CHAPTER III

MACHINERY DEVELOPMENTS AND THEIR ADOPTION PROCESS IN INDIA

The slow and uneven pace of modernisation of textile processes in India has been considered the most vital factor affecting the stagnancy and decay of the mill sector. Most of the mills in India have obsolete machinery compared to international standards. In the previous chapter we noted that at least some mills were able to modernise and come closer to the state-of-the-art technologies. Modernisation has many dimensions and is spread over different departments of a mill. The following section shows the textile manufacturing process, machinery developments and their economic implications for India.

The Textile Manufacturing Process and Machinery Employed

The composite textile manufacturing process converting fibre into yarn and then into finished fabric is a continuous process which can be categorised into five stages:

1. Yarn preparatory
2. Spinning
3. Weaving preparatory
4. Fabric Weaving
5. Fabric finishing.

In the earlier stages of industrialisation, there were, in addition to spinning mills, units having only weaving or only processing machineries. The advantages of consolidation were realised by the managements in the context of that period so that many units were expanded in either backward or forward integration of processes (Mehta, 1953). In Ahmedabad, for example, within a short span of two decades 1911-1931, the number of purely spinning units declined from 17 to 6, either due to liquidation or diversification. Between 1931 to 1935, 6 purely weaving units were either scrapped or diversified into composite units, and the number of composite units increased from 25 in 47
1911 to 58 in 1931 (Mehta, 1949). With the expansion of the decentralised sector, spinning mills came up to augment the ever-increasing yarn requirements.

Figure 3.1 shows the flow-chart of the composite textile mill operations. Sales intervention can be made at five stages: yarn sales in the form of hank cones (for handlooms) or pirns, sized beams, grey fabric, bleached fabric and finished fabric. The yarn preparation consists of cleaning the fibre and bundling it into a continuous length to make it ready for the spinning process. Here, it is spun, twisted and wound onto various kinds of packages according to the operational needs of the next fabric forming stage. Most of the yarn utilisation in composite mills is captive, but mills may also sell yarn at this stage. The weaving preparatory includes pirn winding, sizing, warping and drawing-in to make suitable preparations for fabric forming at the looms in the loomshed. Mills may also sell sized beams or give them out to powerlooms paying conversion charges, later on processing and selling the fabric in the mill's own name. They may also sell grey cloth or send the grey cloth elsewhere for processing when they do not have the particular specialised processing machinery. The grey cloth then passes through one or more finishing processes like mercerising, bleaching, dyeing, printing, etc. and is finally folded and packed for marketing. Damaged fabric is sold as cut-pieces, fents and rags. The process is explained in detail in the following paragraphs, together with machinery developments in the area and their absorption by the Ahmedabad mills.

(1) YARN PREPARATION:

The yarn preparatory process is designed to clean, blend and parallelise the staple fibres for spinning and undergoes the following processes:
FIGURE 3.1
FLOW - CHART OF TEXTILE PRODUCTION OPERATIONS IN MILLS

- MAN-MADE FILAMENT YARN
- COTTON FIBRE
- MAN-MADE FIBRE

- YARN PREPARATION
- SPINNING
- BLOW - ROOM
- CARDING
- COMBERS (OPTIONAL)
- SPEED FRAMES
- RING - FRAMES
- DRAW - FRAMES
- WINDING

- FABRIC PREPARATION
- WEAVING
- PIRN WINDING
- WARPING
- SIZING
- LOOMSHED

- PROCESSING
- WET PROCESSING
- BLEACHING
- DYEING
- FINISHING
- PRINTING
- OTHER FINISHES

- FOLDING AND PACKAGING

- DOMESTIC MARKET
- EXPORT MARKET
Opening, mixing and cleaning:
The raw cotton comes to the mills in a highly compressed baled form and needs to be loosened and cleaned. In the blow-room department, the bales are opened, mixed in the required quantities and fed to the opener, which loosens and mixes the fibre. It is then passed to the scutcher which removes trash from the fibre left over after ginning. Indian cotton bales contain a much higher percentage of trash in the form of leaves, seed-coats, dirt, etc. than the international average (Gupta, 1990) due to improper ginning. The clean cotton cost to the mills is therefore higher due to extra wastage and the increased amount of cleaning required. Different kinds of cottons are blended at this stage to obtain the most optimum technical and economic mix needed for the different varieties produced by the mill. For certain kinds of blended fabrics, man-made staple fibres are mixed after cleaning the cotton by a blender feeder. The fibre is now delivered in the form of a lap which is like a half inch thick and four feet wide cotton blanket rolled up on an iron rod for the next operation. The lap can either be fed to the card manually, or by a conveyer belt or by chute feeding directly from the scutcher to the card.

Upto 1950, opening and lap formation needed two different processes with manual transfer. After that, chute feeding replaced the manual transfer and in 1960, semi-automatic lap doffing and pneumatic lap control was added. By the mid-sixties, mechanical blending and fully automatic lap doffing were incorporated, and the blowing operation was improved. The auto mixer considerably improved the homogeneity of the mixing. The latest chute-fed blow-rooms directly deliver the lap from the fibre in a single process.

In 1980, a new auto doffing blow-room line cost Rs.25 lakhs, while converting a conventional line cost anywhere between 5-10 lakhs and could operate with nearly the same efficiency except for very high value fabrics. There were 93 conventional and 219 single-process scutchers in Ahmedabad in 1980 and 123 of the
single-process lines had automatic doffing systems; the single-process lines having increased from 78 in 1970 and 148 in 1975.

Carding:

The remaining short fibres in the cotton and some more trash are removed at carding where fibres are brushed against a cylinder surfaced with closely set toothed wire. The material is now in the shape of a thick rope and is called a sliver. Until 1960, it was generally accepted that slow carding was necessary for the maintenance of high yarn quality as high speeds would damage the fibre. Presently, due to improved designs and card-clothing materials, speeds have increased drastically. High speed cards almost doubled the machine productivity. The slivers are now stored in cans about 5 times larger than before, thus reducing the amount of operators required for handling them. For a while, tandem carding or passing the lap fibres over two successive cards was tried, but was not very successful due to slow speeds. In Ahmedabad, conventional cards had reduced drastically from 5194 in 1970 and 3553 in 1975 to only 676 in 1980. There were 4225 semi-high speed and 275 high speed cards i.e. nearly 86.9% of the cards were semi/high speed in 1980.

