IEI Centenary Publication

S N Bhaduri Memorial Lecture

A Compilation of Memorial Lectures
presented in

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Background of
S N Bhaduri Memorial Lecture

After gaining considerable experience in the above-mentioned field, he joined ATIRA, Ahmedabad and developed a well-organized team of SQC personnel. He undertook the dual responsibility of training textile mill personnel of western part of the country in SQC and process control techniques and their applications in the mills.

S N Bhaduri obtained his M Sc Degree in Statistics from University of Calcutta and thereafter started working in the field of Statistical Quality Control (SQC) and its application in textile mills.

Adaptation and implementation of the aforesaid techniques not only improved the quality of textile products but also immensely increased the popularity and value of the same in overseas market. Though he was a pioneer in the field of application of SQC and allied techniques in textile mills, he also took keen interest in mechanical processing of textile fibres and development of the same, including textile machines.

In memory of his dedicated service, The Institution of Engineers (India) instituted an Annual Memorial Lecture in his name during the National Convention of Textile Engineers (to be delivered in alternate year).

S N Bhaduri Memorial Lecture

presented during **National Conventions of Textile Engineers**

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Development in Textile Production

Dr J Venkata Rao

Director, NITRA, Ghaziabad

Till eighties, most of the textile functions were controlled by mechanical and electrical systems. Things started changing with the development in application of electronics in textile productions. Developments were, for example, in the shape of reducing wharve diameter and weight of spinning spindles, Ruti-C automatic looms and jet dyeing etc. The thrust was to enhance production speed and quality of product simultaneously. Fortunately the textile production technology did not remain aloof from the advancement of the information technology which began at a unbelievable pace. E-era, finally in late nineties came into existence, taking and making anything and everything into its grip. Now development, once confined to production rate and quality, inclined towards waste reduction, optimum manpower utilization, fast decision making and communication at higher speed. This has not only limited to these areas, instead it spread its wings to the ecological, environmental, carcinogenic dyes chemicals concerns. Development was to be thought of while keeping its overall environmental impact.

Competition in the textile industry today has never been so fierce since the development of the industry during the industrial revolution. Advancements in the information network, e-functioning and convenience of transportation, have pushed the developments in textile production in a big way. Innovation has become the core issue for the textile machine and textile product manufacturers. Developmental scenario rapidly started shaping and reshaping the glamorous world of textiles.

Developmental trend that had always been towards increased automation, speed and control, labour rationalization and reduction in manual intervention, got 'U' turn and started working on energy saving, less dependability on mechanical and electrical operations and quick processes with concept of total automatic.

1. Spinning
2. Weaving
3. Knitting
4. Processing
5. Quality control
6. Information Technology
7. Garments
8. Technical Textiles
9. Value Added Processes

1. SPINNING

Developments in spinning have traveled a long distance right from trying to solve the contamination problem in cotton raw material to the latest compact spinning.

➲ ELIMINATION OF CONTAMINATION AND FOREIGN FIBRES

Contamination problem, loudly talked and discussed in every technological and business forum, has been a core issue for textile machine manufacturers and researchers.

⇒ Contamination Detection at Raw Stage

The "Cotton Sorter" by Barco NV Kortrijk/Belgium has developed a unique system for detection and removal of contaminants in cotton raw material. Ultra-fast CCD cameras detects all unwanted material that differs from cotton and special mechanical flap removes them. The system is placed in pipelines that transports the cotton tufts from bale opener. It helps in removing the foreign particles like packaging material, jute parts, clothes pieces, plastics, leaves, words, stones etc.

⇒ Contamination Detection at Draw Frame Stage

This does not complete here itself. Even at draw frame, a contamination system "Sliver Watch" is used that is to be installed in the creel of draw frames at the first passage. This works on the principle that to stop draw frame in case contaminated sliver is detected indicating operator to eliminate the contamination thus preventing the contamination to go to further draw frame passages. This helps in avoiding spreading of contamination over many metres of yarn. This detection system is based on light absorption principle and detects any thing whose colour is different from the colour of the raw cotton.

⇒ Contamination Detection at Open-end

Barco has also developed ABS contamination detection system to be used on Open-End spinning machines. ABS contamination detector is mounted on the yarn withdrawal tube in spin box and can be fitted on all types of open-end machines. The detector looks at the yarn from all angles and is able to see the full length of the foreign fibre.

➲ New Dimensions in Carding

Most of he developments in cards have been to improve productivity, speeds, incorporation of autolevellers, metallic clothing and so on. Rieter Machines Works Ltd has totally reconceived the concept of carding and innovated the so called C 60 high-performance cards probably from scratch. This unique development is a perfect response to demand for a reduction in the cost of carding. C 60 high-performance card provides increase in working width by 50%, reduction in cylinder diameter and increase in take-off roll diameter. It enables 50% higher production over the C 51 Hi-per-Card depending upon type of raw material and yarn type. Inspite of 50% increase in the carding surface the carding quality is well maintained and results in achieving 50% higher production. Is graded as the worlds fastest and economics card with features consuming less energy. Less wear the technology, components, reduced maintenance and operating efforts and reasonable capital costs.

➲ UNCONVENTIONAL NEW SPUN YARN SPINNING TECHNOLOGY

Development in this direction has put anyone to think for beyond as far as innovations are concerned. DuPont has developed a "UNIPLEX" spun yarn technology that is capable of producing long staple yarn directly from a number of filament yarns (LOY, POY, FDY) by stretching and tearing the filaments followed by bonding by means of air vortexing jets. Uniplex a single step process to convert filament yarns into spun yarns and has a big potential for speed and application (Refer Fig.1).

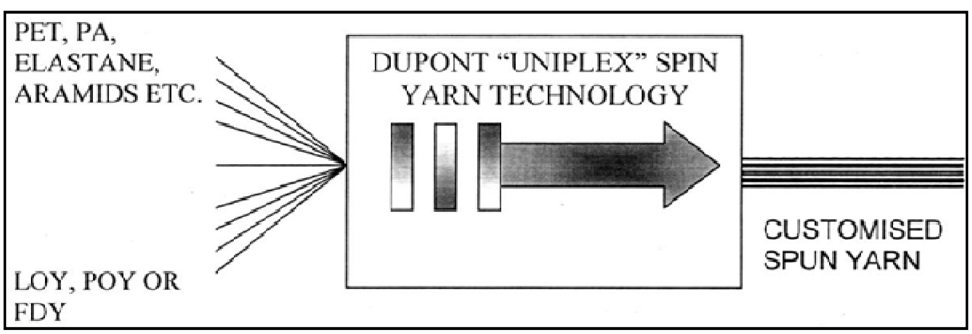

Fig.1 : Broad View "UNIPLEX" Spun Yarn Technology Process

➲ RING-SPINNING TECHNOLOGY ENHANCED TO COMPACT SPINNING

This system, a unique value added development in Ring-spinning system meets the need of ever increasing demand for quality yarn without spending anything on raw material.

In works on a principle where compacting of strand of fibre is condensing zone after the drafting system to an extent so as not to allow the formation of a spinning triangle while twisting the strand of fibres into yarn. This prevents the reduction in yarn strength and undesirable yarn hairiness by avoiding formation of spinning triangle (infact spinning triangle is minimized to greater extent). Nowadays high quality woven and knitted garments are produced from compact yarn. Different manufacturers are compacting the strand of drafted fibres by employing variety of techniques. Some uses magnetic compacting, some uses air suction system for compacting and few also uses perforated drums for getting the compacted strand of fibres. It all depends on their technological innovations they tried to incorporate.

