ments substantially. Recently developed automatic loading and unloading machinery, such as the bobbin doffing machine in spinning, may also significantly affect labor requirements.

New principles and methods of manufacture are challenging conventional processes. The shuttleless loom compared with the conventional loom operates at much higher speeds, requires less maintenance work, and requires fewer preparatory processes. Fabric-forming machines, which have recently been made available in the United States, stitch together fiber layers at 10 to 50 times the output of conventional looms and bypass conventional spinning processes. A revolutionary technique, still in the developmental stage, is open-end spinning which may lead to greater mill automation.

Manufacturing of new products such as the so-called nonwovens (bonded web of fibers), texturized and stretch yarns, foam laminates, and coated fabrics involves new techniques, new skills, and new machines. Some of these, like nonwoven fabrics, require fewer man-hours per unit of output than do conventional fabrics; others, such as stretch fabrics, may require additional labor.

The goal of continuous automatic manufacture is becoming technically feasible in some branches of textile production. A relatively new system of yarn manufacture is capable of integrating several of the processes (bale opening through carding) which conventionally are discrete operations, and linking together the remaining processes through automatic transfer of material between machines. Installed so far in only one or two mills, such systems are initially expensive and require greater product uniformity, but output per man-hour, reportedly, ranges from 70 to 100 percent above conventional mills.

In finishing mills, continuous automated systems, in which pressure, speed, temperature, and other aspects of production are controlled from a central console, are replacing older discontinuous operations. The first computer-directed system for use in a textile production process was recently installed in a large finishing plant to control a complex dyeing procedure.

One of the major developments is the modern layout and design of the plant itself. Most of the 7,000 plants in the industry, built more than 25 years ago, are multistory mills, poorly adapted to modern continuous-flow methods. New mills usually have only one floor, with machines located close to each other so that materials handling is minimized. Moreover, faster and larger-capacity machines, fewer processes, and three-shift operations have reduced the number of machines required for a given output.

Manmade fiber (cellulosic and noncellulosic) is, perhaps, the most important and far-reaching technological factor to have affected the textile industry. The particularly rapid growth of noncellulosics (nylon, polyester, acrylic, spandex, olefin, and other fibers (reflects the chemical industry's outlays for R and D, and for promotion, and the advantages to some processors of lower unit labor requirements, relatively stable prices, and less waste. As shown in table 1, manmade fibers accounted for 57 percent of mill fiber consumption in 1966 (cotton-equivalent basis), compared with 39 percent in 1957 and 23 percent in 1947. Despite considerable research in and promotion of natural fibers, manmade fibers may nevertheless account for as much as 65 percent of all fibers consumed by 1975, with major growth in noncellulosics.

THE RATE OF CHANGE

Definitive figures on productivity (i.e. output per man-hour) which measure the rate of improvement in manpower utilization are not available because of special technical statistical problems.[6] Some rough indication of overall improvement in recent years, however, is suggested by the sharp rise in output between 1960 and 1965. Various measures of textile output indicate that it rose, from 30–35 percent during this period. Estimated all employee man-hours rose by only 4 percent. These changes for the textile industry as a whole reflect substantial variation among individual sectors of the industry.

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[6] In addition to the usual problems of determining the best measure of output for individual products, assigning appropriate weights and achieving reasonable comparability between man-hours and output, there are especially complex problems of changes in quality and product mix and changes in the degree of integration of production facilities.