Drawing:

Six or eight carded slivers are fed to the delivery of a draw-frame which produces one sliver of the same width. The delivery consists of four pairs of drafting rollers arranged in such a manner that each successive pair turns at a higher speed, with the draw ratio being generally equal to the number of slivers fed into it. The fibres are now more aligned and parallel. Sometimes, blending of man-made fibre is done at this stage also. In the later models, an electronic feedback mechanism or the auto leveler monitors the uniformity of the material and adjusts the speeds to maximise the uniformity of the output.

The speeds at drafting have also increased by about ten times, from upto 40 mts. min. to more than 400 mts/min., thus reducing
the number of machines required as well as operatives, besides significant improvements in yarn quality. The number of points where process control has to be exercised have also reduced. In Ahmedabad, the number of high speed draw-frame deliveries has increased from 556 in 1970 (which may most probably be semi-high-speed) to 1333 in 1975 and 1819 in 1980.

Combing:

When long staple fibres are to be spun, combing follows carding and drawing so that any remaining short fibres are shed and the output sliver is one where fibres are more uniform in length and more parallel. This is a costly process as nearly one-fourth of the fibre is combed out as waste. All developments in combing have been aimed at increased speeds. The number of high-speed combers increased from 504 in 1970 to 604 in 1975, but decreased to 577 reflecting the decreasing production of fine and superfine fabrics by the Ahmedabad mills.

Roving:

The draw-frame sliver needs to pass through some more process to impart some more draft and some twist at the speed frame. Traditionally, three sets of fly-frames were used, reducing the cross-section and density of the sliver, called slubbing-interroving. Conventional machines converted to top-arm drafting doubled labour productivity, increased machine productivity by 20% and improved yarn evenness and strength. In the modern speed-frames, only one speed-frame is necessary. The emerging roving, about half the thickness of a pencil, passes through a rotating flyer to the winding point of a bobbin which fits over a rotating spindle. The speed of the bobbin is just enough to give such twist into the roving which can give it the required mechanical strength to feed the spinning frame.

Modern speed-frames produce better quality of rovings at higher speeds, with 100% productivity increases. Other improvements are stop motions, automatic doffing, suction cleaning devices, and
larger bobbins. The number of modern speed-frames increased from 1012 in 1970 to 1272 in 1975 and 4890 in 1980, of which 1819 were high speed.

(2) SPINNING

There are two major kinds of technologies available for the final spinning of yarn—Ring spinning and Open-end or rotor spinning. These have lately been augmented by the Air-jet spinning and Friction spinning technologies.

Ring Spinning:

Bobbins of roving are suspended over the spindles of a ring spinning frame. The drafting rolls draw the roving onto the spinning spindle carrying a bobbin for the yarn and rotating at a high speed. A flanged ring circles the bobbin and around this moves a C-shaped wire traveller. The resulting twist imparts strength to the yarn needed for succeeding stages of fabric formation. Yarn for warp goes on for winding and warping and that for weft is pirn-wound.

Modern ring-frames are characterised by high speeds, high quality of yarn and fewer end breaks. Improvements in ring-frames include high draft systems, pneumatic end collectors, automatic doffing, travelling clearers, automatic splicing/knotting, etc. Today ring-spinning machines work to a speed of 10-12000 rpm. Data on automation of ring frames is available only for 1980, by which time 93.5% of the ring-frames were either converted to top-arm drafting or were original top-arm ones.

Open-end Spinning:

Rotor spinning has been increasingly replacing ring spinning especially for coarse and medium yarns in the developed countries. It is a radically novel method of spinning, using the aero-mechanical technique of yarn formation. The fibres from the sliver are fed through rollers that break the sliver so that individual fibres are fed by an air stream onto the inner surface.
of a high-speed rotating device which imparts twist and forms the yarn.

This technology eliminates the use of speed-frames and ring-frames, forms larger and knotless packages of yarn, needs less operator supervision and handling and gives very high speeds upto 90,000 rpm. or upto 145mts/min. compared to 18mts/min. for conventional ring-spinning. Rotor spinning was originally used for coarse to lower medium counts, but is now increasingly adapted for higher counts. Rotor speeds were originally of the order of 40,000 rpm, they have now reached speeds of 90,000 rpm. The number of operatives needed are very less. Rotor technology arrived in Ahmedabad after 1980, hence authentic data is unavailable but some mills have installed open-end spinning machines for producing yarn for sale.

The new state-of-the-art modern production technologies like wrap-spinning, self-twist systems, airjet and friction spinning have high delivery speeds of 250-300mts/min. While airjet spinning is useful for coarse cotton and blended yarns, friction spinning is employed for the more expensive industrial and worsted yarns.

Winding:

Yarn is transferred from the spinner's bobbin to a larger package called the cone. In the process, the weak places and slubs are removed either manually or electronically and the ends are either spliced or knotted, manually or mechanically. In 1945, winding was manual. In the late fifties, automatic knotters were introduced but the operative was needed to place the ends in a convenient position for knotting. With the modern high-speed systems, operatives are needed only to deposit and remove bobbins from hoppers. Electronic yarn clearers detect and splice the faults automatically. The improvements over time have increased not only the productivity but also the quality of the yarn. In 1970, automation was about 51%. In 1975, automation remained the same but non-automatic machines for cone/cheese winding increased
due to increasing yarn sales by mills. By 1980, 100% automation was achieved. In the pirn-winding department, automatic spindles increased from 5536 in 1970 to 6547 in 1975 and to 9433 in 1980.

(3) WEAVING PREPARATORY:

Before being woven on a loom, the yarn needs some more preparation in terms of strength and packaging into warp beams and weft pirns. The stages of operations are warping, sizing and drawing-in.

Warping:

Packages of yarn from winding are mounted on a large framework called the creel and wound onto a beam. A few hundred yarns are wound onto a section beam and several section beams are then combined together to form the warp beam.

Developments in warping include refinements leading to increased winding speeds, more uniform yarn tension and thread spacing, larger beams, and magazine creels which permit quick replacement of empty cones. Winding speeds increased from up to 100 mts./min. to over 450 mts./min. In Ahmedabad, high speed warping machines increased from only 71 in 1970 to 89 in 1980.

Sizing or Slashing-in:

Yarn is subject to a lot of abrasion and tugging during the process of weaving, and thus requires temporary surface protection and lubrication. Accordingly, it is coated with a size or a starch solution, without which it would tend to break. Blends are sized with polyvinyl alcohol (PVA) or starch - PVA mixtures and most filament yarns do not require sizing. Six or more section beams from the warper are mounted at the feed-end of the slasher and passed through the size-box containing the size-solution and through the squeeze rolls which remove excess sizing. They are then passed through a series of heated drying
rolls called dry cans. After drying, the yarns pass through a comb and are wound up on a loom beam.