Lakshmi has come out with RoCoS Compacting system, Rieter has brought Com 4 Spinning System, Finlane Group has introduced COGNETEX Com4 Wool compact spinning technology and there are so many.

➲ WINDING NOW MADE POSSIBLE FROM BEAM TO CONE

RS-2000 from JAEGGLI -' MECCANO TESSILE has proved its worthiness in making cones directly from beams at a maximum mechanical take-up speed of up 800 metre/min. This development is composed of hi-speed beam unwinder feeding the cone winder with 40 heads from special beams consisting 40 ends each. RS-2000 fitted with new electronic control system enables the machine to perform at the constant winding tension of all the 40 ends, thus producing soft constant density, cone packages suitable for dyeing/waxed cone packages ready for knitting, weaving and stocking

➲ CORE SPUN YARN TECHNOLOGY WITH POSITIVE FEED SYSTEM (FRICTION-CONTROLLED TENSION SYSTEM) AND BREAKAGE DETECTOR SYSTEM

Core spun yarn can be made either by employing elastic or rigid filament as a core and covering the same by natural or synthetic fibres or blend of synthetic and natural fibres. Pinter s.a. has developed a core spun technology that is adaptable to all spinning frames capable of spinning short or long fibres having unique Breakage Detector System with automatic feed-roving stoppage and production control. It produces, particularly for elastic core; a classic "direct insertion processes" with friction-controlled feeding/positive insertion with precise control of the fllament tension by means of either mechanical feeding or servo motor driven feeding. Not only this Pinter s.a. produces custom-made "positive feed system" for each type of spinning frame.

➲ AIR-JET SPINNING GETS FURTHER DEVELOPMENT

Air-jet spinning, among all new spinning methods has gained high expectation due to its characteristics of high output speed and ability to spin finer yarns.

And Air-jet spinning in the form of 'VORTEX' has really made a breakthrough. Vortex spinning enables yarn quality closer to ring yarn than the rotor yarn even at a spinning speeds of over 400 metre/min. in the wide count range (Nm 16 to Nm 120). Air Vortex Spinning system may also be used for producing composite yarns of filaments and staple fibres which attracts attention of yarn manufacturers as well as yarn consumer.

2. WEAVING

Preparation to weaving includes one of most important process called SIZING where developments have been in many forms be it consumption of sizing materials, chemicals, energy, productivity and quality.

➲ CONCEPT OF TANGENTIAL SIZING

TMT MANENTI has developed all together new concept in sizing i.e. Tangential sizing. This can be used for spun staple fibre yarns from woollen mixtures, Iycra polyester, polyamide, as well as filaments. It is capable if sizing upto 13,000 ends by two applications on each side of the warp that apply sizing medium tangentially. This is followed by wet system using cooled, rotating splitting rods and the warp is dried in its doubled state in an infra-red field without any further redirecting. Additional features of tangential sizing is its control systems like measuring of water consumption during pre-wetting by flow meters, sensors for residual moisture measurement, new online instrument for measuring the liquor concentration etc.

➲ INNOVATIONS IN WEAVING TECHNOLOGY

This section has already enjoyed lot many developments right from auto shuttle changing to shuttle less, air-jet, water jet, rapiers weaving machines and many others available in industry.

⇒ Air-jet Weaving technology has been improved by way of incorporation of optimized relay jet entry making processing more reliable and reduced air consumption. This is achieved by controlling two jets at different pressures, through a more precise field of travel with smaller nozzle groups and by way of shortening distances between tank and value and value and nozzle by improving the tensioning jet. The "Omni Plus" with "Unival 100" has attained highest weft insertion rate of 2460 m/min at 1026 rpm with single phase weaving machines.

3. KNITTING

Knitting has been one of the lucrative sector since last two decades for western countries due to its relaxation characteristics and easiness in dressing up. Development has also been on very accelerated speed. Now knitting technology once confined to cotton, nylon, blended, viscose, acrylic yarn have started producing a high quality knitted garments even by lycra.

➲ SEAMLESS APPAREL

Looks something amazing but knitting has enabled, due to its fast developments, seamless hosiery wears. Merz Maschinenfabrik has introduced its new 8 feed MBS knitting machines for seamless body size apparel. Unlike other seamless machines, the new MBS machine uses the large diameter Mayor & Cie monomagnetic selection system. The machines is available in a range of diameters from 10 to 17 ins and in gauges from 16 to 32G.

➲ KNITTING MADE FLEXIBLE

Knitting has also been made speedy and flexible by PILOTELLI who has offered the most useful new pneumatic system for the automatic insertion of yarn to the needle head after yarn breakage. All operations have to do is insert the broken yarn end in a circular tube-shaped vertical yarn guide, insert one yarn, press a button. Compressed automatically sucks in the yarn and presents it to the Knitting head at the correct point making the whole system very practical and quick.

2. WET PROCESSING

➲ IMPROVING COLOUR FASTNESS OF DISPERSE DYED POLYESTER

This technology is developed to effectively remove loose disperse dye stuff from polyester at low temperatures. The theme behind this is that colour is gently lifted so that any loose due is held away from the substrate, without aggressively stripping the garment of colour or markedly affecting shade. Once the dyes have been removed, they are held in suspension by a dispersing system, which effectively prevents dye redeposition on either polyester yarn or fabric. The technology "Milliclean MAU" developed by PPT proves that technology is best to improve the wash fasteners properties of disperse dyed polyester. The after clear treatment is usually conducted after a traditional reduction clear process, but in some cases can be used to replace this. Apart from this unique application, Milliclean MAU can also be utilized on multicoloured prints or garments to treat problem areas of colour withcut creating staining on adjacent areas.

➲ CONTINUOUS MERCERIZING SYSTEM

This new MC 2000 "Continuous Mercerizing System" is an excellent technological development that provides process economics of cotton yarn mercerzing with a quick payback. MC-2000 developed by JAEGGI means whole process to be carried out under full control, reduction in manual workforce, constant quality results and easy process management.

Brief Description of Continuous Mercerizing System

(1) Warping:

➢ Direct Warping Machine

(2) Mercerizing:

➢ Continuous Warp Mercerizing. This includes:

- ⇒ Mercerizing
- ⇒ Neutralizing
- ⇒ Drying
- ⇒ Rebeaming (Take-up)

(3) Winding:

➢ Beam to cones winding machine RS 2000.

MC 2000 Technical Data

- No. of Feeding Ends: 960
- No. of Take up Heads: 24
- No. of Ends per Beams: 40
- Count Ranges: Upto Ne 2/100
- Maximum Mechanical Speed: 100 mt/min.
- Net Wt per Beam: 50 kg
- Production Base: Ne 2/60 75 Kg/h
- Installed Power = 60 KW
- Soda Consumption: 380 gr NaoH100% per each kg. of yarn at 20°C.
- Hot Water: 30 litres per kg of yarn
- Acetic Acid Consumption: 6.6 litres/h
- Steam consumption: 250 kg/hr.

➲ PAD - PATCH DYEING SYSTEM

PB 2000 PAD - Patch Dyeing Line for Yarn is a m/c that completes the continuous Mercerising line. This Dyeing line works on beams coming from continuous Mercerizing line.

PB 2000 Pad - Patch Yarn Dyeing System:

- ➢ Beams from continuous mercerizing line
- ➢ Pad Dyeing
- ➢ Cold storage and washing
- ➢ Hydro-extractor
- ➢ Dryer (High radio-frequency dryer)
- ➢ Winding (from beam to cone on RS 2000)

Technical Data:

- No. of Feeding Heads: 4
- No. of take up Heads : 4
- No. of Ends per Beam: 40
- No. of Feeding Ex : 60
- Count range: upto Ne 100/L
- Production Base: Ne 80/2, 12 kg/h
- Maximum Mechanical speed : 100 mt/min.
- Net wt per beams: 50 kg
- Beam size: Flange 550 × span 550 mm

Benefits:

➲ Saving in Dye Stuffs, auxiliary chemicals, energy, water pollutants and labour cost.

