or established, goods are dutiable at column 1-general rates

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 and renewed in the Trade and Tariff Act of 1984, applies to merchandise imported on or after January 1, 1976 and before July 4, 1993. Indicated by the symbol "A" or "A*" in the special subcolumn of column 1, the GSP provides duty-free entry to eligible articles the product of and imported directly from designated beneficiary developing countries, as set forth in general note 3(c)(ii) to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984; this tariff preference program has no expiration date. Indicated by the symbol "E" or "E*" in the special subcolumn of column 1, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 3(c)(v) to the HTS.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 3(c)(vi) of the HTS. Where no rate of duty is provided for products of Israel in the special subcolumn for a particular provision, the rate of duty in the general subcolumn of column 1 applies.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "CA" are applicable to eligible goods originating in the territory of Canada under the ***United States-Canada Free-Trade Agreement*** (CFTA), as provided in general note 3(c)(vii) to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn of column 1 followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted in title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 3(c)(ix) to the HTS.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), goods covered by the ***Automotive Products Trade Act*** (APTA) (general note 3(c)(iii))

and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 3(c)(iv)), and ***articles imported from freely associated states*** (general note 3(c)(viii)).

The ***General Agreement on Tariffs and Trade*** (GATT) (61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786) is the multilateral agreement setting forth basic principles governing international trade among its more than 90 signatories. The GATT's main obligations relate to most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products; the GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, and other measures. Results of GATT-sponsored multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as Schedule XX.

Officially known as "The Arrangement Regarding International Trade in Textiles," the ***Multifiber Arrangement*** (MFA) provides a framework for the negotiation of bilateral agreements between importing and producing countries, or for unilateral action by importing countries in the absence of an agreement. These bilateral agreements establish quantitative limits on imports of textiles and apparel, of cotton and other vegetable fibers, wool, man-made fibers and silk blends, in order to prevent market disruption in the importing countries—restrictions that would otherwise be a departure from GATT provisions. The United States has bilateral agreements with more than 30 supplying countries, including the four largest suppliers: China, Hong Kong, the Republic of Korea, and Taiwan.

APPENDIX B
STATISTICAL TABLES

Table B-4
Textile machinery and parts: Harmonized Tariff Schedule subheading; description; U.S. Col. 1-rate of duty as of Jan. 1, 1993; final MTN concession rate of duty; U.S. exports, 1992; U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
		Percent		*1,000 dollars*	
8420.10.10	Textile calendering or rolling machines	5.1%	Free (A,CA,E,IL,J)	1,847	2,322
8420.91.10	Cylinders for textile calendering or rolling machines	5.1%	Free (A,CA,E,IL,J)	(2)	411
8420.99.10	Parts of calendering or rolling machines for processing textiles	5.1%	Free (A,CA,E,IL,J)	(2)	379
8443.50.10	Textile printing machinery, nesi	5.1%	Free (A,CA,E,IL,J)	15,011	16,404
8443.90.10	Parts of textile printing machinery	5.1%	Free (A,CA,E,IL,J)	11,722	12,351
8444.00.00[3]	Machines for extruding, drawing, texturing or cutting man-made textile materials	4.5%	Free (A,CA,E,IL,J)	17,665	58,857
8445.11.00[3]	Carding machines for preparing textile fibers	4.2%	Free (A,CA,E,IL,J)	1,580	25,259
8445.12.00	Combing machines for preparing textile fibers	4.2%	Free (A,CA,E,IL,J)	924	3,978
8445.13.00	Drawing or roving machines for preparing textile fibers	4.2%	Free (A,CA,E,IL,J)	1,217	12,471
8445.19.00	Machines for preparing textile fibers, nesi	4.2%	Free (A,CA,E,IL,J)	38,132	44,617
8445.20.00[3]	Textile spinning machines	4.2%	Free (A,CA,E,IL,J)	12,471	220,370
8445.30.00	Textile doubling or twisting machines	4.2%	Free (A,CA,E,IL,J)	4,872	30,942
8445.40.00	Textile winding (including weft-winding) or reeling machines	4.7%	Free (A,CA,E,IL,J)	5,215	43,106
8445.90.00	Machinery for producing textile yarns, nesi; machines for preparing textile yarns for use on machines of heading 8446 or 8447	4.7%	Free (A,CA,E,IL,J)	23,227	13,229
8446.10.00[3]	Weaving machines (looms) for weaving fabrics of a width not exceeding 30 cm	4.7%	Free (A,CA,E,IL,J)	4,803	19,373
8446.21.00[3]	Weaving machines for weaving fabrics of a width exceeding 30 cm, shuttle type, power looms	4.7%	Free (A,CA,E,IL,J)	1,666	15,477
8446.29.00	Weaving machines for weaving fabrics of a width exceeding 30 cm, shuttle type, nesi	4.7%	Free (A,CA,E,IL,J)	1,556	3,209
8446.30.00[3]	Weaving machines for weaving fabrics of a width exceeding 30 cm, shuttleless type	4.7%	Free (A,CA,E,IL,J)	3,110	137,514
8447.11.10[3]	Circular knitting machines with cylinder diameter not exceeding 165 mm, for knitting hosiery	4.4%	Free (A,CA,E,IL,J)	1,939	42,213
8447.11.90	Circular knitting machines with cylinder diameter not exceeding 165 mm, other than for knitting hosiery	4.2%	Free (A,CA,E,IL,J)	8,107	16,012
8447.12.10[3]	Circular knitting machines with cylinder diameter exceeding 165 cm for knitting hosiery	4.4%	Free (A,CA,E,IL,J)	769	1,796
8447.12.90[3]	Circular knitting machines with cylinder diameter exceeding 165 cm, other than for knitting hosiery	4.2%	Free (A,CA,E,IL,J)	5,663	19,631
8447.20.00	Flat knitting machines; stitch-bonding machine	(4)	(4)	8,329	(4)
8447.20.10[3]	V-bed flat knitting machines	5.1%	Free (A,CA,E,IL,J)	(4)	19,350
8447.20.40	Warp knitting machines	Free	(4)	(4)	35,270