The earliest equipment in sizing consisted of a size box and two cylinders. Since then, there have been progressive improvements in size recipes and increase in the number of cylinders or the multi-cylinder sizer with 4 to 10 cylinders leading to better and more uniform sizing. High-speed sizing machines increased from 74 in 1970 to 139 in 1975 and to 184 in 1980, 173 of them being multi-cylinder type.

Drawing-in:

The warp yarns are threaded individually into the loom or drawn-in through the drop-wires, healds and reed and fixed to a cloth take-up roll. If a warp is exhausted on an incomplete roll, the new threads are tied-in and the knots pulled through the drop wires, healds and reed.

Drawing-in and tying-in are tedious manual tasks. Drawing-in has been partially automated, while tying-in is less complex and has been fully automated. Both are labour intensive processes, consuming about an hour for automatic tying-in and more than a day for manual drawing-in. Due to this, warp beams are wound with enough yarn to produce very long lengths of fabric to allow the loom to operate for several days without requiring a new warp beam.

(4) WEAVING:

While the warp yarns are drawn into the loom from a warp beam, the weft yarn is drawn off the shuttle, housing the pirn which moves through the warp yarn or from spools, cones or cheeses mounted on the side of the loom. The warp is interlaced with the weft which passes over and under various combinations of warp yarn. This interlacing is performed on the loom and the different patterns of the warp-weft arrangement are called constructions, varieties or sorts within the broad varieties. There are three
primary motions on looms: shedding, picking and beating-up. Shedding is the raising of certain warp threads to form a V-shaped opening through which the weft yarn is passed. The passing movement is called picking. In fly-shuttle looms, picking is done by the shuttle containing the weft bobbin. In shuttleless looms, this is carried out either aero-dynamically or hydro-dynamically. After picking, the loose weft is rushed or beaten up to the rest of the cloth being wound up on the take-up roll.

Fly Shuttle Looms—Ordinary and Automatic

The fly shuttle, a 12"-16" flat oblong wooden object with tapered ends carries a bobbin, or pirn, holding a few hundred yards of weft yarn. In the older or "Ordinary" models, the loom operator has to stop the loom to replace the bobbin when it is empty. Automation of this process has radically changed the labour content of weaving. In the "automatic" models, a feeler senses the yarn supply and replaces the spent bobbin automatically. In a further development, the loom-mounted winders for bobbins permit a reduction in the number of weft bobbins required per loom from upto 500 to only 30, with consequent economies in space, material and labour costs. Loom assignments per weaver have increased from 2 to as many as 120 looms abroad. Other developments in the shuttle-weaving process have led to wider widths and increases in weaving efficiency. There were 39489 non-automatic and 7512 automatic looms in Ahmedabad in 1970. In 1975, the automatic looms increased to 8083 and in 1980, to 9656.

Shuttleless Looms:

The fly-shuttle looms suffered from several disadvantages like (i) loom stoppage during shuttle-change, (ii) the necessity to wind yarn onto small package to fit inside the shuttle, and (iii) speeds could not be increased above a certain level due to inherent mechanical constraints.

The "gripper" shuttleless loom was a radical development in loom technology. Here the weft insertion mechanism is supplied with
yarn from a cone and a succession of grippers which carry only the required amount of yarn for one weft insertion and are projected across the shed. These looms can be made very wide and are set up to weave fabrics that are later cut into two or three widths, the only disadvantage being an unfinished selvedge. The "rapier" looms are another variation based on the same technology. Although the gripper and rapier looms moved away from shuttle technology, weft conveyance was still mechanical. In the "jet" looms, the weft yarn is either blown (in the air-jet loom) or spit (in the water-jet loom) across the shed. However, these looms are suitable only for filament yarns.

The new developments in the form of shuttleless weaving have meant higher speeds, wider widths and better quality of cloth produced with savings in labour and repair parts. The high capital costs of these looms renders them economically viable only for producing high-priced varieties. Besides, the use of shuttle looms is still necessary for fancy varieties. There were 140 shuttleless looms in India in 1975, of which 12 were in Ahmedabad. In 1980, 463 of the 486 looms were in Bombay, without any addition to their number in Ahmedabad.

(5) FABRIC FINISHING

The 'grey' or unfinished fabric that emerges from the loom has to undergo various permutations and combinations of finishing processes before it becomes suitable for use by the consumer. The various rolls of similar fabric from the loom are sewn together end to end to form a continuous length of material. The fabric then undergoes one or more of the following processes:

Singeing and Cropping/Shearing:

The fabric is rapidly passed through a gas flame to remove fuzz, lint and other foreign objects from the fabric. It is also sheared or cropped to remove loose fibres protruding from yarn and yarn-ends. Developments have mainly been in the area of
speed, and the capability of the newer machines to leave the cloth seams undisturbed.

Bleaching:

The bleaching operation is needed to remove stains that have occurred during fabric construction and the natural off-white colour from the fabric. The older method used kiers or vessels in which up to 5 tons of cloth was boiled in a weak solution of sodium hydroxide. In the modern finishing plants, a continuous process is followed, wherein the fabric is first run through a rapid desizing steamer, washed, impregnated with a 3% sodium hydroxide solution and passed on to the J-Box, which runs the fabric through it for an hour at 212°F. temperatures. Next, the fabric receives a hot wash, impregnated with 2% solution of sodium peroxide, passed through a second J-Box, washed again and sent to a dryer, fully bleached.

Mercerising:

This operation is optional and can be carried out before or after bleaching. It is a continuous process applied to cotton fabrics to improve dye-holding, in which the fabric is passed through a 15-20% solution of sodium hydroxide which is then removed with hot water. This process is not usually carried out on low-priced dyed fabrics. Expensive fabrics like rubia, cambric, etc. need chain-mercerising while poplins and long-cloth can be mercerised on chainless machines.

Shrinking:

Shrinking is a continuous process in which the fabric is immersed in water, stretched, held against a woollen rubber blanket under tension, and allowed to shrink to a uniform dimension as the tension is released. This reduces the future residual shrinkage in cotton fabrics to less than 1%. There are many processes available for this operation, the most well-known being the "sanforized" finish.
Stentering:
The stenter is a drying range and is used at various stages of finishing. The stentering frame is a 60-200 feet long device, across which the fabric is held by mechanical fingers or stenter pins for uniform width as the fabric continuously flows and passes down. Developments here have mainly been towards energy conservation.

Dyeing:

Dyeing is the process of colouring the fabric by immersing it in a solution of dyestuffs. Formerly, dyeing was carried out in vessels called jiggers in batches of 600-800 metres of fabric per lot. The development of the continuous process jigger permitted lot sizes of 30,000-40,000 metres of fabric. Jigger dyeing is still found to be eminently suitable for cotton fabrics. With improvements in instrumentation, the latest being micro-processor controls, this has facilitated the control of important parameters in dyeing.