➲ Extra Low Liquor Ratio

➲ Brighter colour tone and absolute uniformity of shades

➲ Improved fastness of dyes

➲ RADIO FREQUENCY DRYER

Severe problems faced during drying in process house have become major motivating factor for the R&D team of machine manufacturers to innovate a system that makes drying problems negligible.

Radio Frequency Drying Technology is a development in this direction. FTDW Fongs Radio frequency Dryer allows the drying of natural and man made fibres in staple, hank, cone, package and top form normally immediately after hydro-extraction. This results in good uniformity and better final handling.

Benefits:

- Only humid parts are heated i.e. selective heating
- Uniform drying at low temperature, improved fibre quality and softeners
- Time and energy saving (1.2 kg water per KW high frequency power), also power consumption is directly proportional to humidity contents
- Residual humidity controlled within +1- 1%
- Constant and repeatable drying level.

1. VEGA CLASS DYEING MACHINES
2. VEGA TERRUT DYEING MACHINES
3. VEGA PLLISS DYEING MACHINES

- INFRARED DRYING - ANOTHER NEW CONCEPT IN DRYING

Radiant process has developed infrared drying system that includes Infrared Predryer, Selvedge Infrared Dryer, Infrared Full Dryer systems. Dryer system Infrared Pigment curing system and stenter optimizer process house in order to accrue lot many benefits. Some of the important ones are:

- Significant Cost Saving
- Custom made to existing production lines
- Environment - friendly and requires far less maintenance
- Accurate temperature control that facilitates higher production standards and process repeatability.
- Emitter failure / Electronic failure detection system
- More efficient than traditional drying system

These infrared dryers are available in flat bed / one tower / two tower / three tower types depending upon the application and use.

- COLLETTE™ SYSTEM FOR SCOURING OF COTTON GOODS

In traditional alkaline scouring where fats, waxes, pectins responsible for hydrophobic effect are removed by applying large quantities of alkali which emulsifies and saponifies the waxes, on the other hand, COGNIS has developed a system which enables enzymatic treatment to be carried out in an acidic medium. This allows the enzymatic treatment to be combined with desizing and bio-polishing.

In enzymatic treatment special enzymes - PECTNASE - are applied. These pectinases form a complex with the pectin, which is embedded in the waxes, and hydrolyze it.

Due to this the originally insoluble pectin can be selectively split and removed from the primary cell. The hydrolyzed pectin can now be dispersed. By spotting the pectin from the primary cell wall, the surface of the fibre and remaining wax are more easily accessible to the effect of detergents and can be removed.

Enzymatic treatment developed by COLETTE™ SYSTEM brings the many advantages. Some of them are :

Benefits:

- Reduction of process cost.

- Reduction of COD of waste water
- Substantial reduction in chemical costs.
- Reduction of water and energy consumption
- Less fibre damage and softer handle

➲ COSMETICS AND HEALTH

Cosmetics' and Health, looking to name of topic, anyone may get surprised that how wet processing of textiles are concerned with cosmetics and health. No wonder, any thing may happen in this technology loving society.

COGNIS "THE SKINTEX CARE SYSTEM" (Something extra one would love to have). Smart fabrics have become a hot talk now-a-days. But the clothes having cosmetic ingredients, a new trend in the textile industry, can well be termed as "ACTIVE CLOTHES". Cosmetics can not remain in bottles and tubes, something to applied on skin as and when needed. Get the feeling, flavour and heartfelt smooth touch every time you wear a procedure "MATCH" the color instantly. One can also do the required color corrections and do "Quality Check" and obtain" Electronic approval - pass/fail" from the buyer/supplier. This will change the working of Dye House in textile mill. Color management is Dye House Management.

Author presents his ideas based on available technologies for modem Dye House.

India is now well known for conventional IT application. However, technical software packages are not developed by Indian Software companies.

There are very few attempts by a few individuals. Authour is one of them who developed color matching software in 1980. A few Indian companies such as Jay Instruments and Premier Colorscan offer low cost instruments with software.

Recently, P Ravichandran of Anglo French Textiles, Pondicherry has developed" Praveen Colorscan System" (3) . Based on his theoretical knowledge, mathematical skills and practical dyeing experience he has developed good and working software which is effectively used in his company and achieved significant economic gains. This development of software in Indian industry is encouraging. However, Indian color using industries should invest in R & D and come out with software of international 'standard with affordable price tag. One should also incorporate all aspects of color management in Dye House Management programs.

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Ecological Considerations for Textiles with Reference to International Trade

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Introduction

Globalization has transformed the patterns of production and consumption of textile and clothing products. Rapid technological innovation and market opening have made contract manufacturing with distant suppliers in a growing number of emerging economies common practice for developed economies. The Uruguay Round Agreement has set to accelerate these trends. As quota restrictions were removed, a more level playing field appears to have emerged, intensifying competition. Government and industry across the globe are now getting ready to the WTO era. The signs are that high standards of social and environmental performance by textile producers and garment makers need to be critical for success. As subcontracting becomes central to the clothing strategies, so retailers are focusing on the quality of their supply chain. For many, this means rationalizing their supplier base to include only those producers who can meet demanding requirements for quality, price and turnaround times. Taken together, these trends provide a powerful deflationary force on costs throughout the supply chain. This deflationary pressure gives a new urgency to the search for productivity improvements particularly with reference to environmental and social standards. Increasingly, the clothing market is dividing between the high-end branded goods and price-sensitived is counters. Brand value is becoming increasingly central to many clothing retailers and protecting reputation from allegations of poor practice along the supply chain is now one of the major motivating forces for companies to social and environmental conditions for their producers.

As early as the 1970s, it was reported that workers responsible for clothing quality control often experienced problems of tearfulness, coughs and other skin allergic reactions. People wearing clothes that did not need ironing incurred skin infection. At that time, however, incidents like these were largely ignored. Since the 1980s, particularly in the late 1980s, along with progress in science and technology and the increased environmental awareness of the public, reports on the potential harm of certain textile products have received a great deal of attention. Now there are many reports expressing criticism and doubts on the harm of textile products to human health.

In modern textile production, processes such as dyeing, printing, finishing are typical chemical processes, and pollution problems caused in these processes can hardly be overlooked. People become increasingly concerned about the pollutant residues in textile products and their harm to human health.

Generally, harmful substances in textiles and clothing products include the following categories:

§ Formaldehyde, fluorescent bleacher, and softener (may cause allergies)

§ Residues of pesticides, antiseptics, and mold inhibitors in cotton and in wool fiber, such as pentachlorophenol (e.g. PCP)

§ Residues of heavy metals

§ Residues of azo monomers, formaldehyde, and halide carrier in chemical fiber

§ Residues of pesticide and fertilizer used in cotton farming

Since the 1990s, many countries have adopted environmental standards and requirements restricting the use of harmful chemicals in the production of textile and clothing. Some of these standards and requirements are mandatory. The best known is the Second Amendments to the Consumer Protection Act issued by the German government in 1994 prohibiting the use of certain azo dyes liberating harmful aryl amines. In addition, there are a number of ecolabelling standards, the goal of which is to reduce pollution on a voluntary basis.The best known ones are Milieukeur and Eko of the Netherlands and Oeko-Tex 100 and Toxproof of Germany, EU-Flower of European Union.