See footnotes at end of table.

Table B-4—Continued
Textile machinery and parts: Harmonized Tariff Schedule subheading; description; U.S. Col. 1-rate of duty as of Jan. 1, 1993; final MTN concession rate of duty; U.S. exports, 1992; U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
		Percent		*1,000 dollars*	
8447.20.60[3]	Flat knitting machines, other than V-bed or warp; stitch-bonding machines	4.7%	Free (A,CA,E,IL,J)	([4])	12,153
8447.90.00	Other knitting machines	([4])	([4])	43,835	([4])
8447.90.10[3]	Braiding and lace-braiding machines	4.7%	Free (A,CA,E,IL,J)	([4])	5,661
8447.90.50	Embroidery machines	4.2%	Free (A,CA,E,IL,J)	([4])	61,537
8447.90.90	Knitting machines other than circular or flat knitting; machines for making gimped yarn, tulle, trimmings or net	4.4%	Free (A,CA,E,IL,J)	([4])	3,513
8448.11.00[3]	Dobbies and jacquards, card reducing, copying, punching or assembling machines for use with machines of heading 8444, 8445, 8446, or 8447	4.7%	Free (A,CA,E,IL,J)	7,187	25,061
8448.19.00[3]	Auxiliary machinery for machines of heading 8444, 8445, 8446, or 8447, nesi	4.7%	Free (A,CA,E,IL,J)	20,445	9,430
8448.20.10	Parts and accessories of machines for extruding or drawing man-made textile filaments	4.7%	Free (A,CA,E,IL,J)	108,032	17,871
8448.20.50	Parts and accessories of machines of heading 8444 or of their auxiliary machinery, nesi	4.2%	Free (A,CA,E,IL,J)	17,965	20,079
8448.31.00	Card clothing as parts and accessories of machines of heading 8445 or of their auxiliary machinery	6.6%	Free (A,CA,E,IL,J)	833	894
8448.32.00	Parts and accessories of machines for preparing textile fibers, other than card clothing	4.2%	Free (A,CA,E,IL,J)	39,961	26,447
8448.33.00	Spindles, spindle flyers, spinning rings and ring travelers of machines of heading 8445 or of their auxiliary machinery	4.2%	Free (A,CA,E,IL,J)	2,619	5,233
8448.39.10	Parts of spinning, doubling or twisting machines of heading 8445 or of their auxiliary machinery	4.2%	Free (A,CA,E,IL,J)	8,275	59,497
8448.39.50	Parts of winding or reeling machines of heading 8445 or of their auxiliary machinery	4.7%	Free (A,CA,E,IL,J)	8,835	58,009
8448.39.90	Parts and accessories of machines of heading 8445 or their auxiliary machinery, nesi	4.7%	Free (A,CA,E,IL,J)	18,476	21,156
8448.41.00	Shuttles for weaving machines (looms)	4.7%	Free (A,CA,E,IL,J)	745	900
8448.42.00	Reeds for looms, healds and heald-frames of weaving machines (looms) or their auxiliary machinery	4.7%	Free (A,CA,E,IL,J)	16,534	5,121
8448.49.00[3]	Parts and accessories of weaving machines (looms) or of their auxiliary machinery, other than shuttles, reeds, healds and heald-frames	4.7%	Free (A,CA,E,IL,J)	18,070	121,921
8448.51.10[5]	Latch needles for knitting machines	10%	Free (A,CA,E,IL,J)	([4])	52,188
8448.51.20	Spring-beard needles for knitting machines	([6])	Free (CA,E,IL,J)	([4])	1,271
8448.51.30[5]	Needles for knitting machines other than latch needles or spring-beard needles	([7])	Free (CA,E,IL,J)	([4])	2,545
8448.51.40[8]	Needles for knitting machines	([4])	([4]) (CA,E,IL,J)	400	([4])