A change in dyeing technology was inevitable with the advent of synthetics. The beam-dyeing machine dyes fabrics at high temperatures and under high pressure conditions, and the fabric is fed in open-width as against bundle form in jigger dyeing. In a later development, jet-dyeing overcame the difficulties of space and batch operations with cloth-feed in rope form. Jet-dyeing also resulted in increased productivity. In beam dyeing, a batch of 100-200 kgs of fabric (approximately 1000 to 2000 mts) took 3 hours. The jet-dyeing operation takes only one minute for 300-1000 mts of fabric, depending on its construction. The only disadvantage of jet-dyeing is its non-versatility, and that it performs best with rapid dyes. Thus beam dyeing still continues to play a significant role in synthetic fabric dyeing.
Printing:
In mills, one of the earliest techniques for printing, still used widely for small lots, was manual printing. In this method, cloth is laid taut on tables and designs printed by passing the colour paste through a silk screen, each screen serving one colour. The first development in mechanisation was that of roller printing by the photogravure technique, which increased the speed of the printing process to 50-60 mts./min. However, set-up time on the machine increased greatly with design change, colour change, etc. and proved uneconomical for small lots. The flat-bed screen printing machine overcame this difficulty, though it could achieve speeds of only 15-20 mts./min. This was followed by the rotary screen printing machines which achieved speeds of 40-50 mts./min. There are numerous other printing techniques like duplex printing, resist printing, discharge printing etc.

Surface Finishes:

These add quality or special effects to the fabric and may or may not last for many washes. They include glazing or starching, calendering or ironing, embossing, creping, wrinkling and moireing.

Wrinkle-resistant, wash and wear and permanent press finishes are obtained by coating the fabric with resins or similar reactants, and have become popular for cotton fabrics which have to compete with synthetics. Other chemical finishes that have been developed include water-repellant, flame-proofing, mildew proofing, antibacterial, heat reflectant and other finishes.

Once the required processing operations are carried out on the fabric, the finished fabric is taken to the packing section where it is scrutinised, cut, folded or rolled, packed and stored for sales through the distribution network.
In the post-war period, 81% of the world's spindles and 66% of the loomage was concentrated in the U.S.A and Western Europe with a significant share in textile exports (Thigpen, 1978). With the expansion of the industry in third world countries, the advanced countries found that they were losing the competitive edge due to rising wage costs. Moreover, the supply of cotton from these countries was affected due to self-consumption. There was large scale scrapping of spindleage and loomage and by the mid-sixties, the share of Western Europe and USA had declined to 40% of world spindleage and 26% of the loomage. (Thigpen, 1978).

The textile industry in the advanced countries encouraged innovations that would reduce the work force and raise productivity. In the cotton textile segment, the developments were concentrated on obtaining higher speeds, to produce larger packages and to reduce the number of processing stages in spinning, on introducing automation in weaving and on obtaining longer lengths in chemical processing towards realisation of economies of scale. However, the use of raw cotton put constraints on the achievable speeds. More significant innovations in the textile industry may be attributed to the introduction and aggressive penetration of synthetic fibres which tilted the inter-fibre competition in favour of man-made fabrics. There were initial difficulties due to low consumer acceptance and difficulties inherent in weaving and dyeing of man-made fibres on traditional machinery. The introduction of texturising and the conversion of tow helped overcome these difficulties. Texturised yarn imparts qualities like bulk, greater aesthetic value and superior weaving properties, while "tow" resembles the natural fibre and improves its spinnability and blending qualities when converted to "top".

All through the first two decades after the Second World War, nylon and polyester eroded the market share of cotton through technical innovation, product development and marketing techniques. By 1976, cotton had lost about 50% of the world
market. By this time, shortages of pulp and pollution awareness resulted in the decline of rayon staple fibres, and polyester and acrylic became the major fibres used for clothing. Most of the major innovations in textile technology make great demands on yarn quality. Most of them need either cotton yarn of superior quality and uniformity or man-made fibres. This can be explained with reference to weaving. While the ordinary looms can use yarn of inferior quality, automatic looms need better yarn, and shuttleless looms even more so. The water-jet and air-jet looms are ideally suited for fine deniers of nylon or polyester yarns only.

The impact of the innovations in the industry on its economies has been profound. Firstly, the capital requirements per unit of output are 8 to 10 times higher than the traditional machines. The capital costs as a proportion of total costs increase greatly and need maximum capacity utilisation with minimum downtime. With progressive technical developments, the use of labour is drastically reduced. The most advanced technology may sometimes use as little as 7% of the workforce compared to a traditional mill (Schmitz, 1985). Thus modern technologies can become economically viable only if the higher capital costs are offset by savings in wages, power and wastages, maximum capacity utilisation, and high price realisation for the fabrics produced on them.

World shipments of conventional ring spindles rose in 1990 by 18% accompanied by a corresponding decline in shipments of open-end rotors. This reflects to a large extent the pattern of shipments by geographical destination and the type of technology employed. Two thirds of the 5.0mn. short staple ring spindles shipped in 1990 went to Asia, of which 1.1mn. went to India alone, an increase of 150% on 1989. As an older technology, ring spindle machinery is less capital intensive. It is therefore chosen in preference to superior machinery in countries like India where foreign exchange is short, rates of interest on borrowed capital are high, labour is plentiful and wage rates low compared to developed countries. Since the state-of-the-art weaving
technologies need yarn produced on modern machines as a prerequisite for strong and faultless yarns of long lengths, their use is limited to mills weaving fabrics in the very high-priced ranges for domestic and export markets. Since the present gross features of the economy may be expected to continue into the foreseeable future, the use of conventional machinery rather than modern technologies will prevail except for a very limited, small segment of the Indian textile industry.

The textile mill industry in India presents a mixed picture, with various kinds of technologies co-existing side by side. A mill may possess an open-end spinning unit for yarn sales and conventional ringframes for captive consumption or it may have ordinary, automatic as well as shuttleless looms for different end-uses. The price parity between raw cotton and man-made fibres has made the adoption of artificial fibres for mass consumption very difficult. This, coupled with the competition from powerlooms, has made the market for mill-made cloth very limited. Moreover, resistance to reduce labour has meant that modern technologies become unviable. The mill sector thus selectively uses the modern technologies for its exports and for its high-priced domestic market. The next section critically analyses some aspects of modernisation as undertaken by the composite mills in India.