An attempt is made in the present paper to discuss some of the aspects of ecological implications and the ways and means to manage them to meet various demands by the importing nations. As a progressive nation, India has also taken various initiatives through the participation of industry, Trade and Government. Due to the time constraint these are just noted in the paper.

Environmental Considerations

Consumers all over the world are increasingly becoming environmental and health conscious. Developing countries are spear heading the cause especially to protect the ecology and preventing global warming, minimizing the depletion of ozone layer etc. Some of the developments like Kyoto protocol for global warming, Montreal protocol for Ozone depletion are the illustration of the global concerns. There are other types of developments like ban on certain dyes and chemicals, ecolabels, REACH, Organic Cotton etc. to be complied by international traders as per the counterpart's whims and fancies. This situation is critical in the case of exporting nations in the category of either least developed or developing countries. Many a times these appear to be either non-tariff barriers or technical barriers for trade. The Non-Tariff Barriers (NTBs) which consist of a wide range of issues like quality norms, environmental specifications, subsidies, social issues, etc., are going to determine the market access and share of textile products in the absence of quantitative restrictions after the year 2004. Out of these, environmental issues are the most significant. Such environmental issues can broadly be classified as: Product related and Process related.

While each country has its own regulatory framework governing these aspects, there have been numerous voluntary standards/ guidelines with respect to the environmental / ecological compliance by manufacturing companies/products. This paper attempts to analyze the status of such environment related issues in the Indian textile industry and suggests an appropriate action plan.

Process related Environmental Issues

2.2a The process related environmental issues primarily revolve around the way the goods are manufactured, with the objective of minimizing adverse impact on local environment due to manufacturing activity, an institutional framework with a plethora of laws/rules/ guidelines/Standards have emerged over a period of time. It has also led to implementation of multiple standards by the enterprises thereby increasing the over heads.

b In India, the regulatory framework governing the environmental compliance of textiles manufacturing activities has been in place for the past many years. The Ministry of Environment & Forests, Government of India and the State Governments are responsible for the formulation of regulations and the overall monitoring of compliance of the industry to such regulations. Use of eco-friendly substances in the entire value-chain, right from the raw-material stage to finishing and packing is an important aspect of producing eco-friendly textiles. The Indian textile industry needs to recognize this aspect and take necessary measures by switching over to safer alternatives.

Product related Environmental Issues

2.3a On the other hand the product related environmental issues voice the concern of the customer/user relating to the harmful effects of use of the product. With this as the primary focus, many standards have been developed the world over to limit/ban the presence of various harmful substances in textiles & clothing. Germany was the first country to impose a comprehensive ban/limit on the presence of azo dyes capable of releasing 22 banned amines. Following the German ban many countries including India introduced ban on either the amines themselves or the dyes capable of releasing these amines.

b William Henry Perkin discovered the first synthetic dyestuff in the year 1857. The Textile Colouration industry got a new dimensions and the recent news and research has indicated that 150+ years of these chemicals have led extensive damage to our health and to the environment.

Azo Ban

2.4a On 28 July 1994, the German government issued the Second Amendments to the Consumer Protection Act. The law prohibits the use of azo dyes in textile products that have direct skin contact for prolonged periods, such as textile garments (even outerwear) and bath towels. These banned substances can be any of the 20 specific cancer-causing aromatic amines that are formed from the azo group decomposition process (reduction cleavage). The law took effect as on 1 July 1995. Sales of textile products using such banned substances in the dyeing or printing process are prohibited in Germany. On 27 July 1995, the Fourth Amendments to the Consumer Protection Act was adopted, adding to the blacklist two more aromatic amines which are suspected by the Health Committee of EU to have cancer-causing effects. This makes the number of banned substances (amines) increase to 22. The law is also applicable to pigments based on the banned amines.

2.4b The German Ministry of Health finalized the testing methods for azo dyes in natural and artificial fibers (cotton, wool, silk, viscose). A product that contains less than 30 ppm of the banned amine is regarded as a non-azo product. The German law also stipulated that violating this Act will constitute a criminal offence and will be severely punished. Should a product be found containing the blacklisted substances in sample, the product concerned will be burnt and the importer or producer will be penalized?

2.4c Since the enactment of the German Act and its implementation on 1 April 1996, it has aroused great attention in many countries, particularly in some European countries and many developing countries including India. The Government of India had prohibited handling of Benzidine and azo- based dyes (112 commercial dyes) capable of releasing any of the 22 harmful amines, as listed in German ban is given in Table 1.

Table 1. List of banned Aryl Amines

i) 4-Amino biphenyl (CAS-No.: 92-67 -1)
ii) Benzidine (CAS-No.: 92-87-5)
iii) 4-Chlor-o-toluidine (CAS-No.95-69-2)
iv) 2-Naphthylamine (CAS-No.: 91-59-8)
v) p-Chloroaniline (CAS-No. 106-47 -8)
vi) 2,4-Diaminoanisole (CAS-No.615-05-4)
vii) 4,4'-Diamino diphenyl methane (CAS No. : 101-77-9)
viii) 3,3'-Dichloro benzidine (CAS-No. : 91-94-1)
ix) 3,3' -Dimethoxy benzidine (CAS- No.: 119-90-4)
x) 3,3'-Dimethyl benzidine (CAS-No. : 119-93-7)
xi) 3,3'-Dimethyl-4,4'-diamino diphenyl methane (CAS-No.: 838-88-0)
xii) p-Cresidine (CAS-No.: 120-71-8)
xiii) 4,4'-Methylene-bis- (2-chloraniline) (CAS No.: 101-14-4)
xiv) 4,4'-Oxydianiline (CAS-No.: 101-80-4)
xv) 4,4'-Thiodianiline (CAS-No.: 139-65-1)
xvi) o-Toluidine (CAS-No.: 95-53-4)
xvii) 2,4-Diamino toluene (CAS-No. 95-80-7)
xviii) 2,4,5-Trimethyl aniline (CAS-No. : 137-17-7)
xix) o-aminoazotoluene (CAS-No.: 97-56-3)
xx) 2-amino-4-nitrotoluene (CAS No. : 99-55-8)
xxi) p-amino azo benzene
xxii) 2-methoxyaniline

2.4d In India, the regulatory framework governing the environmental compliance of textiles manufacturing activities has been in place for the past many years. The Ministry of Environment & Forests, Government of India and the State Governments are responsible for" formulation of regulations and overall monitoring of compliance of the industry to such regulations. Despite existence of stringent environmental laws/regulations, the compliance level by Indian textile industry has not been very satisfactory. It has been a common knowledge that a large number of textile industry, and units, particularly processing, fail to meet many of these norms. The highly decentralised nature of Indian textile industry further complicates the enforcement of legislation. For example, the fragmented and small-scale nature of the industry cannot support an individual treatment plant in every company. The solution to this problem is to have common effluent treatment plants on the basis of sharing of costs. Barring few textile clusters in the country, concept of common ETP is yet to become popular in the industry, The State Governments and other local authorities need to facilitate the ecocompliance by the textiles companies by way of infrastructural support like supply of water of acceptable quality, earmarking of suitable area for ETPs and dumping of sludge etc.

e The Government of India has initiated several measures to equip the Indian textile industry in meeting the requirements emerging out of such restrictions. The small-scale sector, both the manufacturers of dyes and chemicals and the processors, need to be educated/sensitized further to comply with the requirements. At the same time, the legislations by the Ministry of Environment and Forests also require a critical examination to plug the loopholes both in terms of coverage as well as its enforcement.