See footnotes at end of table.

Table B-4—Continued
Textile machinery and parts: Harmonized Tariff Schedule subheading; description; U.S. Col. 1-rate of duty as of Jan. 1, 1993; final MTN concession rate of duty; U.S. exports, 1992; U.S. imports, 1992

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1993		U.S. exports, 1992	U.S. imports, 1992
		General	Special[1]		
		Percent		*1,000 dollars*	
8448.51.50	Sinkers, needles and other articles used to form stitches, nesi, for machines of heading 8447	4.4%	Free (A,CA,E,IL,J)	2,230	5,930
8448.59.10[3]	Parts of knitting machines of heading 8447 or of their auxiliary machines, nesi	4.7%	Free (A,CA,E,IL,J)	5,227	34,065
8448.59.50[3]	Accessories of machines of heading 8447 or of their auxiliary machines, nesi	4.4%	Free (A,CA,E,IL,J)	8,439	11,014
8449.00.00	Machines for the manufacture or finishing of felt or nonwovens and parts thereof	([4])	([4])	6,811	([4])
8449.00.10	Finishing machinery for felt or nonwovens and parts thereof	5.1%	Free (A,CA,E,IL,J)	([4])	15,564
8449.00.50	Machinery for making felt hats; blocks for making hats; parts thereof	4.4%	Free (A,CA,E,IL,J)	([4])	12,174
8451.40.00	Washing, bleaching or dyeing machines for textile yarns, fabrics or made up textile articles	5.1%	Free (A,CA,E,IL,J)	23,963	44,570
8451.50.00	Machines for reeling, unreeling, folding, cutting or pinking textile fabrics	4.4%	Free (A,CA,E,IL,J)	43,463	15,181
8451.80.00	Machinery for the handling of textile yarns, fabrics or made up textile articles, nesi	5.1%	Free (A,CA,E,IL,J)	56,549	36,037
8451.90.00	Parts of machines for the handling of textile yarns, fabrics or made up textile articles, nesi	5.1%	Free (A,CA,E,IL,J)	49,701	58,508

[1] Programs under which special tariff treatment may be provided, and corresponding symbols for such programs as they are indicated in the "Special" subcolumn, are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement on Trade in Civil Aircraft (C); United States-Canada Free-Trade Agreement (CA).
[2] Less than $1,000.
[3] Temporary duty suspension provision applies to certain articles in this subheading.
[4] Not applicable.
[5] Temporary duty suspension provision applies to the articles in this subheading.
[6] $0.19 per 1,000 + 6.4%
[7] $0.23 per 1,000 + 8.2%
[8] 8448.51.40 appears only as a Schedule B export number.

Source: U.S. exports and imports were complied from official statistics of the U.S. Department of Commerce.