MODERNISATION IN THE COMPOSITE MILLS OF INDIA

In India, the term textile modernisation has been used with different connotative and denotative meanings, ranging from component replacements or renovation to replacement of machinery with similar technology for overcoming wear and tear or rehabilitation/replacement, as well as machinery replacement/expansion with upgraded technology or modernisation. Addition of machinery has not taken place only for expansion; it has also been undertaken for balancing the machines due to changes made in earlier or later processes, and for changes in product-mix needing additions of special machinery to take care of the specific needs of the new products. Modernisation may be
undertaken for various reasons. One or more of the following considerations have lead to modernisation of machinery in a mill:
- Reduction of costs
- Improving the quality of a fabric/yarn
- Balancing of equipment
- Increasing labour or machine productivity
- Decreasing labour costs
- Introducing new products in the product-mix
- Reducing damage and value-loss
- Overcoming statutory constraints on expansion of capacity

According to the Census of Manufactures, the capital investment in the textile industry in 1950 amounted to Rs.2030mn. comprising a fixed capital of Rs.660mn. and working capital of Rs.1370mn. Since then, a host of working parties, committees, and task forces have recommended renovation and modernisation of machinery. Many of them have accepted the reasons for slow pace of modernisation in the traditional textile industry and recommended the help of the government, mainly in the form of provision of low-cost capital. This was on the lines similar to India's competitors in textiles like USA, Germany, Japan, France, Korea, etc. For example, according to the Kogekar Cotton Textile Committee Report, over a period of 5 years from 1959 to 1963, USA had spent the equivalent of Rs.20000mn., Japan Rs.8200mn. and France Rs.4220mn.; during 3 years from 1959 to 1962, UK had invested Rs.5600mn. In contrast, India spent Rs.5100mn. over the period of 15 years from 1951 to 1966, with a much higher installed capacity of spindles and looms (Kulkarni, 1979). Many of the newly developing countries like Korea possess state-of-the-art machinery as they have established their textile industries in recent years.

Compared to the level of modernisation in the textile industries of most countries, India seems to have lagged far behind. Though data of age structure of textile machinery in mills in India is available (Ila Kantilal, 1984), it is not very relevant since critical machine parts are bound to be replaced periodically
(Iyer, 1984). Table 3.1 shows the extent of machinery modernisation in the composite mills in India. The average figures of automatic machinery should be treated with caution since interviews reveal that there exist wide differences and that machinery in many mills in India is old and obsolete, rundown and not well-maintained. The report of the expert committee appointed by the World Bank (World Bank, 1975) contained some scathing remarks about the obsolescence of machinery in many of our mills.

However, a closer analysis of the table shows that adoption of modern machinery by the composite mill sector has been highly selective. Detailed analysis of techno-economic advantages have shown that most of the developments taking place in advanced countries are not appropriate under Indian socio-economic conditions. (Rao and Garde, 1984; Garde and Shanbhag, 1984; Iyer, 1984) Machinery developments in the developed countries were made for savings in labour complements, reducing air/effluent pollution, conserving water/energy, etc. More importantly, the cost of capital is not as high as in India.

The International Textile Manufacturer's Federation (ITMF) periodically publishes comparative data on the production costs for selected countries. The cost figures are for new mills in each country producing identical fabrics with identical state-of-the-art technology. Given the difficulties which are inherent in cost comparisons across countries, the values should be viewed as broad indicators and too much accuracy should not be read into them. Table 3.2 shows cost comparisons of fabric weaving in India with other countries for 1981 and 1989. Our wage rates at Rs.19.28 or $1.20 per hour are the lowest, while capital interest rate at 14.0% is higher than all countries except Brazil. One of the points which a closer study of the reports revealed was that the labour deployment in India is higher than all the countries for identical machinery, considerably reducing the oft-cited advantage of low wage-rates (ITMF, various issues). The critical role of raw material prices is also seen. India's competitiveness and ability to hold a stable price line depends
heavily on an assured supply of cotton at favourable prices. India has now lost the advantage of being the cheapest producer of fabrics to Korea.

Table 3.3 shows a time-series of weaving manufacturing costs and total cost per yard of fabric in India. Our raw material costs as a percentage of total fabric costs have fluctuated between 30% to 49%, while the costs of capital (Depreciation and Interest) have increased from 19% to 42%.

According to surveys by the Textile Research Associations, once the true technological advantage of the new machinery has been established, and the payback periods reasonable, the Indian textile industry in general has been found to accept the modern machines. The financially stronger and progressive mills are able to adopt the new technology faster than their weaker counterparts, and some of them have not been able to do so at all. The low profitability of the Indian cotton textile industry and the scarcity of capital seem to have been mainly responsible for the slow adoption of new technology coupled with unavailability of indigenous machinery when needed. Interviews with mill managements reveal that mills are wait-listed for as much as 3-4 years by the indigenous machinery manufacturers while imported machinaries, when allowed, carry heavy customs duties and face fluctuating exchange rates.

For machines like shuttleless looms or even automatic looms, it has been proved that they were economically viable only if the ex-mill price of fabric woven on them exceeded Rs.20/mt. and Rs.12/mt. respectively (Garde and Shanbhag, 1984) in 1980. Only a few mills who could cater to this narrow market segment could therefore think of adopting automatic or shuttleless looms. Two other studies in Asian countries in the 1970s, (Rhee & Westphal, 1977) for South Korea and (Hill, 1979) for Indonesia, (both quoted in Mazumdar, 1991) also found that imported fully-automatic looms were at appropriate shadow factor prices inferior to the semi-automatic looms. Statistics of consumer purchases have proved that the market segment for these high-priced
varieties is extremely narrow (CPT, Various issues). The slow absorption of new technology may thus be termed an economic gap rather than a technology gap.

Information regarding modernisation of textile machinery in India is woefully inadequate and available only upto 1980. The composite mills of India spent Rs.4297mn on plant and machinery expansion and modernisation between 1975-1980 (Table 3.4). Of this amount, 33.6% was spent on expansion and 66.4% on modernisation and rehabilitation. The Ahmedabad mills accounted for 23% of the total amount and the Bombay mills for 28%. While the Ahmedabad mills spent 30.1% of the total amounts spent in the period 1977-1980 on spinning, 24.1% on weaving, 32.7% on processing, and the rest on engineering and other machinery, the Bombay mills spent 33.3%, 36.6% and 21.3% respectively on spinning, weaving, and processing machinery. This was partly due to the differences in the state of modernisation in the two centres in 1977 itself. Subsequent data after 1980 is not available. Except for 1976 which was a very bad year for the textile industry, mills have spent increasingly higher amounts year after year within their constraints of financial accessibility. Aggregate expenditure figures for 1975-1985 are not available, but at a rough estimate based on Reserve Bank of India’s data for about 250 private cotton mill companies of India (ICMF Handbook, 22nd Edition), mills increased their plant and machinery at a compound annual growth rate of about 16% over a period of 10 years between 1975-76 and 1985-86.