Impact of Azo Ban in India

2.5a Various measures initiated by Government of India in preventing the use of harmful dyes and auxiliaries by the textile industry has resulted in the importers of textiles from India not insisting on the testing of each consignment of textiles for the presence of the banned amines. The importers of textiles now accept a declaration by Indian exporter regarding the absence of the harmful azo dyes capable of releasing the banned amines.

b Due to the removal of quantitative restrictions in the import of textiles in accordance with the negotiated settlement with the WTO, large quantity of textiles is now being imported to India. In order to ensure that the imported textiles are not dyed with any of the 112 dyes prohibited by the Government of India, the Director General of Foreign Trade (DGFT), has issued a public notice No.12 (RE 2001) 1997 -2000 dated 3 May, 2001 for the testing of all the textile consignments in the selected eco laboratories of Textiles Committee and Central Silk Board.

Eco-friendly Compliance

2.6a Use of eco-friendly processes and substances in the entire value-chain, right from raw material stage to finishing and packing is an important aspect of producing eco-friendly textiles. The Indian textile industry needs to recognize this aspect and take necessary measures by switching over to safer alternatives. Table 1 gives an illustration list of toxic substances that are to be avoided.

Table 1: List of toxic substances to be avoided in textiles

Textile process	Toxic substances to be avoided
Cotton growing	Banned pesticides such as DDT, Dieldrin, Aldrin
Wool storing	Banned Insecticides
Silk worm culture	Banned Pesticides
Sizing	PCP as preservative
Scouring	Chlorinated products
Bleaching	Chlorine bleaching
Dyeing and Printing	Azo dyes releasing harmful amines dyes containing traces of heavy metals Formaldehyde as a mordant
Finishing	Formaldehyde as a finishing agent
Garment manufacture	Stain removers containing chlorinated products
Packaging	Wooden boxes treated with insecticides

2.6c. The textile eco-labels, which prescribe norms for the presence of harmful substances in the products, have been the best instruments for the companies to demonstrate the compliance of their products to the econorms. Most of the eco-labels adopt "Cradle-to- Grave" approach for the manufacture of eco-friendly textiles. All of them are voluntary in nature. Most of these labels cover the following substances: (i) formaldehyde, (ii) toxic pesticides, (iii) pentacholorophenol (PCP), (iv) Heavy Metal traces, (v) azo dyes which release carcinogenic amines, (vi) halogen carriers, (vii) chlorine bleaching. The norms for the presence of these substances vary from label to label. The Government of India has also brought out a voluntary eco-mark scheme prescribing the limitations for the presence of the substances.

2.6d Increasing awareness and concern for protecting the ecology especially in Europe and USA has lead to demand for organic cotton textiles and ecofriendly textile in the international trade. Organic cotton is the fibre produced without use of toxic and persistent pesticides or chemical fertilizers, sewage sludge, irradiation or genetic engineering. The textile produced out of this needs to be certified for its product identity as organic and ecofriendly throughout the supply chain by an independent accredited organization. The latest version of the standard is Global Organic Textile Standards (GOTS). The standards are promoted in India by a few agencies such as IMO. Switzerland, Control Union Certification, India.

2.6e Though the GOTS, aligns with cotton, it applicable to other natural fibres like Silk, Wool, Hemp, Ramie, etc. The theology is to objectively establish through documentation and ethical practices at both levels cultivation and manufacture. These tools can provide confidence in the costumers on one hand; they also offer mechanism to protect ecology and health of flora and fauna apart from conserving the global environment, processing industry needs to pool its resources to establish common effluent treatment plants, which are the most cost-effective techno-economic options to comply with the statutory requirements.

Summing Up

India has done reasonably well in ensuring that its textile companies are more ecofriendly today as compared to a decade ago.

However, small and medium scale industries particularly the manufacturers of dyes and chemicals as well as the processors are required to take a few more remedial measures in ensuring that the processes adopted by them and the products are more eco-friendly.

Apart from sensitizing this sector, the loopholes in the ban imposed by the Government of India and its implementation should also be plugged to make it more effective.

The norms prescribed by the various Sate Pollution Control Boards are required to be critically examined and rationalized. The

The ISO 14000 EMS standards and eco labels including GOTS are required to be adopted by the industry in a big way.

The culture of testing the chemicals, dyes and textiles should also become an essential ingredient of quality systems of the textile companies.

The adoption of these measures will go a long way in equipping the Indian textile industry to become more eco-friendly which will help in enhancing its global market share and promote sustainable development/growth of the industry.

Innovative Fiber Developments — Driver for Textiles Growth Beyond 2020

Mr Sandesh C Kadam

Sr. Vice-President, Reliance Industries Limited, Hazira

The population profile of India is shifting towards a larger composition of people in the age group 15- 29. By 2026,Two-Third of Young population belonging to urban areas coupled with rising income levels, will act as a key growth factor for the Indian textile and Fashion Industry. This major shift in population profile will result in paradigm shift in Needs of the people. The Age-old Pyramid exhibiting 3 basic needs of a Human Being as 'Food', 'Clothes' & 'Shelter' is set to change & a gradual change is already evident during last decade. The new pyramid that is emerging has several new components like Luxury, Education, Safety & entertainment whereas traditional clothing has taken a back seat. The Indian Textiles Industry needs to align itself with the changing demand pattern & varied customer requirements, think beyond customary apparel end use and focus on development of Innovative fibers for other end uses like Functional textiles, Home-Textiles, Industrial & automotive sector & so on. His paper encapsulates 'Innovative Fiber Developments Initiatives' across the Globe.

'Functional Textiles' has witnessed most of the innovations in differentiated textiles during recent years. The innovations are aimed at enhancing luxury & comfort of the man-made fabrics. "VENTCOOL", one such innovation, is the world first triacetate conjugate fiber produced by Mitsubishi, which is cubically, transformed depending on wet and dry conditions. Under dry condition, natural crimps of the fiber suppress breathability. When the fiber moistens due to perspiration, it momentarily elongates to improve breathability, automatically controlling ventilation within clothes. "SOPHISTA", Perspiration absorbing & Fast drying fiber (Ethylene-vinyl alcohol) introduced by "Kuraray" has a hydrophilic radical synthesized with fiber which catches water and releases moisture immediately giving the fiber advantages of both synthetic and natural fiber. "LONW AVE", a Far Infrared Radiation polyester staple by Kuraray has varied types of special ceramics dispersed during fiber extrusion that radiate far-infrared effectively. "Recron® MICRELLE" by "Reliance Industries Ltd", a yarn with inbuilt moisture management uses advanced Bi-component technology with yarn containing both Polyester & Nylon having a final dpf of < 0.1 for special effect, feel & functions. "Recron® KOOLTEX" is another yarn with higher surface area & modified crosssection has softer feel & aids in faster Water/ Sweat diffusion & dissipation of body heat during strenuous exercise. Various Polyester producers worldwide offer "Anti-microbial" fiber which essentially uses Silver component which has captured extensive market in functional wear & sports wear. "Low pill fiber", which uses modified polyester, so that PES fiber breaks easily avoiding pill formation, is used for high quality wool blends. Current innovative efforts in Functional textiles include developing new 'optical fiber' that structurally produces beautiful color with optical interference without the use of dye, like a Morpho butterfly, development of technology to recycle used clothing made of polyester/cotton blend & to turn cotton into nano-particles for use as cellulose composites. Research is also in progress for development of new fibers derived from natural substances obtained by melt spinning by developing a technology to transform cellulose into thermoplastic and thermoplastic cellulose into fiber with melt spinning method.

