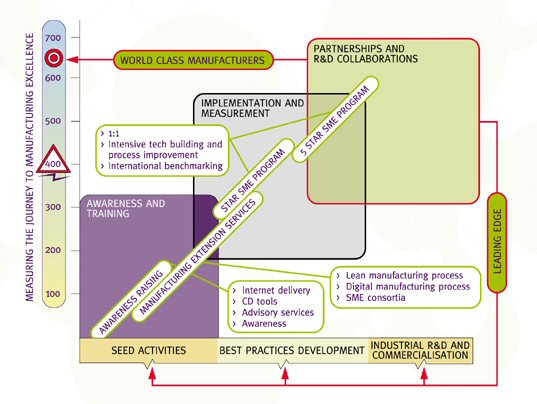
* + Manufacturing
* collaboration activities between industry, academia and government. A central component of the benchmarking activity is the world class rating scale on the left-hand side of Figure 1.



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| Textile, Textile Product, and Apparel Manufacturing   |  | | --- | | Significant Points |  * Employment is expected to decline because of technological advances and imports of apparel and textiles from lower-wage countries. * Extensive on-the-job training is required to operate new high-technology machinery. * Production workers account for almost 2 out of 3 jobs. * About 4 out of 10 jobs are in three States—California, North Carolina, and Georgia.  |  |  |  | | --- | --- | --- | |  |  |  |   The textile, textile product, and apparel manufacturing industries include establishments that turn fiber into fabric and fabric into clothing and other textile products. While some factories are highly automated, others still rely mostly on people to cut and sew pieces of fabric together. The apparel industry has moved mainly to other countries with cheaper labor costs, while the textile industry has been able to automate much of its production to effectively compete with foreign suppliers. This industry is evolving and its need for a more highly skilled workforce is growing.  ***Goods and services.*** The establishments in these industries produce a variety of goods, some of which are sold to the consumer, while others are sold as inputs to the manufacture of other products. Natural and synthetic fibers are used to produce threads and yarns—which may be woven, knitted, or pressed or otherwise bonded into fabrics—as well as rope, cordage, and twine. Coatings and finishes are applied to the fabrics to enhance the decorative patterns woven into the fabric, or to make the fabric more durable, stain-resistant, or have other properties. Fabrics are used to make many products, including awnings, tents, carpets and rugs, as well as a variety of linens—curtains, tablecloths, towels, and sheets. However, the principal use of fabrics is to make apparel. Establishments in the apparel manufacturing industry produce many knitted clothing products, such as hosiery and socks, shirts, sweaters, and underwear. They also produce many cut-and-sew clothing items like dresses, suits, shirts, and trousers.  ***Industry organization.*** The three individual industries—textile mills, textile product mills, and apparel manufacturing—have many unique characteristics. Textile mills provide the raw material to make apparel and textile products. They take natural and synthetic fibers, such as cotton and polyester, and transform them into fiber, yarn, and thread. Yarns are strands of fibers in a form ready for weaving, knitting, or otherwise intertwining to form a textile fabric. They form the basis for most textile production and commonly are made of cotton, wool, or a synthetic fiber such as polyester. Yarns also can be made of thin strips of plastic, paper, or metal. To produce spun yarn, natural fibers such as cotton and wool must first be processed to remove impurities and give products the desired texture and durability, as well as other characteristics. After this initial cleaning stage, the fibers are spun into yarn.  Textile mills then go on to produce fabric by means of weaving and knitting. Workers in weaving mills use complex, automated looms to transform yarns into cloth. Looms weave or interlace two yarns, so they cross each other at right angles to form fabric. Knitting mills use automated machines to produce fabric of interlocking loops of one or more yarns  At any time during the production process, a number of processes, called finishing, may be performed on the fabric. These processes—which include dyeing, bleaching, and stonewashing, among others—may be performed by the textile mill or at a separate finishing mill. Finishing encompasses chemical or mechanical treatments performed on fiber, yarn, or fabric to improve appearance, texture, or performance.  Textile mills that also make the end products in the same factory are included in this sector; otherwise, if the fabric is purchased the product made is considered a product of the textile mills products sector or apparel manufacturing sector. The textile product mills sector comprises establishments that produce a wide variety of textile products for use by individuals and businesses, but not including apparel. Some of the items made in this sector include household items, such as carpets and rugs; towels, curtains, and sheets; cord and twine; furniture and automotive upholstery; and industrial belts and fire hoses. Because the process of converting raw fibers into finished textile products is complex, most textile mills specialize.  The apparel manufacturing industry transforms fabrics produced by textile manufacturers into clothing and accessories. By cutting and sewing fabrics or other materials, such as leather, rubberized fabrics, plastics, and furs, workers in this industry help to keep consumers warm, dry, and fashionable.  The apparel industry traditionally has consisted mostly of production workers who performed the cutting and sewing functions in an assembly line. This industry remains labor-intensive, despite advances in technology and workplace practices. Although many workers still perform this work in the United States, the industry increasingly contracts out its production work to foreign suppliers to take advantage of lower labor costs in other countries. In its place, a growing number of apparel manufacturers perform only the entrepreneurial functions involved in apparel manufacturing—buying raw materials, designing clothes and accessories and preparing samples, arranging for the production and distribution of the apparel, and marketing the finished product.  Many of the remaining production workers work in teams. For example, sewing machine operators are organized into production “modules.” Each operator in a module is trained to perform nearly all of the functions required to assemble a garment. Each module is responsible for its own performance, and individuals usually receive compensation based on the team’s performance.  ***Recent developments.*** The textile and apparel manufacturing industries are rapidly modernizing, as new investments in automation and information technology have been made necessary by growing international competition. Firms also have responded to competition by developing new products and services. For example, some manufacturers are producing textiles developed from fibers made from recycled materials. These innovations have had a wide effect across the industry. Advanced machinery is boosting productivity levels in textiles, costing some workers their jobs while fundamentally changing the nature of work for others. New technology also has led to increasingly technical training for workers throughout the industry. Computers and computer-controlled equipment aid in many functions, such as design, patternmaking, and cutting. Wider looms, more computerized equipment, and the increasing use of robotics to move material within the plant are other technologies recently designed to make the production plant more efficient. Despite these changes, however, the apparel industry—especially its sewing function—has remained significantly less automated than many other manufacturing industries.  One advantage the domestic industry has is its closeness to the market and its ability to react to changes in fashion more quickly than can its foreign competitors. Also, as retailers consolidate and become more cost conscious, they require more apparel manufacturers to move toward a just-in-time delivery system, in which purchased apparel items are quickly replaced by new items directly from the manufacturer, rather than from a large inventory kept by the retailer. Through electronic data interchange—mainly using barcodes—information is quickly communicated to the manufacturers, providing information not only on inventory, but also about the desires of the public for fashion items.  Some apparel firms have responded to growing competition by merging with other apparel firms and by moving into the retail market. In addition to the production of garments they also are contracting out functions—for example, warehousing and order fulfillment—to concentrate on their strengths: design and marketing. Computer aided design systems have led to the development of “product life cycle management, under which potential new fashions can now be transmitted around the planet over the Internet. Such changes may help the apparel manufacturing industry meet the growing competition and continue to supply the Nation’s consumers with garments at an acceptable cost.   |  |  |  | | --- | --- | --- | | Working Conditions |  |  |   ***Hours.*** Some factories run 24 hours a day causing production workers to work evenings and weekends. Many operators work on rotating schedules, which can cause sleep disorders and other stress from constant changes in work hours. Overtime is common for these workers during periods of peak production. Managerial and administrative support personnel typically work a 5-day, 40-hour week in an office setting, although some of these employees also may work significant overtime. Travel is an important part of the job for many managers and designers, who oversee the design and production of apparel. As more production moves abroad, foreign travel is becoming more common. Quality-control inspectors and other workers also may need to travel to other production sites, especially if working for large companies.  ***Work environment.*** Working conditions vary greatly. Production workers, including frontline managers and supervisors, spend most of their shift on or near the production floor. Some factories are noisy and can have airborne fibers and odors, but most modern facilities are relatively clean, well lit, and ventilated.  In 2006, work-related injuries and illnesses in textile mills averaged 4.4 per 100 full-time workers, compared with 6.0 percent for all manufacturing and 4.4 percent for the entire private sector. Work-related injuries and illnesses in textile product mills averaged 4.5 per 100 full-time workers, and in apparel manufacturing, the rate was 2.9 per 100 full-time workers.  