There has been a popular misconception in the minds of policy makers and textile researchers about mill modernisation before 1976 when the Soft-Loan Scheme was launched. Evidence shows that many mills did avail of the financial assistance under the Technical Development Fund (TDF) and the "Deferred Payment Scheme" offered by Commercial banks with the "Bills Rediscounting Facility" (BR Scheme) from the Industrial Development Bank of India (IDBI). The Technical Development Fund helped the mills to import special textile machinery which was not available indigenously. Data for 1983 onwards is not available, but an
### TABLE 3.1
AUTOMATIC MACHINERY IN THE COMPOSITE MILLS OF INDIA

(Percentages)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Spinning Machinery:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Blow-room</td>
<td>9-12</td>
<td>52.4</td>
<td>52.0</td>
<td>68.2</td>
</tr>
<tr>
<td>2. Cards</td>
<td>0</td>
<td>15.3</td>
<td>32.1</td>
<td>81.2</td>
</tr>
<tr>
<td>3. Combers</td>
<td>0</td>
<td>42.7</td>
<td>48.2</td>
<td>54.2</td>
</tr>
<tr>
<td>4. Ringframes</td>
<td>8-12</td>
<td>NA</td>
<td>NA</td>
<td>85.1</td>
</tr>
<tr>
<td>Weaving Machinery:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Warping machines</td>
<td>5-10</td>
<td>55.6</td>
<td>66.8</td>
<td>76.2</td>
</tr>
<tr>
<td>2. Sizing machines</td>
<td>2-6</td>
<td>24.2</td>
<td>38.3</td>
<td>58.0</td>
</tr>
<tr>
<td>3. Looms</td>
<td>4-8</td>
<td>16.4</td>
<td>20.3</td>
<td>23.6</td>
</tr>
</tbody>
</table>

**Note:** *1950 data are ATIRA estimates.

**Source:** Computed from Indian Textile Bulletin, Annual Census of Machinery, Office of the Textile Commissioner, Ministry of Commerce, Bombay, Various issues.
### TABLE 3.2
INTERNATIONAL COMPARISONS OF FABRIC COSTS - 1981, 1989

(Percentages)

<table>
<thead>
<tr>
<th>Cost element</th>
<th>Brazil</th>
<th>Germany</th>
<th>India</th>
<th>Japan</th>
<th>Korea</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1981</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fabric Prod. Costs (US$/yd.)</td>
<td>0.98</td>
<td>1.03</td>
<td>0.78</td>
<td>0.97</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Cost break-up(%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Labour</td>
<td>7</td>
<td>18</td>
<td>6</td>
<td>10</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Power</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Auxiliary material</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Capital (Dep+Int)</td>
<td>23</td>
<td>16</td>
<td>21</td>
<td>16</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>Yarn manufacturing</td>
<td>24</td>
<td>22</td>
<td>19</td>
<td>22</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>Raw material</td>
<td>34</td>
<td>37</td>
<td>42</td>
<td>40</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

| **1989**                |        |         |       |       |       |     |
| Total fabric Costs (US$/yd.) | 0.86   | 0.77    | 0.76  | 1.04  | 0.75  |     |
| Cost break-up(%)        | %      | %       | %     | %     | %     | %   |
| Labour                  | 9      | 27      | 6     | 22    | 11    | 25  |
| Power                   | 4      | 9       | 9     | 11    | 11    | 6   |
| Auxiliary material      | 10     | 7       | 10    | 7     | 11    | 8   |
| Capital (Dep+Int)       | 46     | 27      | 41    | 33    | 31    | 32  |
| Raw material            | 31     | 30      | 34    | 27    | 37    | 29  |
| **Total**               | 100    | 100     | 100   | 100   | 100   | 100 |

Wage rates
(US$/hour)
3.25 14.95 1.20 18.32 3.87 12.00
Capital interest rates (%)
17.4% 7.5% 14.0% 5.7% 11.5% 11.5%

**Note:** 1981 and 1989 percentages are not comparable as cost element break-up is different. However, the comparisons between the countries for each year are comparable.

**Source:** International Production Cost Comparisons. International Textile Manufacturers Federation, Various Issues.
### TABLE 3.3
COSTS OF FABRIC PRODUCTION IN INDIA 1979-1989