Last decade has witnessed phenomenal growth in use of fibers in 'Technical Textiles' & 'Home Textiles' application which has catalyzed innovations in this field. Industrial yarns have evaluated & will define future of textiles growth worldwide. Different varieties of Industrial yarns have been developed for varied end uses like GEO-Textiles, Tire (dipped cord), Fire hose, Conveyor belts, Transmission belts, Tarpaulins, Bill boards, Sail cloth, Strapping, Lifting Slings, Safety belt, Ropes/Nets/Strapping, Sewing thread & Geo-Grid & so on. 'BASF'has recently developed "Self-Cleaning Technical Textiles" which is inspired from Lotus leaf & uses nano structure which lets water droplets roll off the surface, taking dirt & other contaminants with them. The fabric has much superior Soil repellence, self cleaning & Soil release properties compared to Fluorocarbon treatment. Textiles using such fiber can stay clean although they can not be washed, e.g. Tents, Umbrellas, Awnings, Flags, Advertisement banners etc. 'Hahl Filaments' (Lenzing Plastics) has developed "Abratape", which is a wide abrasive band made from PA 612 with a high grit content used for wet and dry grinding of high grade steel and stone surfaces. It has much superior abrasive performance than conventional abrasives like metal bristles. They have also developed Co-extruded abrasives where the abrasive filaments are co-extruded with a thermoplastics sleeve. This wrapping process results in reduced wear of machine parts during subsequent processing & reduction of grit loss. "Starlight® UV guard" by 'Radici group' is a UV stabilized PET which is ideally suited for outdoor applications like sun blinds, awnings, outdoor furniture covers, tarpaulins & tents etc. This is much superior to acrylic fabrics as it is much thinner, very high fastness of colors & very good resistance to atmospheric agents. Several organizations are conducting extensive research in development of "Starch based Biopolymers" which has huge potential in agro-textiles where often only a temporarily durability is required e.g. crop protection during one season. "Biodegradability" can offer an advantage by composting of the crop residues together with the agro-textiles after use resulting in important savings in man-hours and costs for removal and disposal. Research is also continued to produce "Photo-chromatic" PET & PP polymers where photo-chromic dyes are incorporated during the fiber spinning. Such polymers can be used in Textile materials with photo-chromic color effects e.g. fashion articles with color changing yarn in the cloth or photo-chromic printings, curtains that provide an automatic sunlight protection in buildings. "Conductive fibers" and fabrics have recently found interesting applications in technical and smart textiles. The combination of electronic components such as sensors and actuators into wearable textiles is essential in medical textiles for monitoring physiological parameters, in technical textiles for transmitting information, in clothing for safety and protection, and in clothing for sports and adventure. "Liquid Crystal Polymer" has also interested researchers recently. It is a polymer which self-organizes into crystals when put into a liquid state & has very high orientation without chain folding. Alignment of crystals gives excellent fiber properties & it has great potential in applications like automotive parts, Cell phone case, Audio case, Toys, Water Transportation Bag, Backstop for a baseball field & Netting of Golf practice range etc. A boom in housing sector has been a boon for 'Home Textiles sector'. CAGR % for Home Textiles worldwide is as high as 1000%.India with lower CAGR of 134% needs to catch up & capture this growing field. Textile leaders in India have initiated dedicated efforts to capture a pie in high growth & high value Home Textiles segments like Upholstery, Curtains & Drapes, Blankets, Bed Linen & Quilts. The other promising sector for innovation in Textile sector is Automobiles. Automotive sector is growing at a 13%.On an average, 3.2Kgs of Fabric is used per car in various sections like Headliner, Seat covers & side panels. Indian Textiles industry needs to gear up to meet the quality requirements of Global automotive producers.