APPENDIX C
DETAILED PRODUCT DESCRIPTION AND FUNCTIONS PERFORMED BY TEXTILE MACHINES

Yarn-preparing and -producing machinery for man-made fibers

Machines for producing man-made textile filaments are highly complex, multiprocess machines that are expensive to build and to install. The machines vary considerably in design and function, according to the process being employed. However, all of them perform the essential function of forcing a spinning solution by means of a precision metering pump through the microscopic holes of a spinnerette, the basic element in the type of machines considered here. The spinnerette consists of a thimble-like cap or jet (usually made of platinum alloy or, in some cases, stainless steel), perforated with a series of tiny holes made to precision specifications. Each spinnerette has from one to several thousand holes, depending upon the type of yarn to be produced. The fine fibers (called filaments) emerging from the holes are hardened or solidified through contact with air or other gas or by means of coagulating chemical baths. The process of extrusion and hardening is called spinning, and should not be confused with the textile operation of the same name in which short fibers are spun into yarns by twisting. While the fibers are being hardened, or after they are hardened, they are stretched (or drawn) to develop strength. The fibers at this stage are made into yarn. The process varies, depending on whether a filament or staple yarn is desired. The filament yarn is produced by twisting together strands of two or more continuous filaments and then winding the yarn onto bobbins. When a very sheer fabric is desired, a single filament (monofilament) might become the yarn for weaving into fabric.

Filament yarn may also be used in knit fabrics. The staple yarn is produced by drawing large groups of continuous filaments without definite twist into a rope-like product called tow. The tow is chopped into short fibers. The staple fiber is then ready to be spun into yarn to be woven or knit. Newer models of these machines incorporate heat-setting and other finishing treatments.

Cotton-opening and picking machinery

Cotton requires an extensive amount of cleaning and processing before it can be transformed into yarn. Textile mills receive raw cotton bales from which seeds and other impurities have been partially removed. After the cotton bales have been torn apart by a bale opener, the raw fibers are passed along a conveyor through a series of screen rolls and beaters which untangle, loosen, and beat the fibers to remove most of the remaining impurities such as cotton seeds, leaves, and dirt. The cotton fibers are then further cleaned, blended, and transformed into a uniform sheet of loose matted fibers and wound into 45-pound rolls (lap).

Carding machinery

Carding machinery consists of a series of rolls whose surfaces are covered with wire or metal teeth. These machines are used in the production of staple yarns in completing the cleaning process. Cards separate, untangle, and begin the process of arranging the sliver into a parallel alignment. A sliver is a uniform rope-like strand composed of loosely assembled, untwisted fibers. The sliver is produced by a card, a comber, or a drawing frame. The production of the sliver is the first step in the textile operation that brings staple fiber into a form that can be drawn (or reduced in bulk) and eventually twisted into a spun yarn.

Combing machinery

The principal function of combing machines (combers) is to straighten and extract all tangled and broken yarn and remove fibers less than 1 and 1/8th inches long. Combing produces a stronger, more even, compact, finer, smoother yarn. Combers are used in the production of yarn for hosiery, underwear, sewing thread, and fine fabrics.

Drawing machinery

Drawing machines are used to improve the uniformity of the sliver by drafting, doubling, and redoubling the fibers. Drawing machines also arrange the fibers in a parallel alinement.

Roving machinery

The two most commonly used roving machines are slubbers and roving frames. Slubbers and rov-

ing frames are used to condense the size of the sliver. Slubbers reduce the size of the thick sliver to the diameter of a lead pencil. Roving frames further reduce the diameter of the sliver to the size of the lead in a lead pencil (roving). The rovers then slightly twist the fibers and then winds them onto a bobbin. This is the intermediate step between a sliver and finished yarn.

Spinning machinery

Spinning machines are used to reduce the roving to the required fineness, and then to twist and to wind the yarn onto a cap, bobbin, or paper tube. The three basic kinds of spinning machines are fly frame spinners, ring spinners, and mule spinners. Fly frame spinners are used primarily to spin worsted and coarser yarns. Fly frames use a two-armed U-shaped device called a flyer, which fits on top of a revolving spindle. The strands of partially processed roving enter one of the arms of the flyer and travel downward and are wound around a bobbin or tube as the spindle rotates. Ring spinners are the most widely used spinning machine. The spinning process is similar to that used by the fly frame, except, instead of using a flyer, it uses a small weight traveling around a ring (traveler) that simultaneously twists one or more strands of roving into yarn and winds them onto a bobbin. Mule spinners are used primarily to spin soft, finer grade yarns, such as wool. The mule is considerably slower than the continuous and fly frame spinners. Mule spinners draw out a length of roving, twist it, and then wind it onto a cap or bobbin and then repeat the process.