(Rs./Yd.)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing cost (Rs/yd.)</td>
<td>2.36</td>
<td>2.49</td>
<td>2.72</td>
<td>3.61</td>
<td>4.09</td>
<td>4.99</td>
</tr>
<tr>
<td>Total fabric cost (Rs/yd.)</td>
<td>4.68</td>
<td>6.39</td>
<td>6.63</td>
<td>7.31</td>
<td>9.86</td>
<td>12.17</td>
</tr>
<tr>
<td>Cost break-up (%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Raw material</td>
<td>49</td>
<td>42</td>
<td>39</td>
<td>37</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>Capital (Dep+Int)</td>
<td>NA</td>
<td>19</td>
<td>30</td>
<td>33</td>
<td>42</td>
<td>41</td>
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<tr>
<td>Auxiliary material</td>
<td>NA</td>
<td>21</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Waste</td>
<td>NA</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>NA</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Spinning</th>
<th>Weaving</th>
<th>Processing Eng. etc.</th>
<th>Total</th>
<th>Modernisation and Rehabilitation (Mn.Rs.)</th>
<th>Grand Total</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>AHMEDABAD</td>
<td>22.4</td>
<td>57.9</td>
<td>80</td>
<td>Expansion</td>
<td></td>
<td></td>
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<tr>
<td>1976</td>
<td>BOMBAY</td>
<td>13.5</td>
<td>102.5</td>
<td>115</td>
<td>Modernisation and Rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>ALL-INDIA</td>
<td>203.0</td>
<td>314.6</td>
<td>532</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1978</td>
<td>AHMEDABAD</td>
<td>40.3</td>
<td>61.1</td>
<td>101.4</td>
<td>Rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>BOMBAY</td>
<td>31.7</td>
<td>56.1</td>
<td>87</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>ALL-INDIA</td>
<td>244.2</td>
<td>375</td>
<td>-32.1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1975</td>
<td>AHMEDABAD</td>
<td>5.8</td>
<td>21.7</td>
<td>NA</td>
<td>Spinning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>BOMBAY</td>
<td>6.6</td>
<td>18.6</td>
<td>NA</td>
<td>Weaving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>ALL-INDIA</td>
<td>39.6</td>
<td>24.9</td>
<td>69.6</td>
<td>Processing Eng. etc.</td>
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<td></td>
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<td>1978</td>
<td>AHMEDABAD</td>
<td>8.7</td>
<td>19.3</td>
<td>4.0</td>
<td>Total Spinning</td>
<td></td>
<td></td>
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<tr>
<td>1979</td>
<td>BOMBAY</td>
<td>12.4</td>
<td>26.7</td>
<td>2.4</td>
<td>Weaving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>ALL-INDIA</td>
<td>86.2</td>
<td>44.5</td>
<td>89.7</td>
<td>Total Processing Eng. etc.</td>
<td></td>
<td></td>
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<tr>
<td>1975</td>
<td>AHMEDABAD</td>
<td>28.3</td>
<td>52.1</td>
<td>9.7</td>
<td>Expansion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>BOMBAY</td>
<td>21.8</td>
<td>15.0</td>
<td>2.9</td>
<td>Modernisation and Rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>ALL-INDIA</td>
<td>96.0</td>
<td>50.5</td>
<td>99.0</td>
<td>Rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>AHMEDABAD</td>
<td>31.0</td>
<td>25.6</td>
<td>42.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>BOMBAY</td>
<td>15.7</td>
<td>20.3</td>
<td>14.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>ALL-INDIA</td>
<td>111.8</td>
<td>71.5</td>
<td>183.3</td>
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<tr>
<td>Total 77-80</td>
<td>AHMEDABAD</td>
<td>73.8</td>
<td>118.7</td>
<td>36.0</td>
<td>Spinning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BOMBAY</td>
<td>56.5</td>
<td>82.6</td>
<td>19.6</td>
<td>Weaving</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ALL-INDIA</td>
<td>332.6</td>
<td>201.4</td>
<td>383.8</td>
<td>Processing Eng. etc.</td>
<td></td>
<td></td>
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<tr>
<td>Total 75-80</td>
<td>AHMEDABAD</td>
<td>348.7</td>
<td>348.7</td>
<td></td>
<td>Expansion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BOMBAY</td>
<td>224.4</td>
<td>224.4</td>
<td></td>
<td>Modernisation and Rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ALL-INDIA</td>
<td>1443.1</td>
<td>1443.1</td>
<td></td>
<td>Rehabilitation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Figures in parantheses indicate percentages to grand total expenditures.  
amount of Rs.5539.2mn. was disbursed to the mills under these two schemes between 1974-75 and 1983-84 (IDBI Operational Statistics, Various issues). Typically, capital expenditure at that time was limited to machinery purchases of isolated, one-shot nature. After 1976, the approach to modernisation changed to one of planned, phased out, large-scale machinery changes with long-range business goals. However, the former type of modernisation has also continued. Out of 108 mills which availed of the Soft Loan Scheme, 76 undertook it in one phase, 29 in two phases and 3 mills in three phases. (IDBI Operational Statistics, Various issues).

The composite mills spent Rs.6408.3mn. between 1977-1985 under the Soft Loan Scheme. Estimates made in 1981-82 by IDBI showed that nearly 6.4mn spindles and 85000 looms were replaced/modernised by the mills utilising soft loans and the production of yarn and fabrics by these mills increased by about 50% and 27% respectively (Vaidya and Patil, 1985). The private sector composite mills spent Rs.5114.1mn. on 192 projects under the Soft Loan Scheme alone between 1977 and 1985 of which 68.3% was in the form of institutional loans and 31.7% by way of promoter's contribution (IDBI Operational Statistics, Various issues). These figures do not include amounts spent by the mills on capital expenditure from their own reserves or loans taken under the other Schemes. The Textile Modernisation Fund Scheme was introduced in June 1985 and has disbursed Rs.7580mn. at 11.5% interest for mill modernisation. From August 1990, the minimum rate of interest has been increased to 14%. The Bills Rediscounting Scheme seems to have gained momentum with the introduction of the Soft Loan Scheme, more probably because 1978-1979-1980 was a very good period for the industry after nearly 5 bad years. The introduction of the Soft-Loan Scheme coincided with the announcement of the Multi-Fibre Policy in 1976 which liberalised the use of man-made fibres by the cotton textile industry. In fact, under circumstances of acute cotton shortage, the industry was compelled to use a minimum of 10% of its fibre consumption from man-made fibres. Several composite mills shifted
their product-mix from purely cotton to include blended and synthetic fabrics.

It has been held by some people in the industry and IDBI that the emphasis on technical modernisation was not matched by organisational modernisation (Vaidya and Patil, 1985). According to them, many mills switched over to the production of blended and synthetic varieties without properly assessing the capacity to market them or their capacity to finance the resultant increase in working capital requirements, changes in work culture, training of operatives, upgradation in spinning quality, testing facilities, and other necessary back-up facilities for optimum exploitation of the sophisticated machinery. Many of the units encountered serious problems even inspite of having taken all reasonable precautions. This was because the natural entry barriers into the narrow market segment for high-priced varieties resulted in high unsold stocks inventory. Distress sales by loss-making mills further brought down prices of these varieties. All these factors, coupled with increasing costs of production, resulted in all but the financially sound companies into making heavy losses. In fact, it had been established that an average mill manufacturing low/medium priced fabrics would only break-even even if it achieved productivity norms in terms of technical performance and fully utilised its capacity (Garde, Grover, and Mehtani, 1984.)

A study at ATIRA undertaken for 67 composite mills of India which had substantially modernised their machinery shows that even though modernisation generally led to increase in sales value, it did not necessarily lead to increase in profitability. Thirty-four mills from the sample showed a declining trend in profitability, (of which 11 mills registered negative profits), 23 mills showed fluctuating profits, while only 3 mills registered increasing profits (Sankar, 1984). Another study undertaken by the same author in 1990 of 41 composite mills which had undertaken massive modernisation of machinery showed after statistical analysis no significant relationship between
modernisation expenditure and improvement in cash profits (Sankar, 1991).

There is another very important consideration for modernisation. Several studies of technical and inter-firm comparison type conducted by Textile Research Associations over the last 15-20 years have demonstrated that i) the existing machines are not being used as effectively as they could be, and ii) the labour employment ratio is higher than the norms in many mills. We may examine this area in greater detail.