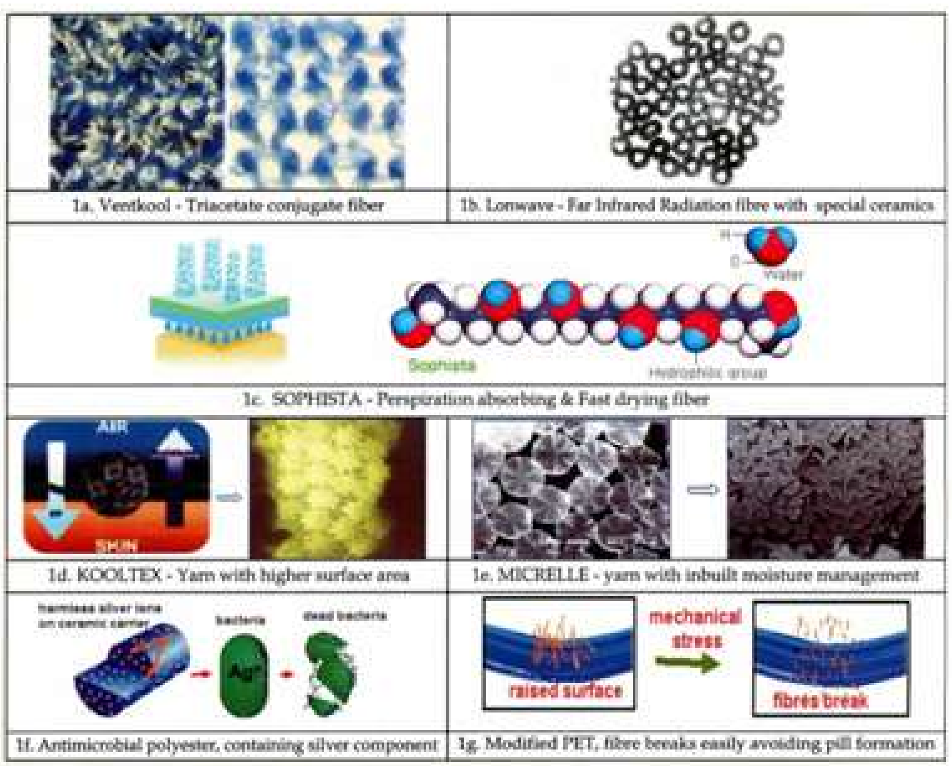


Fig. 1 : Examples of Innovations in Functional Textiles

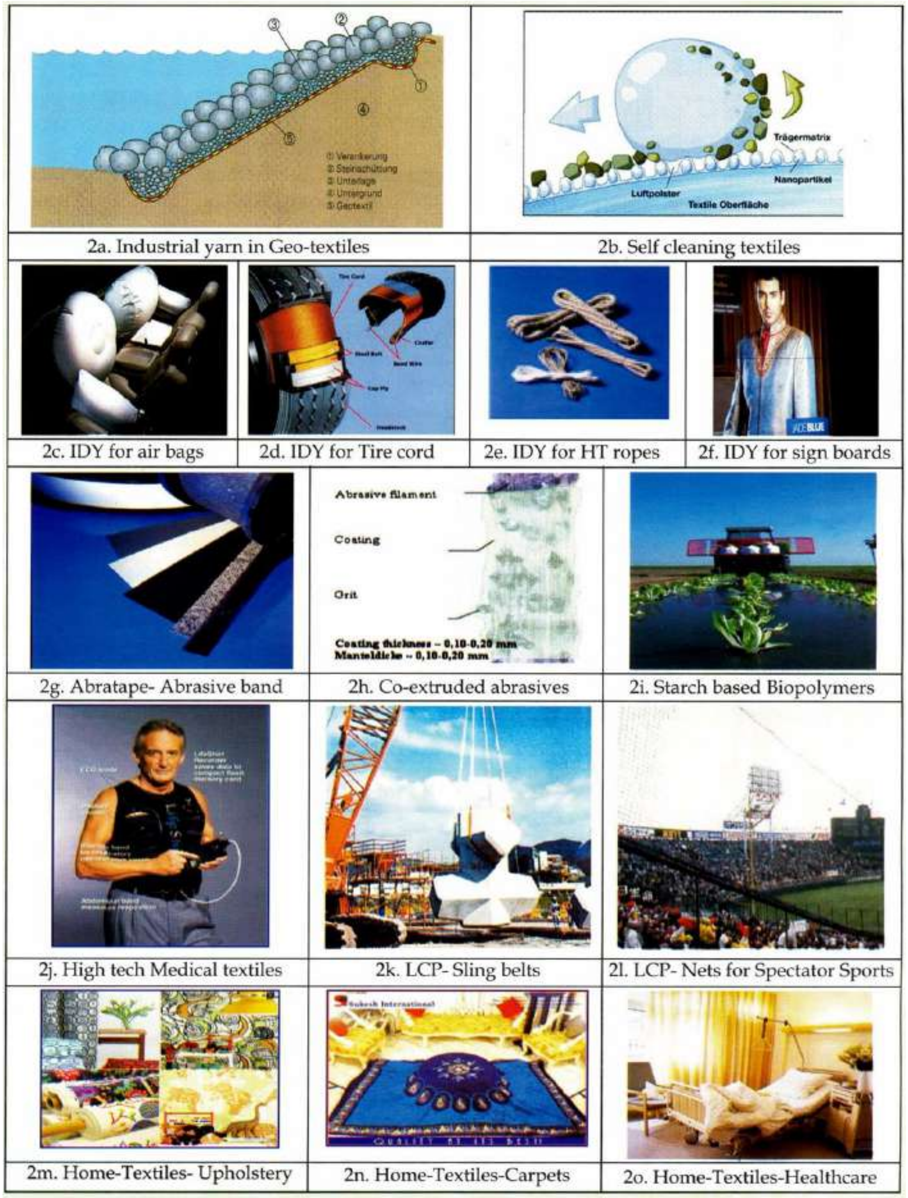


Fig. 2 : Examples of Innovations in Technical/Home Textilesa

"Nanotechnology" is the most recent technology field which finds two major application areas in textiles. One of them is the dyeing and finishing of textiles by the use of nano-particles to create specific properties such as oil and water repellency, anti-bacterial properties, self-cleaning by photo catalysis. The other is the production of nano-fibers from fibre forming polymers and the applications of these fibres in textiles & industrial fields. Nano fibres with the diameters of 100 to 200 nm have 1000 times' greater surface areas that traditional textile fibers with 100

□m. Nanotechnology, though still very early in its infancy, is already proving to be a useful tool in improving the performance of textiles which brings in added value and additional revenue. The use of nanotechnology is allowing textiles to become multifunctional & has vast potential in various applications like Biomedical Applications, Space Applications, Military and Defense Application, Electrical and Optical Applications, Agricultural Applications, Filtration Applications, Composite Applications & so on. Nano-fibers provide dramatic increases in filtration efficiency at immeasurable decreases in permeability. "Nanofiber composite" manufactured by 'Donaldson' holds

2.5 times more dust than polyester filter spunbond fabric. Fibers such as carbon, Kevlar, and glass are used in "reinforcement of composites" in the fields of engineering to get important properties such as high modulus and strength to weight ratio. Nano fibers have shown promising potential in various "Biomedical areas" like medical prostheses, smart clothes, drug delivery carriers, wound dressings, cosmetic skin masks, and tissue scaffolds. Electro-spun biodegradable polymers can be spun onto the wound skin. They form a thin web onto the skin which protects skin from microbe & helps to heal the wound quickly. Further nano fibrous mats are being explored as biomedical grafts and wound dressings. In "Military applications", protecting clothes made from Nanofibers enable long term protection, stand heavy weather conditions, endure nuclear, chemical, and biological effects and increase efficiency. Nanofibers which have high numbers of pores with small pore sizes provide high resistance to penetration of the chemicals into the fabrics. In "Space applications", Carbon based Nanofibers which are hundred times stronger than steel, are utilized in space vehicles and devices such as space shuttle. Moreover, Nanofibers can be used in sun and light platforms in the space. In "Electrical and optical applications", Nanofibers having the ability to transmit electricity are used in the production of the small electronic devices and in the fabrication of some machines. Because surface area of the electrodes are proportional to the chemical reaction speed, electrospun Nanofibers membranes are used appropriately in the production improving of high performance batteries. The other potential applications of nanofibers are wires, capacitors, transistors and diodes for "Information technology" and enzyme carriers. The introduction of micro fibers into traditional textile markets has created a wave of new garments claiming stain resistance and extremely soft hand. The introduction of nanofibers and nano coatings can take apparel innovations further. For example, man-made "Cashmere" has been developed with a softer hand than that of worsted wool, offering the feel of cashmere at a fraction of the cost. "Noise abatement" with Nanofibers webs is another growing application. Due to minute sizes of nanofibers as well as the nano sized spaces, the noise energy is converted into heat energy within very thin layer of a Nanofibers web; hence the noise is efficiently absorbed. Sound absorption panels are conveniently used in aerospace, automobiles, theaters, cinemas, concert studios and sound recording studios.

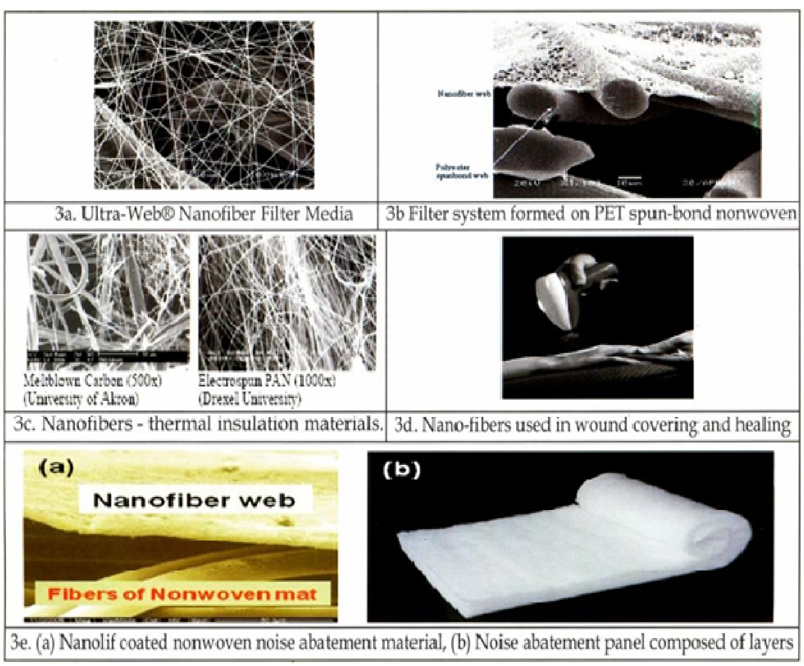


Fig.-3: Examples of Innovations in Nano-Textiles

To sum-up, 'Next Generation Textiles' in 21st Century would demand innovative approaches to think beyond customary end uses & meet the changing demands. New emerging fields like Nanotechnology, Technical textiles,

Functional textiles & Home Textiles will define the future of textiles growth in India. Growth in these sectors is very low in the Indian Textiles industry compared to the Global benchmarks & hence dedicated innovative efforts are vital for the survival of Textiles Industry in India.