When appropriate, the use of protective shoes, clothing, facemasks, and earplugs is required. Also, new machinery is designed with additional protection, such as noise shields. Still, many workers in textile production occupations must stand for long periods while bending over machinery, and noise and dust still are a problem in some plants. Apparel manufacturing operators often sit for long periods and lean over machines. New ergonomically designed chairs and machines that allow workers to stand during their operation are some of the means that firms use to minimize discomfort for production workers. Another concern for workers is injuries caused by repetitive motions. The implementation of modular units and specially designed equipment reduces potential health problems by lessening the stress of repetitive motions. Workers sometimes are exposed to hazardous situations that could produce cuts or minor burns if proper safety practices are not observed.  The movement away from traditional piecework systems in apparel manufacturing often results in a significant change in working conditions. Modular manufacturing involves teamwork, increased responsibility, and greater interaction among coworkers than on traditional assembly lines.   |  |  |  | | --- | --- | --- | | Employment |  |  |   In 2006, approximately 595,000 wage and salary workers were employed by the textile, textile product, and apparel manufacturing industries. The apparel manufacturing segment, particularly cut and sew apparel manufacturing, was the largest of the three employing 238,000 workers. In addition, there were also about 39,000 self-employed workers in this industry.   | **Table 1. Percent distribution of employment and establishments in textile, textile product, and apparel manufacturing by detailed industry sector, 2006** | | | | --- | --- | --- | | **Industry segment** | **Employment** | **Establishments** | |  |  |  | | **Total** | 100.0 | 100.0 | |  |  |  | | **Textile mills** | 32.7 | 18.0 | | **Fabric mills** | 15.0 | 7.0 | | **Textile and fabric finishing and fabric coating mills** | 9.7 | 8.8 | | **Fiber, yarn, and thread mills** | 8.0 | 2.2 | |  |  |  | | **Textile product mills** | 27.1 | 33.0 | | **Textile furnishings mills** | 15.2 | 12.7 | | **Other textile product mills** | 11.9 | 20.3 | |  |  |  | | **Apparel manufacturing** | 40.3 | 48.9 | | **Cut and sew apparel manufacturing** | 31.3 | 43.1 | | **Apparel knitting mills** | 5.6 | 2.5 | | **Apparel accessories and other apparel manufacturing** | 3.3 | 3.4 |   Most of the wage and salary workers employed in the textile mills, textile product, and apparel manufacturing industries in 2006 were found in California and in the southeastern States. California, Georgia, and North Carolina, together accounted for over 40 percent of all workers. The Northeast and South Carolina also have significant employment in this industry. While most apparel and textile establishments are small, employment is concentrated in mills employing 50 or more persons. These establishments accounted for more than 70 percent of all apparel and textile workers.  Over 70 percent of the jobs in the textile, textile products, and apparel manufacturing industry are in establishments that employ 50 or more workers.   |  |  |  | | --- | --- | --- | |  |  |  |  | **Table 1. Present structure of textile industries Bangladesh** | | | | | | --- | --- | --- | --- | --- | | **Industry segment** | **No. of Mills & Spindle** | **Installed Capacity (kg)** | **Production /year(M** | **Employment** | | **Spinning (Public)** | **24** | **4,60,000** | 40 |  | | **Total** |  |  |  | 100.0 | |  |  |  |  |  | | **Textile mills** |  |  |  | 18.0 | | **Fabric mills** |  |  |  | 7.0 | | **Textile and fabric finishing and fabric coating mills** |  |  |  | 8.8 | | **Fiber, yarn, and thread mills** |  |  | 8.0 | 2.2 | |  |  |  |  |  | | **Textile product mills** |  |  | 27.1 | 33.0 | | **Textile furnishings mills** |  |  | 15.2 | 12.7 | | **Other textile product mills** |  |  | 11.9 | 20.3 | |  |  |  |  |  | | **Apparel manufacturing** |  |  | 40.3 | 48.9 | | **Cut and sew apparel manufacturing** |  |  | 31.3 | 43.1 | | **Apparel knitting mills** |  |  | 5.6 | 2.5 | | **Apparel accessories and other apparel manufacturing** |  |  | 3.3 | 3.4 |   Occupations in the Industry  The textile and apparel industries offer employment opportunities in a variety of occupations, but production occupations accounted for 65 percent of all jobs; some of which are unique to the industry ([table 2](http://www.bls.gov/oco/cg/cgs015.htm#table2)). Additional jobs may be found at the headquarters of some of these textile and apparel companies that are generally classified in a separate industry.  ***Production occupations.*** Many workers enter these industries as *machine setters and operators*. They are responsible for setting each machine and monitoring its operation. They also determine if they need repairs or adjustments, and if so, they may clean and oil the machines and repair or replace worn parts. If the machine breaks down, machine setters and operators must be able to diagnose problems quickly and get it restarted as soon as possible to reduce costly machine idle time. Textile machine setters and operators also install, level, and align components such as gears, chains, dies, cutters, and needles.  Textile machine setters and operators thread yarn, thread, or fabric through guides, needles, or rollers. They adjust the controls for proper tension, speed, and heat; for electronically controlled equipment, they program controls or key in instructions using a computer keyboard. Operators then start the machines and monitor their operation, observing control panels and gauges to detect problems.  Skilled production occupations also include quality-control inspectors, who use precision measuring instruments and complex testing equipment to detect product defects, wear, or deviations from specifications.  The apparel manufacturing industry also has a large number of production occupations that help transform the fabric into clothing and accessories. Before sewing can begin, pattern pieces must be made, layouts determined, and fabric cut. *Fabric and apparel patternmakers* create the “blueprint” or pattern pieces for a particular apparel design. This often involves “grading,” or adjusting the pieces for different-sized garments. Grading once was a time-consuming job, but now it is quickly completed with the aid of a computer. *Markers* determine the best arrangement of pattern pieces to minimize wasted fabric. Traditionally, markers judged the best arrangement of pieces by eye; today, computers quickly help determine the best layout.  The layout arrangement is then given to *cutters*. In less automated companies, cutters may use electric knives or cutting machines to cut pattern pieces. In more automated facilities, markers electronically send the layout to a computer-controlled cutting machine, and *textile cutting machine setters, operators, and tenders* monitor the machine’s work.  *Sewing machine operators* assemble or finish clothes. Most sewing functions are specialized and require the operator to receive specific training. Although operators specialize in one function, the trend toward cross-training requires them to broaden their skills. *Team assemblers* perform all of the assembly tasks assigned to their team, rotating through the different tasks, rather than specializing in a single task. They also may decide how the work is to be assigned and how tasks are to be performed.  *Pressers* receive a garment after it has been assembled. Pressers eliminate wrinkles and give shape to finished products. Most pressers use specially formed, foot-controlled pressing machines to perform their duties. Some pressing machines now have the steam and pressure controlled by computers*. Inspectors, testers, sorters, samplers, and weighers* inspect the finished product to ensure consistency and quality.  ***Other occupations.*** *Industrial machinery mechanics* account for about 2 percent of industry group employment. They inspect machines to make sure they are working properly. They clean, oil, and grease parts and tighten belts on a regular basis. When necessary, they make adjustments or replace worn parts and put the equipment back together. Mechanics are under pressure to fix equipment quickly because breakdowns usually stop or slow production. In addition to making repairs, mechanics help install new machines. They may enter instructions for computer-controlled machinery and demonstrate the equipment to machine operators.  Plant workers who do not operate or maintain equipment mostly perform a variety of other material-moving tasks. Some drive industrial trucks or tractors to move materials around the plant, load and unload trucks, or package products and materials by hand.  *Engineers* and *engineering technicians*, although a vital part of the textile and apparel industries, account for less than 1 percent of employment in these industries. Some engineers are *textile engineers*, who specialize in the design of textile machinery or new textile production methods, or the study of fibers. The industries also employ other types of engineers, particularly *industrial* and *mechanical engineers.*  *Fashion designers* are the artists of the apparel industry. They create ideas for a range of products including coats, suits, dresses, hats, and underwear. Fashion designers begin the process by making rough sketches of garments or accessories, often using computer-assisted design (CAD) software. This software prints detailed designs from a computer drawing. It can also store fashion styles and colors that can be accessed and easily changed. Designers then create the pattern pieces that will be used to construct the finished garment. They measure and draw pattern pieces to actual size on paper. Then, they use these pieces to measure and cut pattern pieces in a sample fabric. Designers sew the pieces together and fit them on a model. They examine the sample garment and make changes until they get the effect they want. Some designers use assistants to cut and sew pattern pieces to their specifications.   | **Table 2. Employment of wage and salary workers in textile, textile product, and apparel manufacturing by occupation, 2006 and projected change, 2006-2016. (Employment in thousands)** | | | | | --- | --- | --- | --- | | **Occupation** | **Employment, 2006** | | **Percent  change,  2006-16** | | **Number** | **Percent** | | **All occupations** | 595 | 100.0 | -35.4 | |  |  |  |  | | **Management, business, and financial occupations** | 27 | 4.5 | -35.8 | | **Top executives** | 9 | 1.6 | -40.4 | | **Industrial production managers** | 5 | 0.8 | -32.2 | |  |  |  |  | | **Professional and related occupations** | 15 | 2.5 | -33.3 | | **Fashion designers** | 4 | 0.6 | -47.8 | |  |  |  |  | | **Sales and related occupations** | 17 | 2.8 | -35.0 | | **Sales representatives, wholesale and manufacturing** | 12 | 2.0 | -33.8 | |  |  |  |  | | **Office and administrative support occupations** | 64 | 10.8 | -38.5 | | **Bookkeeping, accounting, and auditing clerks** | 6 | 1.0 | -34.9 | | **Customer service representatives** | 6 | 1.1 | -28.3 | | **Production, planning, and expediting clerks** | 5 | 0.9 | -36.0 | | **Shipping, receiving, and traffic clerks** | 12 | 2.0 | -39.7 | | **Stock clerks and order fillers** | 6 | 1.0 | -44.0 | | **Secretaries and administrative assistants** | 6 | 0.9 | -37.2 | | **Office clerks, general** | 8 | 1.4 | -36.0 | |  |  |  |  | | **Installation, maintenance, and repair occupations** | 28 | 4.7 | -20.9 | | **Industrial machinery mechanics** | 10 | 1.7 | -13.3 | | **Maintenance and repair workers, general** | 9 | 1.5 | -26.3 | | **Maintenance workers, machinery** | 3 | 0.5 | -26.1 | |  |  |  |  | | **Production occupations** | 389 | 65.3 | -35.8 | | **First-line supervisors/managers of production and operating workers** | 22 | 3.7 | -32.0 | | **Team assemblers** | 11 | 1.9 | -20.5 | | **Printing machine operators** | 7 | 1.1 | -35.4 | | **Pressers, textile, garment, and related materials** | 7 | 1.2 | -46.2 | | **Sewing machine operators** | 142 | 23.9 | -42.5 | | **Sewers, hand** | 3 | 0.5 | -42.8 | | **Tailors, dressmakers, and custom sewers** | 5 | 0.8 | -42.4 | | **Textile bleaching and dyeing machine operators and tenders** | 17 | 2.9 | -32.7 | | **Textile cutting machine setters, operators, and tenders** | 13 | 2.2 | -35.6 | | **Textile knitting and weaving machine setters, operators, and tenders** | 36 | 6.1 | -33.0 | | **Textile winding, twisting, and drawing out machine setters, operators, and tenders** | 40 | 6.7 | -24.7 | | **Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers** | 4 | 0.7 | -30.9 | | **Fabric and apparel patternmakers** | 5 | 0.9 | -47.0 | | **Cutting workers** | 8 | 1.3 | -35.5 | | **Inspectors, testers, sorters, samplers, and weighers** | 20 | 3.4 | -37.6 | | **Packaging and filling machine operators and tenders** | 5 | 0.8 | -31.9 | | **Helpers—Production workers** | 15 | 2.6 | -29.1 | |  |  |  |  | | **Transportation and material moving occupations** | 49 | 8.2 | -38.3 | | **Industrial truck and tractor operators** | 8 | 1.3 | -30.3 | | **Laborers and freight, stock, and material movers, hand** | 15 | 2.5 | -38.4 | | **Packers and packagers, hand** | 16 | 2.7 | -46.4 | |  |  |  |  | | Note: Columns may not add to totals due to omission of occupations with small employment | | | |  |  |  | | --- | --- | |  |  |   Training and Advancement  As the production of textiles and apparel items becomes more technologically advanced, education and training is playing a larger role in the workplace. While a high school diploma or GED may be sufficient for some entry-level positions and for some machine operators, familiarity with computers and some postsecondary training is needed for more technical jobs and to operate more sophisticated machinery. Additionally, as more of the production of apparel is moved offshore, the workers who remain in apparel manufacturing are more likely to be administrative and professional workers who often require more formal postsecondary education or a Bachelor’s degree.  ***Production occupations.*** Most production workers in textile and apparel manufacturing are trained on the job. Although a high school diploma is not required, some employers prefer it. Extensive on-the-job training has become an integral part of working in today’s textile mills. This training is designed to help workers understand complex automated machinery, recognize problems, and restart machinery when the problem is solved. Some of this training may be obtained at technical schools and community colleges. Basic math and computer skills are important for computer-controlled machine operators so some job applicants are screened through the use of tests, to ensure that they have the necessary skills.  Increasingly, training is offered to enable people to work well in a team-oriented environment. Many firms have established training centers or host seminars that encourage employee self-direction and responsibility and the development of interpersonal skills. Because of the emphasis on teamwork and the small number of management levels in modern textile mills, firms place a premium on workers who show initiative and communicate effectively.  Cutters and pressers are trained on the job, while patternmakers and markers usually have technical or trade school training. All of these workers must understand textile characteristics and have a good sense of three-dimensional space. Traditional cutters need exceptional hand-eye coordination. Computers are becoming a standard tool for these occupations because patternmakers and markers increasingly design pattern pieces and layouts on a computer screen. New entrants seeking these jobs should learn basic computer skills. Those running automatic cutting machines could need technical training, which is available from vocational schools.  Sewing machine operators must have good hand-eye coordination and dexterity, as well as an understanding of textile fabrics. They normally are trained on the job for a period of several weeks to several months, depending on their previous experience and the function for which they are training. Operators usually begin by performing simple tasks, working their way up to more difficult assemblies and fabrics as they gain experience.  Advancement for sewing machine operators, however, is limited. Advancement often takes the form of higher wages as workers become more experienced, although operators who have good people and organizational skills may become supervisors. Operators with a high school diploma and some vocational school training have more chances for advancement.  ***Professional and related occupations.*** Above all else, fashion designers need a good sense of color, texture, and style. In addition, they must know how to use computer-assisted design and understand the characteristics of specific fabrics, such as durability and stiffness, and anticipate construction problems. Obtaining a 4-year degree in art or fashion design is preferred, although a 2-year degree may suffice. This specialized training usually is obtained through a university or design school that offers 4-year or 2-year degrees in art, fine art, or fashion design. Many schools do not allow entry into a bachelor’s degree program until a student has completed a year of basic art and design courses. Applicants may be required to submit drawings and other examples of their artistic ability. Formal training also is available in 2- and 3-year fashion design schools that award certificates or associate degrees. Graduates of 2-year programs generally qualify as assistants to designers.  Beginning designers usually receive on-the-job training. They normally need 1 to 3 years of training before they advance to higher level positions, such as assistant technical designer, pattern designer, or head designer. Sometimes fashion designers advance by moving to bigger firms. Some designers choose to move into positions in business or merchandising.  Engineering applicants generally need a bachelor’s or advanced degree in a field of engineering or production management. Degrees in mechanical or industrial engineering are common, but concentrations in textile-specific areas of engineering are especially useful. For example, many applicants take classes in textile engineering, textile technology, textile materials, and design. These specialized programs usually are found in engineering and design schools in the South and Northeast. As in other industries, a technical degree with an advanced degree in business can lead to opportunities in management.  ***Employment change.*** Wage and salary employment in the textile, textile product, and apparel manufacturing industries is expected to decline by 35 percent through 2016, compared with a projected increase of 11 percent for all industries combined. Nevertheless, some job openings will arise as experienced workers transfer to other industries or retire or leave the workforce for other reasons.  Increasing investment in technology by textile mills, and the resulting increase in labor productivity, is the major reason for the projected decline in employment in the textile mills sector. Wider looms, robotics, new methods for making textiles that do not require spinning or weaving, and the application of computers to various processes result in fewer workers being needed to produce the same amount of textile products. Companies are also continuing to open new, more modern plants, which use fewer workers, while closing inefficient ones. As this happens, overall demand for textile machine operators and material handlers will continue to decline, but demand for those who have the skills to operate the more high-technology machines will grow.  Changing trade regulations are the single most important factor influencing future employment patterns. Because the apparel manufacturing sector is labor intensive, it is especially vulnerable to import competition from nations in which workers receive lower wages. In 2005, quotas for apparel and textile products were lifted among members of the World Trade Organization, including most U.S. trading partners and, in particular, China. Although some bilateral quotas have been re-imposed between the United States and China, the expiration of quotas in 2005 has allowed more apparel and textile products to be imported into the United States. Because many U.S. firms will continue to move their assembly operations to low-wage countries, this trend is likely to affect the jobs of lower skilled machine operators most severely. It does not, however, have as adverse an effect on the demand for some of the pre-sewing functions, such as designing, because much of the apparel will still be designed by American workers.  Continuing changes in the market for apparel goods will exert cost-cutting pressures that affect all workers in the textile and apparel industries. Consumers are becoming more price conscious, retailers are gaining bargaining power over apparel producers, and increasing competition is limiting the ability of producers to pass on costs to consumers. Apparel firms are likely to respond by relying more on foreign production and boosting productivity through investments in technology and new work structures.  Apparel firms also continue to merge or consolidate to remain competitive. This trend continues to drive down the number of firms in this industry. In the future, the apparel manufacturing sector will be dominated by highly efficient, profitable organizations that have developed their dominance through strategies that enable them to be among the lowest cost producers of apparel. Consolidation and mergers are likely to result in layoffs of some workers.  