PRODUCTIVITY

A high level of productivity is a necessary though not a sufficient condition for reaching a minimum level of sustained profitability. Data published by the Reserve Bank of India over a period of 20 years has shown that the return on investment in textiles is only 8-9% as against 12-14% in other industries and fluctuating greatly from year to year. Profits after tax as percentage of net worth for the Indian cotton textile industry have been either negative or negligible for seven out of thirteen years between the period 1975-76 and 1987-88 (Table 2.6). Studies undertaken by Textile Research Associations and personal interviews of mill managements reveal that one of the most important factors affecting profitability from amongst those within the direct control of the mill managements are the machine and labour productivity. Mills which are operating at low levels of productivity suffer much higher losses whenever the parity between sale prices of yarn and cloth and purchase prices of cotton and man-made fibres becomes adverse. This pushes them into the vicious circle of low productivity - less profits - less maintenance/renovation/ modernisation - low productivity. The achievements of high machine and labour productivity and capacity utilisation of existing machinery are absolutely necessary prerequisites for further modernisation besides financial soundness of the unit.
The Textile Research Associations have evolved methods to measure productivity of the machinery and labour complements expressed as indices, so that they are independent of what the mill manufactures to make direct comparison between mills or a set of mills possible. Table 3.5 gives the various indices in the spinning and weaving departments of 49 sample mills over a period of 4 years from 1978-1982. The Productivity Index (PI) of a department in a textile mill is defined as

\[
\text{Machine Productivity Index (MPI)} = \frac{\text{Production per machine-shift : Mill value}}{\text{Number of operatives per shift : Mill value}} \times 100
\]

where \( MPI = \frac{\text{Production per machine-shift : Standard value}}{\text{Number of operatives per shift : Standard value}} \times 100 \)

The computation of labour efficiency has not been undertaken because it in turn depends heavily on machine type and efficiency and its maintenance and working conditions. These effects cannot be quantified and separated from the labour efficiency. The Machine Efficiency Index (MEI) has been formulated, so that of the shortfall in Machine Productivity Index (MPI), whatever is not due to MEI is due to production parameters like speed and twist. The indices are defined in such a way that the standard value is 100 for each of them. Thus, the index for a mill can range anywhere from well below 100 to well above 100 depending on whether the particular level of productivity in a mill is poor or excellent compared to norms. The indices for achievable levels of productivity refer to the level that a mill can achieve with existing machinery. The achievable indices also show the extent of modernisation in a
<table>
<thead>
<tr>
<th></th>
<th>PFI</th>
<th>MPI (Range)</th>
<th>AMPI (Range)</th>
<th>LER (Range)</th>
<th>ALER (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>71</td>
<td>91 (63-119)</td>
<td>93 (82-105)</td>
<td>119 (82-221)</td>
<td>103 (91-118)</td>
</tr>
<tr>
<td>Ringframes</td>
<td>71</td>
<td>93 (59-126)</td>
<td>93 (82-100)</td>
<td>114 (72-198)</td>
<td>100 (96-102)</td>
</tr>
<tr>
<td>Loomshed</td>
<td>82</td>
<td>97 (67-105)</td>
<td>97 (92-100)</td>
<td>104 (80-250)</td>
<td>100 (100-103)</td>
</tr>
<tr>
<td>Non-auto</td>
<td>93</td>
<td>97 (66-103)</td>
<td>97 (92-100)</td>
<td>91 (68-109)</td>
<td>100 (100-100)</td>
</tr>
<tr>
<td>Autolooms</td>
<td>79</td>
<td>96 (59-109)</td>
<td>97 (92-103)</td>
<td>112 (77-154)</td>
<td>101 (100-108)</td>
</tr>
</tbody>
</table>

**Note:** Sample of 49 composite mills.
mill. Thus, if the achievable PI itself is far below 100, it indicates a smaller extent of machinery modernisation and vice versa.

It can be easily observed from the table that there is a gap of 20 points between the overall Productivity Index (PI) from 71 to 91 which can be bridged with the existing machinery either through increase in Machine Productivity Index (MPI) or through decrease in the Labour Employment Ratio (LER). However, the gap of 9 points between 91 and 100 can be bridged only through modernisation. Thus, while 69% of the productivity gap can be achieved on the existing machines, only 31% needs updated machinery. The range values highlight the wide differences between the mills. It is clear, therefore, that optimum utilisation of existing machinery is a pre-requisite for a unit contemplating modernisation.

**Improvements in Machine and Labour Productivity:**

Within the country there is a substantial amount of inter-mill and inter-regional variation in labour productivity. This is attributed to one or more causes like low work assignments, improper working practices, improper layout of machinery, and its insufficient maintenance, low machine productivity, improper working conditions and the like. Our work assignments are not only lower than other countries, but they differ even within the country. For example, while in most centres, mills work for about 350 days in a year on a 24 hour basis, the Ahmedabad mills have not been able to adopt the 7-day scheme as yet. The working hours are also significantly lower. Rationalisation leading to 6 looms per weaver was carried out in Bombay in November 1985, while the Ahmedabad mills, despite protracted negotiations, have been able to allot only 4 looms per weaver and most mills in Madhya Pradesh only two looms per weaver. In some centres, loom allocation is constrained by the total reed space allotted per weaver.
In the pre-war years, the mill sector in India was renowned for excellent machinery maintenance (India, 1927 and India, 1932, quoted in Kulkarni, 1979). The compulsions to overwork the machines during the Second World War without access to stores and spares encouraged a slackness on the part of mill managements, staff and the workers towards maintenance, which has never been the same again. Interviews with senior technical staff reveal that few mills do have international standards of machinery maintenance in India, but most mills neglect this area with grave consequences.

The thrust of modernisation has been on reduction of costs to withstand domestic and international competition. It is a moot point whether this has been actually achieved by itself, given the high machinery prices and high cost of capital in India. Bhave, et al (1983), Garde and Shanbhag (1984) and Kimothi and Garde (1978) show that although labour costs do come down with machinery renewal, the high capital costs overtake the savings generated in labour costs unless accompanied by a significant upgradation in product-mix which should be reflected in higher sales price realisation. Another interesting point to note is that even if modernisation is considered as a viable firm-level strategy, the aggregate consequences at the level of the sector would be that a large number of mills would be forced to compete in a relatively narrow market segment of high priced and durable fabrics.

Be that as it may, there is no doubt that the long-term plans of a composite mill to enter either the high-priced fabric market or the export market or both would come to naught unless accompanied by modernisation up to a certain required level of technology together with proper maintenance of machinery, labour complements, work culture and other support systems. The profitability picture after appropriate modernisation is based on the assumption that the product-mix will change as visualised and that the technical performance will improve to the required norms. While the latter is entirely within the control of mill management, the former, except for marketing, is dependent
largely on the external environment with its constraints of fluctuating agricultural incomes and low rates of growth in real incomes of the population.