Twisting machinery

Twisters, like ring spinners, rely on ring travelers as an essential part of the twisting process. Ring travelers are small, open rings made of metal or, in some cases, of plastic; they are produced to close tolerances in many sizes and shapes. The weight of the traveler is an important factor—the weight of any 10-metal travelers cannot vary more than half a grain. If the weight of the traveler is significantly off, the traveler will foul the yarn. Teamed with the spinning spindle and ring, travelers form the heart of the yarn preparatory spinning process. Horns on the traveler fit around the flange of the ring, and together they assist the spinning spindle in twisting the yarn, applying tension necessary for winding and guiding the yarn onto the bobbin as it winds. Moving at a very high rate of speed for long periods of time, the traveler floats around the ring. Instead of being propelled by the machine, it is activated and controlled by the stock in process.

Winding and warp-preparing machinery

Winders are machines used for rewinding yarn from the spinning frame package into forms suitable for other processes, such as hanks or skeins for dyeing operations, cheeses (cylindrical packages of yarn wound on paper or wooden tubes) for warping operations, and cops (coned-shaped roll of yarn) for looms shuttles used in the insertion of the weft yarn in weaving operations. Concurrent with the winding process the yarn may be given a certain treatment, such as emulsion or waxing. The various types of warp-preparing machinery include beamers, warpers, slashers, warp-tying, and warp drawing-in machines; these machines are used to prepare warp yarn for use in looms, warp-knitting machines, and other textile machines.

Slashing machinery

Slashing machines are used to immerse warp yarns, which run vertically or lengthwise in woven goods, into starch liquors, gelatins, or other compounds which strengthen the warp yarns for the weaving process. After the cloth is woven, the sizing compound is washed from the fabric.

Heat-set, stretch texturing machinery

Texturing is the process of crimping, imparting random loops, or otherwise dofting continuous filament yarn to increase cover, resilience, abrasion resistance, warmth, insulation, moisture absorption or to provide a different surface texture. In recent years, the versatility and speed of false-twist machines have resulted in dominance of these machines in the texturing machine market. The false twist method of texturing involves stretching, twisting, heat-setting, and untwisting

of the yarn. Continuous multifilament yarn is taken from a supply package and fed at controlled tension (stretched) through a heating unit and against a series of rollers turning in different directions to impart twist. Above the rollers, the tension in the yarn is released, allowing it to contract partially and untwist. The result is a bulkier, more elastic yarn.

Weaving machinery (looms)

Weaving machines produce fabric by interlacing warp yarns, which run lengthwise through woven fabric, with filling yarns, which run crosswise at right angles, by weaving over and under the yarn. Looms usually produce flat goods; however, some tubular fabrics are woven on broad looms, and some, on circular looms. There are different types of looms named according to the type of mechanism used (or fabric type produced), such as shuttle and shuttleless looms (projectile/missile, air jet, water jet, rapier, fly) and pile fabric looms. Loom size ranges from up to 150 inches, used to manufacture broadloom carpets, to less than 12 inches, used to produce ribbons and belts.

Knitting machinery

Knitting machines inter-loop a vertical row of stitches with a horizontal (or crosswise) row of stitches by use of a needle to form rows of connected loops. Knitting machines are generally divided into four categories: circular, full-fashion hosiery, flat, and warp. Circular knitting machines are used principally to produce hosiery, underwear, sweaters, and outerwear. Circular knitting machines produce tube goods by continually running thread around the fabric. Full-fashioned knitting machines are used to knit articles, such as hosiery, underwear, sweaters, and other apparel, that have been shaped by adding or removing stitches. The two most commonly used full-fashion knitting machines are the V-bed flat knitting machine and the links-and-links flat knitting machine.

Flat knitting machines have needles set in a straight line and held in place by a flat plate called the needle bed. These machines usually produce flat fabrics with selvage edges (outer edges joined together in the seaming), or they may produce a tube of fabric, fashioned or straight articles, or more intricate patterns and designs than other knitting machines can. They are used principally to produce high-quality outerwear and underwear. Tubular fabrics are generally confined to coarse work for sweaters and headwear.

The links-and-links machines are special types of knitting machines used to produce the purl stitch, which resembles the stitch produced in hand knitting and which is popular for infant's and women's outerwear. These machines consist of both circular and flat types.

Warp knitting machines range from the very simple types to large machines with many rows of needles. In some cases, these machines are equipped with jacquard or similar mechanisms to produce various designs. The most popular types of warp fabrics are made on tricot, milanese, and raschel machines. These fabrics are used for underwear, dresses, and various other articles. The raschel knitter is the most versatile of all fabric-producing knitting machines, capable of knitting articles ranging from fragile hairnets to coarse rugs, and can accommodate every conceivable type of material in a wide range of counts.