Some segments of the textile mill products sector, like industrial fabrics, carpets, and specialty yarns, are highly automated, innovative, and competitive on a global scale, so they will be able to expand exports as a result of more open trade. Other sectors, such as fabric for apparel, will be negatively affected, as a number of apparel manufacturers relocate production to other countries. Textile mills are likely to lose employment as a result. The expected increase in apparel imports will adversely affect demand for domestically produced textiles.  New technology will increase the apparel manufacturing sector’s productivity, although it is likely to remain labor-intensive. The variability of cloth and the intricacy of the cuts and seams of the assembly process have been difficult to automate. Machine operators, therefore, will continue to perform most sewing tasks, and automated sewing will be limited to simple functions. In some cases, however, computerized sewing machines will increase the productivity of operators and reduce required training time.  Technology also is increasing the productivity of workers who perform other functions, such as designing, marking, cutting, and pressing. Computers and automated machinery will continue to raise productivity and reduce the demand for workers in these areas, but the decline will be moderated by growth in demand for the services of these workers generated by offshore assembly sites. The rapid rate at which fashions change also will boost demand for workers employed in U.S.-based firms that have quick-response capabilities.  ***Job prospects.*** Despite the overall decline in employment, job prospects for skilled production workers, engineers, merchandisers, and designers should be fair as the industry evolves into one that primarily requires people with good communication skills, creativity, and who are skilled enough to operate today’s high technology computer-operated machines. The United States is leading the world in discovering new fibers and finding new uses for high-technology textiles. For example, biotechnology research is expected to lead to new sources of fibers, such as corn and other plants, and result in improvements in existing fibers. Some fibers currently being introduced have built-in memories of color and shape, and some have antibacterial qualities. Nanotechnology will also contribute to development of original fibers and garments for specialty uses. As these technologies and engineering advancements in textile production are implemented, the need will grow for more highly skilled workers who can work in an increasingly high-technology environment.   |  |  |  | | --- | --- | --- | | Earnings |  |  |   ***Industry earnings.*** Average weekly earnings of nonsupervisory production workers were $509 in textile mills, $478 in textile product mills, and $387 in apparel manufacturing establishments in 2006, compared with $691 for production workers in all manufacturing and $568 for production workers throughout private industry. Wages within the textile industry depend upon skill level and type of mill. In addition to typical benefits, employees often are eligible for discounts in factory merchandise stores.  Earnings in selected occupations in textile and apparel manufacturing appear in table 3. Traditionally, sewing machine operators are paid on a piecework basis determined by the quantity of goods they produce. Many companies are changing to incentive systems based on group performance that considers both the quantity and the quality of the goods produced. A few companies pay production workers a salary.   | **Table 3. Median hourly earnings of the largest occupations in textile, textile product, and apparel manufacturing, May 2006** | | | | | | --- | --- | --- | --- | --- | | **Occupation** | **Textile mills** | **Textile product mills** | **Apparel manufacturing** | **All industries** | | **First-line supervisors/managers of production and operating workers** | $20.44 | $19.71 | $16.84 | $22.74 | | **Textile knitting and weaving machine setters, operators, and tenders** | 11.96 | 12.36 | 10.22 | 11.68 | | **Inspectors, testers, sorters, samplers, and weighers** | 11.37 | 11.01 | 9.33 | 14.14 | | **Textile bleaching and dyeing machine operators and tenders** | 11.17 | 12.53 | 10.22 | 11.20 | | **Textile winding, twisting, and drawing out machine setters, operators, and tenders** | 10.78 | 11.98 | 10.19 | 11.08 | | **Textile cutting machine setters, operators, and tenders** | 10.41 | 10.52 | 9.71 | 10.39 | | **Helpers—production workers** | 10.29 | 9.66 | 8.40 | 9.97 | | **Laborers and freight, stock, and material movers, hand** | 10.11 | 9.86 | 8.81 | 10.20 | | **Sewing machine operators** | 9.53 | 9.63 | 8.45 | 9.04 | | **Packers and packagers, hand** | 9.24 | 8.91 | 8.44 | 8.48 |   ***Benefits and union membership.*** Relatively few workers in the textile and apparel industries belong to unions. Only 3 percent of apparel and textile workers were union members or were covered by a union contract in 2006, compared with 12 percent for the economy as a whole.    **Textile manufacturing**  **Textile manufacture** is a major [industry](http://en.wikipedia.org/wiki/Industry). It is based in the conversion of three types of [fibre](http://en.wikipedia.org/wiki/Fiber) (fiber is an alternative spelling in the US but not in Britain and the Commonwealth) into [yarn](http://en.wikipedia.org/wiki/Yarn), then [fabric](http://en.wikipedia.org/wiki/Fabric), then [textiles](http://en.wikipedia.org/wiki/Textile). These are then fabricated into [clothes](http://en.wikipedia.org/wiki/Clothing) or other artifacts. [Cotton](http://en.wikipedia.org/wiki/Cotton) remains the most important natural fibre, so is treated in depth. There are many sources of fibre, and variable processes available at the [spinning](http://en.wikipedia.org/wiki/Spinning) and fabric-forming stages coupled with the complexities of the [finishing](http://en.wikipedia.org/wiki/Finishing) and colouration processes to the production of a wide ranges of products. There remains a large industry that uses [hand techniques](http://en.wikipedia.org/wiki/Textile_manufacturing_by_pre-industrial_methods) to achieve the same results.   |  | | --- | | **Contents**   * [1 Processing of Cotton](http://en.wikipedia.org/wiki/Textile_manufacturing#Processing_of_Cotton)   + [1.1 Cultivating and harvesting](http://en.wikipedia.org/wiki/Textile_manufacturing#Cultivating_and_harvesting)     - [1.1.1 Issues](http://en.wikipedia.org/wiki/Textile_manufacturing#Issues)   + [1.2 Preparatory Processes- Preparation of yarn](http://en.wikipedia.org/wiki/Textile_manufacturing#Preparatory_Processes-_Preparation_of_yarn)   + [1.3 Spinning- Yarn manufacture](http://en.wikipedia.org/wiki/Textile_manufacturing#Spinning-_Yarn_manufacture)     - [1.3.1 Measurement](http://en.wikipedia.org/wiki/Textile_manufacturing#Measurement)   + [1.4 Weaving-Fabric manufacture](http://en.wikipedia.org/wiki/Textile_manufacturing#Weaving-Fabric_manufacture)     - [1.4.1 Measurements](http://en.wikipedia.org/wiki/Textile_manufacturing#Measurements)     - [1.4.2 Associated job titles](http://en.wikipedia.org/wiki/Textile_manufacturing#Associated_job_titles)   + [1.5 Knitting- Fabric manufacture](http://en.wikipedia.org/wiki/Textile_manufacturing#Knitting-_Fabric_manufacture)   + [1.6 Finishing- Processing of Textiles](http://en.wikipedia.org/wiki/Textile_manufacturing#Finishing-_Processing_of_Textiles)   + [1.7 Economic, environmental and political consequences of cotton manufacture](http://en.wikipedia.org/wiki/Textile_manufacturing#Economic.2C_environmental_and_political_consequences_of_cotton_manufacture) * [2 Processing of other vegetable fibres- other processes](http://en.wikipedia.org/wiki/Textile_manufacturing#Processing_of_other_vegetable_fibres-_other_processes) * [3 Processing of Protein fibres](http://en.wikipedia.org/wiki/Textile_manufacturing#Processing_of_Protein_fibres) * [4 Processing of man made fibres](http://en.wikipedia.org/wiki/Textile_manufacturing#Processing_of_man_made_fibres)   + [4.1 Discussion of types of man made fibres](http://en.wikipedia.org/wiki/Textile_manufacturing#Discussion_of_types_of_man_made_fibres)   + [4.2 Additional processes associated with man made fibres](http://en.wikipedia.org/wiki/Textile_manufacturing#Additional_processes_associated_with_man_made_fibres) * [6 References](http://en.wikipedia.org/wiki/Textile_manufacturing#References) |   **Processing of Cotton**  Cotton is the world's most important natural fibre. In the year 2007, the global yield was 25 million tons from 35 million hectares cultivated in more than 50 countries.  There are five stages   * Cultivating and Harvesting * Preparatory Processes * Spinning * Weaving * Finishing   **Cultivating and harvesting**  [Cotton](http://en.wikipedia.org/wiki/Gossypium) is grown anywhere with long, hot dry summers with plenty of sunshine and low humidity. Indian cotton, gossypium arboreum is finer but the staple is only suitable for hand processing. American cotton, gossypium hirsutum produces the longer staple needed for machine production. Planting is from September to mid November and the crop is harvested between March and May. The [cotton bolls](http://en.wikipedia.org/wiki/Capsule) are harvested by stripper harvesters and spindle pickers, that remove the entire boll from the plant. The cotton boll is the seed pod of the cotton plant, attached to each of the thousands of seeds are fibres about 2.5 cm long.  **Ginning**  The seed cotton goes in to a [Cotton Gin](http://en.wikipedia.org/wiki/Cotton_Gin). The cotton gin separates the seeds and removes the "trash" (dirt, stems and leaves) from the fibre. In a saw gin, circular saw grab the fibre and pull it through a grating that is too narrow for he seeds to pass. A roller gin is used with longer staple cotton,. Here a leather roller captures the cotton. A knife blade, set close to the roller detaches the seed. by drawing them through teeth in circular saws and revolving brushes which clean them away.  The ginned cotton fibre, known as lint, is then compressed into bales which are about 1.5m tall and weigh almost 220 kg. Only 33% of the crop is usable lint. Commercial cotton is priced by quality, and that broadly relates to the average length of the staple, and the variety of the plant. Longer staple cotton ( 2 1/2 in to 1 1/4 in) is called Egyptian, medium staple ( 1 1/4 in to 3/4 in) is called American upland and short staple ( less than 3/4 in) is called Indian  The cotton seed is pressed into a cooking oil. The husks and meal are processed into animal feed, and the stems into paper.  **Issues**  Cotton is farmed intensively and uses large amounts of fertiliser and 25% of the worlds insecticide. Native Indian variety were rainwater fed, but modern hybrids used for the mills need irrigation, which spreads pests. The 5% of cotton bearing land in India uses 55% of all pesticides. Before mechanisation, cotton was havested manually and this unpleasant task was done by the lower castes, and in the United States by slaves of African origin.  **Preparatory Processes- Preparation of yarn**   * **Ginning, bale-making and transportation** is done in the country of origin. * **Opening and cleaning**   [http://upload.wikimedia.org/wikipedia/commons/thumb/5/5d/Catalonia_Terrassa_mNATEC_Batuar_1885.jpg/140px-Catalonia_Terrassa_mNATEC_Batuar_1885.jpg](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_Batuar_1885.jpg)  [http://en.wikipedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_Batuar_1885.jpg)  Platt Bros. Picker  Cotton mills get the cotton shipped to them in large, 500 pound bales. When the cotton comes out of a bale, it is all packed together and still contains vegetable matter. The bale is broken open using a machine with large spikes. It is called an **Opener**.In order to fluff up the cotton and remove the vegetable matter, the cotton is sent through a picker, or similar machines. A **picker** looks similar to the carding machine and the cotton gin, but is slightly different. The cotton is fed into the machine and gets beaten with a beater bar, to loosen it up. It is fed through various rollers, which serve to remove the vegetable matter. The cotton, aided by fans, then collects on a screen and gets fed through more rollers till it emerges as a continuous soft fleecy sheet, known as a lap.   * **Blending**,   Mixing & Scutching   * **Carding**   *Main article:* [*Carding machine*](http://en.wikipedia.org/w/index.php?title=Carding_machine&action=edit&redlink=1)  [http://upload.wikimedia.org/wikipedia/commons/thumb/b/b2/Catalonia_Terrassa_mNATEC_CardaObridora.jpg/140px-Catalonia_Terrassa_mNATEC_CardaObridora.jpg](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_CardaObridora.jpg)  Carding machine  Carding: the fibres are separated and then assembled into a loose strand (sliver or tow) at the conclusion of this stage.  The cotton comes off of the picking machine in laps, and is then taken to carding machines. The carders line up the fibres nicely to make them easier to spin. The carding machine consists mainly of one big roller with smaller ones surrounding it. All of the rollers are covered in small teeth, and as the cotton progresses further on the teeth get finer (i.e. closer together). The cotton leaves the carding machine in the form of a sliver; a large rope of fibres.   * **Combing** is optional,but is used to remove the shorter fibres, creating a stronger yarn.   [http://upload.wikimedia.org/wikipedia/commons/thumb/f/fe/Catalonia_Terrassa_mNATEC_Pentinadora.jpg/140px-Catalonia_Terrassa_mNATEC_Pentinadora.jpg](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_Pentinadora.jpg)  A Combing machine   * **Drawing** the fibres are straightened   Several slivers are combined. Each sliver will have thin and thick spots, and by combining several slivers together a more consistent size can be reached. Since combining several slivers produces a very thick rope of cotton fibres, directly after being combined the slivers are separated into rovings. These rovings are then what are used in the spinning process. Generally speaking, for machine processing a roving is about the width of a pencil.Next, several slivers are combined. Each sliver will have thin and thick spots, and by combining several slivers together a more consistent size can be reached. Since combining several slivers produces a very thick rope of cotton fibres, directly after being combined the slivers are separated into rovings. These rovings (or slubbings) are then what are used in the spinning process.  Generally speaking, for machine processing, a roving is about the width of a pencil.  Drawing frame: Draws the strand out  Slubbing Frame: adds twist, and winds on to bobbins  Intermediate Frames: are used to repeat the slubbing process to produce a finer yarn.  Roving frames: reduces to a finer thread, gives more twist, makes more regular and even in thickness, and winds on to a smaller tube.  **Spinning- Yarn manufacture**  *Main article:* [*Cotton-spinning machinery*](http://en.wikipedia.org/wiki/Cotton-spinning_machinery)   * **Spinning**   The spinning machines take the roving, thins it and twists it, creating yarn which it winds onto a bobbin.  In [mule spinning](http://en.wikipedia.org/wiki/Spinning_mule) he roving is pulled off a bobbin and fed through some rollers, which are feeding at several different speeds.This thins the roving at a consistent rate. If the roving was not a consistent size, then this step could cause a break in the yarn, or could jam the machine. The yarn is twisted through the spinning of the bobbin as the carriage moves out, and is rolled onto a cop as the carriage returns. Mule spinning produces a finer thread than the less skilled [ring spinning](http://en.wikipedia.org/w/index.php?title=Ring_spinning&action=edit&redlink=1).   * The mule was an intermittent process, as the frame advanced and returned a distance of 5ft.It was the descendant of 1779 Crompton device. It produces a softer less twisted thread that was favoured for fines and for weft. It requires considerable skill, so was womens work. * The ring was a descendant of the Arkwright water Frame 1769. It was a continuous process, the yard was coarser, had a greater twist and was stronger so was suited to be warp. Requiring less skill it was mens work. Ring spinning is slow due to the distance the thread must pass around the ring, other methods have been introduced. These are collectively known as Break or Open-end spinning.   Sewing thread, was made of several threads twisted together, or doubled.   * **Checking**   This is the process where each of the bobbins is rewound to give a tighter bobbin.   * **Folding and twisting**   Plying is done by pulling yarn from two or more bobbins and twisting it together, in the opposite direction that that in which it was spun. Depending on the weight desired, the cotton may or may not be plied, and the number of strands twisted together varies.   * **Gassing**   *Main articles:* [*Singe#Textiles*](http://en.wikipedia.org/wiki/Singe#Textiles) *and* [*Gassing*](http://en.wikipedia.org/wiki/Gassing)  Gassing is the process of passing yarn, as distinct from fabric very rapidly through a series of Bunsen gas flames in a gassing frame, in order to burn off the projecting fibres and make the thread round and smooth and also brighter. Only the better qualities of yarn are gassed, such as that used for voiles, poplins, venetians, gabardines, many Egyptian qualities, etc. There is a loss of weight in gassing, which varies' about 5 to 8 per cent., so that if a 2/60's yarn is required 2/56's would be used. The gassed yarn is darker in shade afterwards, but should not be scorched.[[17]](http://en.wikipedia.org/wiki/Textile_manufacturing#cite_note-16)   |  | | --- | |  |  |  |  |  |  | | --- | --- | --- | --- | | [http://upload.wikimedia.org/wikipedia/commons/thumb/b/b8/Textile-Spinning_room.jpg/120px-Textile-Spinning_room.jpg](http://en.wikipedia.org/wiki/File:Textile-Spinning_room.jpg)  Mule spinning | [http://upload.wikimedia.org/wikipedia/commons/thumb/7/79/Catalonia_Terrassa_mNATEC_Selfactina.jpg/120px-Catalonia_Terrassa_mNATEC_Selfactina.jpg](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_Selfactina.jpg)  Mule spinning | [http://upload.wikimedia.org/wikipedia/commons/thumb/e/ec/Ringspinnen.JPG/90px-Ringspinnen.JPG](http://en.wikipedia.org/wiki/File:Ringspinnen.JPG)  Ring spinning | [http://upload.wikimedia.org/wikipedia/commons/thumb/5/5e/Ring_spinning_machine_in_the_1920s.jpg/120px-Ring_spinning_machine_in_the_1920s.jpg](http://en.wikipedia.org/wiki/File:Ring_spinning_machine_in_the_1920s.jpg)  Ring spinning |   **Measurement**   * Cotton Counts: The number of pieces of thread, 840 yards long needed to make up 1 lb weight. 10 count cotton means that 10x840 yds weighs 1lb. This is coarser than 20 count cotton where 20x840 yards are needed. * Hank: A length of 7 leas or 840 yards * Thread: A length of 54 in (the circumference of a warp beam) * Bundle: Usually 10 lbs * Lea: A length of 80 threads or 120 yards * Denier: this is an alternative method. It is defined as a number that is equivalent to the weight in grams of 9000m of a single yarn. 15 denier is finer than 30 denier. * Tex: is the weight in grams of 1km of yarn. * **Weaving-Fabric manufacture**   The weaving process uses a loom. The lengthway threads are known as the warp, and the cross way threads are known as the weft. The warp which must be strong needs to be presented to loom on a warp beam. The weft, passes across the loom in a shuttle, that carries the yarn on a pirn. These pirns are automatically changed by the loom. Thus, the yarn needs to be wrapped onto a beam, and onto pirns before weaving can commence.   * **Winding**   After being spun and plied, the cotton thread is taken to a warping room where the winding machine takes the required length of yarn and winds it onto warpers bobbins   * **Warping or beaming**   [http://upload.wikimedia.org/wikipedia/commons/thumb/c/c1/Catalonia_Terrassa_mNATEC_Ordidor.jpg/140px-Catalonia_Terrassa_mNATEC_Ordidor.jpg](http://en.wikipedia.org/wiki/File:Catalonia_Terrassa_mNATEC_Ordidor.jpg)  A Warper  Racks of bobbins are set up to hold the thread while it is rolled onto the warp bar of a loom. Because the thread is fine, often three of these would be combined to get the desired thread count.[citation needed].   * **Sizing**   Slasher sizing machine needed for strengthening the warp by adding starch.   * **Drawing in, Looming**   The process of drawing each end of the warp separately through the dents of the reed and the eyes of the healds, in the order indicated by the draft.   * **Pirning (Processing the weft)**   Pirn winding frame was used to transfer the weft from cheeses of yarn onto the pirns that would fit into the shuttle   * **Weaving** * At this point, the thread is woven. Depending on the era, one person could manage anywhere from 3 to 100 machines. In the mid nineteenth century, four was the standard number. A skilled weaver in 1925 would run 6 [Lancashire Looms](http://en.wikipedia.org/wiki/Lancashire_Loom). As time progressed new mechanisms were added that stopped the loom any time something went wrong. The mechanisms checked for such things as a broken warp thread, broken weft thread, the shuttle going straight across, and if the shuttle was empty. Forty of these [Northrop Looms](http://en.wikipedia.org/wiki/Northrop_Loom) or automatic looms could be operated by one skilled worker.   [http://upload.wikimedia.org/wikipedia/commons/thumb/e/ea/Strickmaschine_im_Museum.JPG/180px-Strickmaschine_im_Museum.JPG](http://en.wikipedia.org/wiki/File:Strickmaschine_im_Museum.JPG)A Draper loom in textile museum,  The three primary movements of a loom are shedding, picking, and beating-up.   * *Shedding*: The operation of dividing the warp into two lines, so that the shuttle can pass between these lines. There are two general kinds of sheds-"open" and "closed." Open Shed-The warp threads are moved when the pattern requires it-from one line to the other. Closed Shed-The warp threads are all placed level in one line after each pick. * *Picking*:The operation of projecting the shuttle from side to side of the loom through the division in the warp threads. This is done by the overpick or underpick motions. The overpick is suitable for quick-running looms, whereas the underpick is best for heavy or slow looms. * *Beating-up*: The third primary movement of the loom when making cloth, and is the action of the reed as it drives each pick of weft to the fell of the cloth.   A [Cartwright Loom](http://en.wikipedia.org/wiki/Power_loom) was an early power loom, that stopped each time the pirn was empty are needed an operative to replace the shuttle. [Jacquard Looms](http://en.wikipedia.org/wiki/Jacquard_Loom) and [Dobby Looms](http://en.wikipedia.org/wiki/Dobby_loom) are looms that have sophisticated methods of shedding. They may be separate looms, or mechanisms added to a plain loom.  **Measurements**   * Ends and Picks: Picks refer to the weft, ends refer to the warp. The coarseness of the cloth can be expressed as the number of picks and ends per quarter inch square , or per inch square. Ends is always written first. For example: *Heavy domestics are made from coarse yarns, such as 10's to 14's warp and weft, and about 48 ends and 52 picks.* **Associated job titles** * Piecer * Scavenger * Weaver * Tackler * Draw boy * Pirner   **Knitting- Fabric manufacture**  [http://upload.wikimedia.org/wikipedia/commons/thumb/b/b4/Rundstrickmaschine_Nadel_scharf.jpg/180px-Rundstrickmaschine_Nadel_scharf.jpg](http://en.wikipedia.org/wiki/File:Rundstrickmaschine_Nadel_scharf.jpg)  [http://en.wikipedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Rundstrickmaschine_Nadel_scharf.jpg)  A circular knitting machine.  [http://upload.wikimedia.org/wikipedia/commons/thumb/b/bb/Rundstrickmaschine_Zungennadeln.jpg/180px-Rundstrickmaschine_Zungennadeln.jpg](http://en.wikipedia.org/wiki/File:Rundstrickmaschine_Zungennadeln.jpg)  Close-up on the needles.  [Knitting](http://en.wikipedia.org/wiki/Knitting) by [machine](http://en.wikipedia.org/wiki/Knitting_machine) is done in two different ways; warp and weft. Weft knitting (as seen in the pictures) is similar in method to hand knitting with stitches all connected to each other horizontally. Various weft machines can be configured to produce textiles from a single spool of [yarn](http://en.wikipedia.org/wiki/Yarn) or multiple spools depending on the size of the machine cylinder (where the needles are bedded). In a warp knit there are many pieces of yarn and there are vertical chains, zigzagged together by crossing the yarn.  Warp knits do not stretch as much as a weft knit, and it is run-resistant. A weft knit is not run-resistant, but stretches more, this is especially true if spools of [Lycra](http://en.wikipedia.org/wiki/Lycra) are processed from separate spool containers and interwoven through the cylinder with cotton yarn giving the finished product more [flexibilty](http://en.wikipedia.org/wiki/Spandex) making it less prone to having a 'baggy' appearance. The average [t-shirt](http://en.wikipedia.org/wiki/T-shirt) is a weft knit.  **Finishing- Processing of Textiles**  The **grey cloth**,woven cotton fabric in its loom-state, not only contains impurities, including warp size, but requires further treatment in order to develop its full textile potential. Furthermore, it may receive considerable added value by applying one or more finishing processes.   * **Desizing**   Depending on the size that has been used, the cloth may be steeped in a dilute acid and then rinsed, or enzymes may be used to break down the size.   * **Scouring**   Scouring, is a chemical washing process carried out on cotton fabric to remove natural wax and non-fibrous impurities (eg the remains of seed fragments) from the fibres and any added soiling or dirt. Scouring is usually carried in iron vessels called [kiers](http://en.wikipedia.org/wiki/Kier). The fabric is boiled in an [alkali](http://en.wikipedia.org/wiki/Alkali), which forms a soap with free fatty acids. ([saponification](http://en.wikipedia.org/wiki/Saponification" \o "Saponification)). A kier is usually enclosed, so the solution of [sodium hydroxide](http://en.wikipedia.org/wiki/Sodium_hydroxide) can be boiled under pressure, excluding [oxygen](http://en.wikipedia.org/wiki/Oxygen) which would degrade the [cellulose](http://en.wikipedia.org/wiki/Cellulose) in the fibre. If the appropriate [reagents](http://en.wikipedia.org/wiki/Reagent) are used, scouring will also remove size from the fabric although desizing often precedes scouring and is considered to be a separate process known as fabric preparation. Preparation and scouring are prerequisites to most of the other finishing processes. At this stage even the most naturally white cotton fibres are yellowish, and bleaching, the next process, is required.  **Bleaching**  *Main article:* [*Textile bleaching*](http://en.wikipedia.org/wiki/Textile_bleaching)  Bleaching improves whiteness by removing natural coloration and remaining trace impurities from the cotton; the degree of bleaching necessary is determined by the required whiteness and absorbency. Cotton being a vegetable fibre will be bleached using an [oxidizing agent](http://en.wikipedia.org/wiki/Oxidizing_agent), such as dilute [sodium hydrochlorite](http://en.wikipedia.org/w/index.php?title=Sodium_hydrochlorite&action=edit&redlink=1) or dilute [hydrogen peroxide](http://en.wikipedia.org/wiki/Hydrogen_peroxide). If the fabric is to be dyed a deep shade, then lower levels of bleaching are acceptable, for example. However, for white bed sheetings and medical applications, the highest levels of whiteness and absorbency are essential.   * **Mercerising**   *Main article:* [*Mercerized cotton*](http://en.wikipedia.org/wiki/Mercerized_cotton)  A further possibility is mercerizing during which the fabric is treated with caustic soda solution to cause swelling of the fibres. This results in improved lustre, strength and dye affinity. Cotton is mercerized under tension, and all alkali must be washed out before the tension is released or shrinkage will take place. Mercerizing can take place directly on grey cloth, or after bleaching.  Many other chemical treatments may be applied to cotton fabrics to produce low flammability, crease resist and other special effects but four important non-chemical finishing treatments are:   * **Singeing**   *Main article:* [*Singe#Textiles*](http://en.wikipedia.org/wiki/Singe#Textiles)  Singeing is designed to burn off the surface fibres from the fabric to produce smoothness. The fabric passes over brushes to raise the fibres, then passes over a plate heated by gas flames.   * **Raising**   Another finishing process is raising. During raising, the fabric surface is treated with sharp teeth to lift the surface fibres, thereby imparting hairiness, softness and warmth, as in flannelette.   * **Calendering**   *Main article:* [*Calender*](http://en.wikipedia.org/wiki/Calender)  Calendering is the third important mechanical process, in which the fabric is passed between heated rollers to generate smooth, polished or embossed effects depending on roller surface properties and relative speeds.   * **Shrinking (Sanforizing)**   *Main article:* [*Sanforization*](http://en.wikipedia.org/wiki/Sanforization)  Finally, mechanical shrinking (sometimes referred to as sanforizing), whereby the fabric is forced to shrink width and/or lengthwise, creates a fabric in which any residual tendency to shrink after subsequent laundering is minimal.   * **Dyeing**   *Main article:* [*Dyeing*](http://en.wikipedia.org/wiki/Dyeing)  Finally, cotton is an absorbent fibre which responds readily to colouration processes. Dyeing, for instance, is commonly carried out with an anionic direct dye by completely immersing the fabric (or yarn) in an aqueous dyebath according to a prescribed procedure. For improved fastness to washing, rubbing and light, other dyes such as vats and reactives are commonly used. These require more complex chemistry during processing and are thus more expensive to apply.   * **Printing**   *Main article:* [*Textile printing*](http://en.wikipedia.org/wiki/Textile_printing)  Printing, on the other hand, is the application of colour in the form of a paste or ink to the surface of a fabric, in a predetermined pattern. It may be considered as localised dyeing. Printing designs on to already dyed fabric is also possible.  **Economic, environmental and political consequences of cotton manufacture**  The growth of cotton is divided into two segments i.e. organic and genetically modified. Cotton crop provides livelihood to millions of people but its production is becoming expensive because of high water consumption, use of expensive pesticides, insecticides and fertiliser. GM products aim to increase disease resistance and reduce the water required. The organic sector was worth $583 million. GM cotton, in 2007, occupied 43% of cotton growing areas.  The consumption of energy in form of water and electricity is relatively high, especially in processes like washing, de-sizing, bleaching, rinsing, dyeing, printing, coating and finishing. Processing is time consuming. The major portion of water in textile industry is used for wet processing of textile (70 per cent). Approximately 25 per cent of energy in the total textile production like fibre production, spinning, twisting, weaving, knitting, clothing manufacturing etc. is used in dyeing. About 34 per cent of energy is consumed in spinning, 23 per cent in weaving, 38 per cent in chemical wet processing and five per cent in miscellaneous processes. Power dominates consumption pattern in spinning and weaving, while thermal energy is the major factor for chemical wet processing.  **Processing of other vegetable fibres- other processes**   * [Flax](http://en.wikipedia.org/wiki/Flax) * [Hemp](http://en.wikipedia.org/wiki/Hemp) * [Jute](http://en.wikipedia.org/wiki/Jute)   **Processing of Protein fibres**   * [Wool](http://en.wikipedia.org/wiki/Wool) * [Silk](http://en.wikipedia.org/wiki/Silk) * [Angora](http://en.wikipedia.org/wiki/Angora)   **Processing of man made fibres**  **Discussion of types of man made fibres**  **Synthetic fibres** are the result of extensive development by [scientists](http://en.wikipedia.org/wiki/Scientist) to improve upon the naturally occurring [animal](http://en.wikipedia.org/wiki/Animal) and plant fibres. In general, [synthetic](http://en.wikipedia.org/wiki/Synthetic) fibres are created by forcing, or [extruding](http://en.wikipedia.org/wiki/Extrusion), fibre forming materials through holes (called spinnerets) into the air, thus forming a thread. Before synthetic fibres were developed, [artificially](http://en.wikipedia.org/wiki/Artificial) manufactured fibers were made from [cellulose](http://en.wikipedia.org/wiki/Cellulose), which comes from [plants](http://en.wikipedia.org/wiki/Plants).  The first artificial fibre, known as [artificial silk](http://en.wikipedia.org/wiki/Artificial_silk) from 1799 onwards, became known as [viscose](http://en.wikipedia.org/wiki/Viscose) around 1894, and finally [rayon](http://en.wikipedia.org/wiki/Rayon) in 1924. A similar product known as [cellulose acetate](http://en.wikipedia.org/wiki/Cellulose_acetate) was discovered in 1865. Rayon and acetate are both artificial fibres, but not truly synthetic, being made from [wood](http://en.wikipedia.org/wiki/Wood). Although these artificial fibres were discovered in the mid-nineteenth century, successful modern manufacture began much later in the 1930's. [Nylon](http://en.wikipedia.org/wiki/Nylon), the first synthetic fibre, made its debut in the [United States](http://en.wikipedia.org/wiki/United_States) as a replacement for [silk](http://en.wikipedia.org/wiki/Silk), and was used for [parachutes](http://en.wikipedia.org/wiki/Parachutes) and other [military](http://en.wikipedia.org/wiki/Military) uses.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]  The techniques used to process these fibres in yarn are essentially the same as with natural fibres, modifications have to be made as these fibers are of great length, and have no texture such as the scales in cotton and wool that aid meshing.  **Additional processes associated with man made fibres**  **References**   1. ^ [***a***](http://en.wikipedia.org/wiki/Textile_manufacturing#cite_ref-Majeed_0-0) [***b***](http://en.wikipedia.org/wiki/Textile_manufacturing#cite_ref-Majeed_0-1) [***c***](http://en.wikipedia.org/wiki/Textile_manufacturing#cite_ref-Majeed_0-2) Majeed, A (January 19, 2009). 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Mahbubul Haque* | | **Introduction**  Bangladesh is one of the leading exporters of ready-made garments in the world and earning nearly 76% of its foreign currency through exporting textiles and ready-made garments. We mainly produce and export two types of textile products e.g. woven and knit goods produced from woven fabric and knit fabric respectively. Presently, almost 100% export oriented knitted fabrics are being produced in the country while more than 60% of the export oriented woven fabric is imported resulting in drainage of huge amount of foreign currency. Apart from woven fabric, we have to import 100% of dyes, chemicals, spare parts and machinery. In recent years, the garment business became very volatile. Some of these problems are worker unrest for low salary for which manufacturers have problem in meeting schedule, import of Indian yarns and competing with other South East Asian countries. At present Vietnam is offering the most competitive garment price in the world. Though, like Bangladesh, Vietnam also imports cotton from other countries and the labor cost in Vietnam is more than that of Bangladesh. They must have established some ways to minimize the cost in order to be competitive in the world market. So it is very clear that, to sustain in the business in world market on a long term basis, Bangladesh should improve its export oriented textile and RMG sector (EOTRS). Some of the following suggestions were put forward to improve the overall performance of the textiles and RMG sector of Bangladesh.  **Development of Research & Development (R & D) Facility**  Most of our competitor countries have very well established textiles and RMG research facilities. An R & D facility can contribute to the following main aspects  **(i)** By R & D, it is possible to find ways to reduce waste and cost of production to maximize profit. **(ii)** Increase productivity by improving process performance and product quality.  **(iii)** New product, market and business ideas can be investigated for further expansion.  **(iv)** Generation of tax revenue due to maximization of profit. **(v)** Monitor and control textile RMG business at national level,  **(vi)** Safeguard and secure our business interest at international level.   http://www.cottonbangladesh.com/image/StpstImprove01.jpgIn many cases we are not able to manufacture certain specialty fabric or quality of some of our woven or knitted products are not up to the buyer's requirements. As a consequence we have to import those specialty fabrics. In such cases the proposed R & D center can do some research on those special products and help the manufacturer to produce them. This type of capability is required in all fields of textile manufacturing. It is also essential to standardize or calibrate our own processing capability in order to estimate minimum waste to be generated. This information is important because if manufacturers know their waste % and manufacturing cost as well as their corresponding standard values then it becomes very easier for them to decide whether they need to improve their processing further or not. Also it will indicate if our manufacturing cost is competitive with competing countries. An R & D centre is also very useful to help business owners by providing ideas about product diversification, development of new products and markets as well.  The following is a demonstration of how the R & D can contribute to the cost of a garment. Every textile product has two major cost components; (a) Raw materials cost and (b) Conversion cost. Through Effective R & D it is possible to achieve contribution from R & D to (i) to (iii) mentioned above and it will be possible to reduce the conversion cost.  The cost of fabric of a garment is nearly 50-60% of its total cost. If we can reduce the conversion cost at each stage i.e. in spinning, weaving, knitting, dyeing printing and finishing, then we will be able to reduce the cost of fabric and the finished garment.  **Who Can Conduct R & D?**   **Individual Industries:** R & D facility could be set up by industries themselves in order to get maximum benefit by evaluating own problems and implement the result in a short period of time. But the overhead cost is very high and only very large organization can afford that.   **Business associations like BTMA, BGMEA & BKMEA:** R & D would be very cost effective if a group of organizations like BTMA, BGMEA & BKMEA set up a facility and finance all the research work to solve the problems faced by the industry.  **Government:** Since the Government receive huge amount of money from this sector in the form of tax and vats. To make this sector more productive, Government could help to develop and manage an R & D facility. Since it would take significant amount of time in planning and development. Presently, it is possible to use facilities like National Institute of Textile Training Research and Design and Bangladesh Jute Research Institute if equipped with some additional equipment for conducting textile research.   **Universities:** Universities like College of Textile Engineering at Tejgaon, Ahsanullah University of Science and Technology (AUST) etc could also make some contribution by doing the research work using the expertise of experience professors if the fund is provided by either Government or industries. These places are equipped with state of art and world class textile laboratory instruments. It also helps creating more knowledgeable and experienced working force who could contribute a lot while serving these industries.  **Add More Value to our Products**  http://www.cottonbangladesh.com/image/StpstImprove02.jpgValue addition is one of the best ways to maximize profit. Value addition means increasing sales value. There are various ways by which value can be added to a product. If we consider two different shirts both of same size and produced from similar raw materials but may behttp://www.cottonbangladesh.com/image/StpstImprove03.jpg sold in the markets with substantial difference in prices. The reason could be one of many e.g. brand, quality control, dyeing or finishing processes used, special finishes like moth proof or fire proof, attribution of art works like embroidery and attachments etc. Since we have comparatively cheap labor and electricity available in Bangladesh we should consider those products which involve more labor and can add more value to a product.    http://www.cottonbangladesh.com/image/StpstImprove04.jpgDifferent types of apparel products require different types of manufacturing infrastructures. If the infrastructure for making shirts could be used to produce suits, it would also be a kind of value addition to the infrastructure. In fact, during production, the higher the processing steps required by the customers, the higher would be the value addition. Some of the high value added products are costly products like high quality sports wear, shirts, suits, jackets etc. An organized R & D can precisely help in attributing value addition as well as finding value added new products and markets. Presently, Bangladesh is mainly producing cheaper textile and apparel products. By R & D it will be possible to say which products will maximize profit and accordingly the marketing and merchandising people of the factories can be guided to target those products.  **Product Diversification**  http://www.cottonbangladesh.com/image/StpstImprove06.jpgStudy of export patterns suggests that Bangladesh is mainly manufacturing garments items made from 100% cotton fiber. Bangladeshi spinning mills produces nearly 90% cottons yarns and only 10% blended yarns, but the global scenario is quite different. China produces the cotton products is only one third of its total volume of export. Similar trend is found in our competitor countries like Pakistan and India. Also, in Bangladesh, the volume of export of apparel products is also very low in comparison to that of non apparel products like bed sheets, bed covers, pillow cases, pillow covers, towels, quilts, curtains etc.  Only 33% apparels are produced from 100% cotton fiber and rest of the apparels are produced from synthetic and other fibers. Bangladesh is mainly concentrating on 33% share of the world's apparel market and does not have any share in the rest 67% synthetic apparel market. Small amount of blended apparels are being exported from Bangladesh but the raw materials, like fabric are imported since quality of the local polyester yarn is not up to the mark. Only several factories are producing synthetic polyester filament yarns and these yarns are consumed locally. Further research and expertise is required to add value to the existing polyester fibers. Bangladesh should seriously think about increasing its activities in the field of synthetic apparel market to have more growth in textile sector and maximize the profit.  **Develop our Synthetic Capability**  http://www.cottonbangladesh.com/image/StpstImprove05.jpgAs was earlier mentioned, 67% of the world's apparels are produced from synthetic fiber known as Man Made Fibers (MMF). In Bangladesh, we only manufacture 100% cotton products. If we can manufacture synthetic fibers as well as dyes and chemical in our country then we will be able to produce woven fabrics locally at much cheaper costs. Synthetic yarns provide better yield and productivity. The cost will further decrease if we can manufacture our own accessories for main machines.  Study of the export pattern of some Asian countries shows some interesting discrepancy between the strategy of textile export of Bangladesh and other countries particularly China, the leader in textile export. The quantity of non-apparel export of all the surveyed Asian countries is almost double of that of apparel export. The volume of Non-apparel export from Bangladesh is also very low in comparison to China and other Asian countries. Therefore Bangladesh should try to explore its non-apparel market.  The export pattern of 100% cotton and MMF products to the US market in the year 2006 shows that export of China's non apparel products is exceptionally higher than apparel export. The scenario is exactly opposite for Bangladesh, i.e. quantity of apparel export is much larger than that of non apparel products. Bangladesh should try to explore its MMF market to have greater access to textile business. MMF is also environmental friendly.  **Need to Develop Woven Sector**  http://www.cottonbangladesh.com/image/StpstImprove07.jpgAt present, nearly 60% of the export oriented woven fabrics are imported. The woven production has some advantages as well as disadvantages over knit production. The advantages are (i) very vast market, (ii) woven products are value added pro-ducts and costly so that profit margin is better than knit garments. The disadvantages of woven products are (i) production, dyeing printing and finishing of woven fabric require lot more expertise and experts than required in the knit fabric manufacturing (ii) cost of weaving plants are much higher than that of knitting plants.  But there is enormous opportunity for woven sector as there is a huge demand in local export oriented garment factories. The garment manufacturers will definitely prefer local fabrics in order to avoid the problems with the overseas fabric sup-pliers and to minimize production time. Unfortunately very few entrepreneurs are interested to invest on this vast market. Woven factories are relatively more profitable industry due to the demand in world market. In china, most of the big garment manufacturers have their own weaving and in some cases spinning facility. In case of woven fabric different types machines are used to make certain quality of fabric. If the garment factory owners have their own weaving facility then participating in world market becomes relatively easier as the marketing people knows very well what type of fabric they needed to produce to fulfill the demand Therefore it is strongly recommended that if possible the garment manufacturers should develop their own weaving facility themselves.  http://www.cottonbangladesh.com/image/StpstImprove08.jpgDeveloping the weaving sector not only our foreign currency retention will be increased as well as our garment business will be better secured. Import of fabric for export market is not a healthy for business as are too many risks associated with this; e.g. (i) lead time is very high, (ii) if the imported fabric is too much defective or of any sort of mismatching arises, then there is no way of compensation in such short period of time. If import of woven fabric is disrupted, the garment business will collapsed in overnight loosing lots of money and leaving millions of garments workers jobless. To avoid this kind of uncertainties and garment manufacturer imports certain excess fabric. It is quite uncertain whether additional fabric will be required or not. Cost of additional fabric definitely is included in the cost of garment. If the fabric is produced locally, this kind of uncertainty can be handled efficiently.  If the export oriented woven sector is developed, we could export woven fabrics. There is also a big advantage of having strong woven sector in the domestic apparel market because huge amount of fabrics as well as garments are imported for our local consumption. If local woven sector is developed, the amount of domestic import of fabric and garment will be less.  Due to some reasons, the woven sector could not flourish well. Some of these reasons and their remedies are discussed below.  **i. Very high initial investment:** Woven projects are associated with very high investment, only large entrepreneurs are interested in woven projects. Government can encourage entrepreneurs by providing advantages like soft loans, tax holidays, tax free import of machinery etc. Other sectors like spinning, dyeing printing and finishing and garment manufacturing sectors should not be comparable with this sector. This is required to manufacture woven fabric locally at lower price so that the cost of garments will be decreased and profit will be increased.   **ii. Introduce blend processing:** The main requirement of yarn for weaving is its strength. During weaving the yarns are subjected to various types of stretching forces. To counteract these forces yarns are sized. Yarn breaks during weaving due to low strength. Bangladesh processes 100% cotton yarns whose strength is much lower than blended yarns. Blended yarns are produced by mixing cotton and synthetic fiber like polyester.  http://www.cottonbangladesh.com/image/StpstImprove09.jpg**iii. Special Woven market:** Weaving and woven dyeing need special type of marketing. The variety of woven fabric is large in comparison to the knitted fabric. Due to continuous change of fashion and quality, particulars of woven fabric changes on a continuous basis. If the Garment manufacturers themselves set up woven and woven dyeing factories, the aspect of fashion change can be managed efficiently. In China, most of the garment manufacturers have their own woven factories.   **iv. Proper R & D may be helpful:** One of the important problems faced by many weaving factories is the sample development. A well organized R & D center will be very helpful in developing samples as well as improving quality. A separate institute can be set up to deal with R & D and training on weaving and woven sector.  **In-service Training**  **i. Training for the operator:** BGMEA could run several training centers where the fresh operators will be trained up to get satisfactory performance by hiring some highly skilled instructors. BGMEA factories can recruit these people with confidence.   **ii. In-service training for the freshly recruited technical personnel:** Apart from the operators, export oriented textile and garment factories recruit various types of technical people having qualifications like diploma and degrees. These freshly recruited experts should be trained by skilled personnel (of the relevant field). At present none of the training institutes in Bangladesh have this type of in-service training facility. Therefore a separate training institute can be set up to train freshly recruited graduates as well as in-service training necessary for improving performance.  **Production of Viscose Can be a Breakthrough in our Export Oriented Textile and RMG Sector.**  Every year Bangladeshi spinning mills import cotton fiber worth billions of dollars and also the local consumption is also very high (nearly 14 crore Kg). It would be breakthrough, if viscose rayon can be developed and added to our export oriented textile and RMG sector. In the past, Bangladesh used to produce viscose rayon in the Karnaphuly rayon mills Ltd. at Chittagong. But at that time the quality of viscose fiber was not very good. Over the years, technology has improved a lot, now viscose has lot of advantages over cotton fiber. It would be profitable if Textile and RMG sector think seriously about producing viscose rayon.  **Develop Local Dye & Chemical Manufacturing Facility**  The cost of dyes and chemicals that are incurred in textile processing plants are substantial. We do not have any dyes, chemicals and auxiliaries manufacturing facility in Bangladesh therefore we have to import them using foreign currency. Therefore we should develop our own manufacturing facility to reduce our cost of production.  **Develop Facility for Machinery & Spare Parts.**  Most of our competitors like China, India and Pakistan manufacture their own spare parts as well as some machinery. In general, Bangladesh does not produce any spare parts at all machinery except simple weaving machines like shuttle loom.. Bangladesh is heavily involved with textile business; manufacturing of textile machinery could be a very big and profitable industrial sector.  **Bank Interest Rates Should be Lower.**  If the bank interest rate is lower like other developing countries, it could be a big incentive for increasing industrial growth.  **Access to the Import Data.**  Export Promotion Bureau (EPB) maintains a details list of products exported from Bangladesh. Similarly a detail list of imported items may be developed and made available when needed. This will be helpful in attracting investors (both local and overseas).. Investment on production of products that are on top of the list will perhaps attract lot of investors; also the risk of marketing will be less.  **Conclusion**  All the concerned authorities may carefully examine the suggestions that are made here. The benefits of the all the suggestions particularly R & D may not be visible in short period of time. Some of them may take even years to get the benefits. In the international market, we cannot play too much with the sales prices of our textile commodities; it is the cost of production where we can play. It seems that by implementing the above suggestions and recommendations we will be able to reduce the cost of fabric and garment. | |

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