Finishing machinery

Because of the wide variety of raw materials used in the manufacture of textiles and the number of different finishes desired, many different finishing machines are required. The operations performed by this equipment are usually classified as either wet or dry processes, and they range in complexity from rather simple operations to those that completely change the character of appearance of the fabric. Some finishing operations are performed before and some after the fabric is made. Among the most important finishing operations are washing, drying, bleaching, dyeing, printing, mercerizing, shearing, snapping, singeing, and moireing. Much of the equipment used is nothing more than vats, tanks, troughs, or other containers, fitted with such simple mechanical features as rollers for leading in the yarn or fabric, squeezing out excess liquid, stirring agitators, and for other devices for wet processing. During 1991, computer-guided laser printing was incorporated by several U.S. textile and apparel mills.

Calendaring is usually done to attach a special finish to fabrics. Calendaring is a mechanical pro-

cess performed by rollers to provide glaze, glossiness, hardness, luster, sheen, and even embossed designs to textile materials. Printing machines are used to print textiles. Roller printing, for example, is used in the application of designs to fabric, using a machine containing engraved metal rollers. Most machines are equipped to handle between 8 and 16 rollers. After printing, the cloth is treated to fix the dye.

Cordage machinery

Cordage machines convert yarn into twine, cord, rope, and cable. The manufacture of cordage consists of the preparation of the fibers for spinning, the spinning of the prepared fibers into yarn, the formation of strand by twisting together two or more yarn ends from a spinning frame, and the laying or twisting together of three or more strands into rope and rope into cable. Forming and laying operations are performed either on separate machines or on compound machines, which perform both operations simultaneously. Twine is an intermediate product, sometimes consisting of parallel fibers with little or no twist, which is used mostly for tying packages or in farm harvesting operations.

Lace and netmaking machinery

The three general types of lace machines are (1) leavers lace machines, (2) nottingham lace-curtain machines, and (3) bobbinet machines. Leavers lace machines are used to produce fancy laces, from very narrow laces to very wide flouncing and all other laces. The leavers go-through machine is a modification of the plain leavers machine; it operates at a higher rate of speed, and it is used more widely than the plain leavers machine. Nottingham lace-curtail machines are used mostly in the production of table cloths, window curtains, curtain nets, and other household articles; they are used also to produce insect and camouflage netting for military purposes. Bobbinet machines produce unfigured fabric usually of hexagonal mesh. Coarse and medium grades are used principally for mosquito netting and as foundation fabric for embroidered lace curtains. Fine grades are used for bridal veils, trimming for wearing apparel, and foundation fabrics for embroidered laces. Some bobbinet is also made with square or fancy mesh. The latter is known as Grecian net. Point d'espirit, or spotted net, is also made on bobbinet machines.

Embroidery machinery

Embroidery machines are of three general types: Swiss looms, Schiffli machines, and Bonnaz machines. Swiss looms are multi-needle looms which produce embroidered fabric, usually 6 feet in width, by passing double-pointed needles back and forth through the fabric to produce a design that resembles hand embroidery. Schiffli machines are also wide, multi-needle machines, but, unlike the Swiss looms, shuttles are used to form the stitch. Schiffli machine needles pass only part way through the fabric, so that the needle thread can be interlocked with shuttle threads on the reverse side of the material to form the stitch, as in machine sewing. The Bonnaz machine resembles a sewing machine. It is a universal feed machine; that is, the machine works or feeds in all directions, and is controlled by a handle that the operator may guide to embroider any type of design.

Swiss looms are used mostly in the production of handkerchiefs. Schiffli machines are used extensively for embroidering edgings and other materials for wearing apparel, handkerchiefs, lace, letters, lace cuffs, collars, and emblems. Bonnaz machines are used for rapid production of embroidery work on dresses, sweaters, ladies' handbags, ladies' hats, gloves, and of fancy spreads and pillowcases.

Braiding and lace-braiding machinery

There are three basic types of textile braiding machines: the comparatively simple Maypole type of braider, which is used to produce sash cords, fire-hose coverings, shoe laces, and ornamental braids; the high-speed braider, which is used chiefly for insulating electric wires and cables; and the Barmen lace braider, which produces a fabric that is similar to homemade laces. These machines produce fabric by interlacing diagonally a series of threads or strands in a maypole fashion.