Trends in Indian Textile Industry

Dr K Selvaraju

Secretary General, The South India Mills Association, Coimhatore

Introduction

The Indian textile industry has numerous inherent strengths .such as strong raw material base both in terms of natural and man-made fibres, abundant availability of skilled man-power at all levels, entrepreneur skills, strong domestic market, indigenous machinery, spares and accessories manufacturing facilities, etc. It has presence along the width and breath of the country unlike any other country in the world. During the last decade, the Indian spinning sector has become the most efficient sector in the world. Though India is number two in terms of production capacities, next only to China, on yarn export front, India continues to have a lion share of over 20 %. However, the industry is plagued with outdated technology in the weaving and processing sectors. These sectors are also highly fragmented and unorganised due to lopsided policies.

The various blue-chip schemes announced by the government during last decade like Technology Mission on Cotton, Technology Upgradation Fund Scheme and the Scheme for Integrated Textile Park has enabled the industry to strengthen its competitiveness on cotton and technology front in spinning. Today, India has become net exporter of cotton. Over Rs.2 lakh crores have been invested in the textile industry during the last decade and the industry has reached a size over USD 77 Bn including USD 27 Bn exports. However, the weaving, processing and garmenting sectors are yet to make substantial progress to achieve the global competitiveness. In the weaving sectors, not even five percent are shuttleless looms and in the processing sector not even 200 processing units are of state of the art technology. In the case of garmenting sector, India is atleast 20 % costlier due to poor scale of operation, outdated systems, lower productivity, etc., when compared to countries like Bangladesh, China and Hong Kong. Hence, the total global share of textiles and clothing is only around 4.5 %.

It is essential to announce the national fibre policy and also a comprehensive textile policy to ensure a sustained growth rate. The new TUF scheme should encourage more investments in the weaving and processing sectors during the 12th Five Year Plan to enhance value addition. The technical textile is an emerging sector. The Government has already launched a dedicated technology mission for technical textiles; but the country is yet to make a substantial progress to meet the domestic requirements and also to achieve a considerable export share. The integrated skill development scheme of ministry of textiles and National Skill Development Corporation functioning under PMO would enable the industry to bridge the skill gaps. On the whole, India has tremendous potential to enhance the textile business in the domestic market due to large population and also in the global market due to inherent advantage.

Capacity Growth Non-SSI Sector

With the opening up of the global trade in textiles and encouragement given by the Technology Upgradation Fund Scheme launched by the Government in April 1999, the number of spinning mills in the country in the Non-SSI sector has increased to 1759 as at the end of December 2011 compared to 1543 at the end of March 1999. However, the number of composite mills have come down to 194 from 281 during the same period resulting in an addition of

8.48 million spindles and 1.36lakh rotors, the number of loom in the sector decreased by 71,000 numbers registering positive growths of 24 per cent in number of installed spindles, 36 per cent in installed rotors and negative growth of 58 per cent in the installed capacity of looms. Table 1 shows the growth of the installed capacity in the Non-SSI Sector.

SSI Sector

The number of mills in the SSI has also increased to 1326 mills as at the end of December 2011 when compared to 896 at the end of March 1999. The number of installed capacity has increased to 4.90 million spindles from 1.95 million spindles and the number of rotors to 2.42 lakhs from 0.51 lakhs during the same period registering growths of 151 per cent and 375 per cent respective during the period.

Table 1 : Installed Capacity - Non-SSI Sector

Year Ending March	No. of Mills Spg	Comp	Total	Installed Capacity Spdls (Mn.)	Rotors 000	Looms 000
1999	1543	281	1824	34.72	383	123
2000	1565	285	1850	35.10	392	123
2001	1565	281	1846	35.53	394	123
2002	1579	281	1860	35.75	409	123
2003	1599	276	1875	36.1	379	119
2004	1564	223	1787	34.02	383	88
2005	1566	223	1789	34.24	385	86
2006	1570	210	1780	34.14	395	73
2007	1608	200	1808	35.61	448	69
2008	1597	176	1773	35.01	461	56
2009	1653	177	1830	37.03	485	57
2010	1673	180	1853	37.68	494	57
2011	1757	183	1940	42.69	518	52
Dec 2011	1759	194	1953	43.20	519	52

Exclusive Weaving

The number of units in the exclusive weaving segment has come down to 171 at the end of December 2011 when compared to 199 units in at the end of March 1999 and the number of installed looms have come down to 14 thousand from the level of 1.23 lakhs during the same period showing a negative growth of 89 per cent.

Powerlooms

The number of power looms in the country as at the end of Iuly 2011 stood at 2.30 millions when compared to 1.60 millions at the end of March 1999 registering a growth of 44 per cent. However, the average number of looms per units has come down to 4.42 loom / unit from 4.46 looms / unit during the period showing that in spite of growth in the number of power loom, there was negative growth in terms of average number of looms / unit.

Handlooms

The handloom sector is highly labour intensive and predominantly located in the rural India. As the powerloom sector started producing all the plain fabrics produced out handlooms, the handloom sector production started declining due to high cost of production. The handloom sector still has very primitive technology for warp and weft preparation. The handloom reservation act, various subsidies, tax exemption, hank yarn obligation, etc., could not sustain the production capacity. Fig. 1 and Fig. 2 show the deteriorating position of number of handloom house holds and the number handlooms in the country. The number of handloom household stood at 22.68 lakhs as per the Third National Handloom Census 2009- 10 conducted by the National Council of Applied Economic Research when compared to 25.2 lakhs and 30.6 lakhs reported in the Second Census conducted in 1995-96 and First Census in 1987-88 respectively.

The number of handlooms stood at 23.77 lakhs as per the Third Census when compared to 32.96 lakhs and 38.90 lakhs reported in the Second and First Census. Apart from the reduction in the number of handloom over census periods, it has brought to light that the percentage of number of working loom to total looms has also come down. From the level of 92.8 per cent (36.10 lakhs) during the First Census, it has come down to 90.9 per cent (29.96 lakhs) during the Second Census and now it works out to 90.3 (21.74 lakhs)per cent in the recent census.

The Third Census reported that 45.9 per cent of households produced less than one metre per weaver per day; 32.3 per cent of households between one to two metres; 10.6 per cent of households between two to three metres; 4.7 per cent of households between three to four metres and 6.5 per cent of households more than four metres.

Fig.1 Handloom households

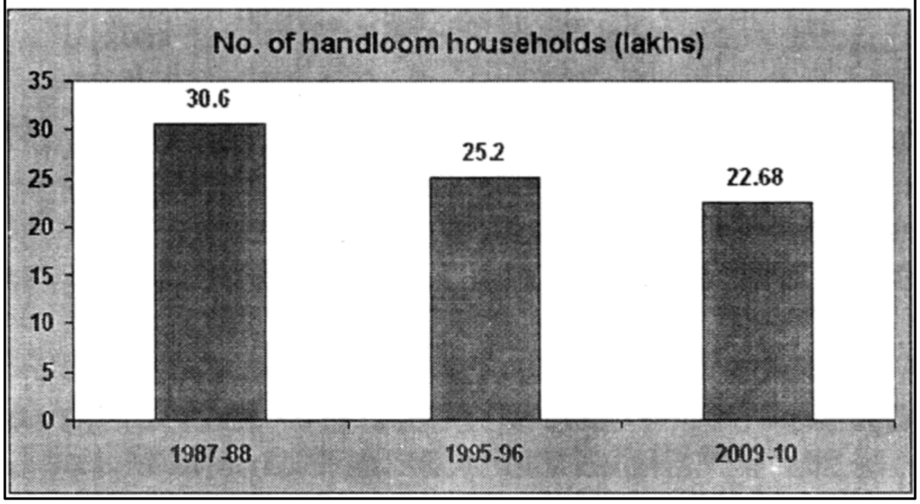


Fig.2 Handloom population

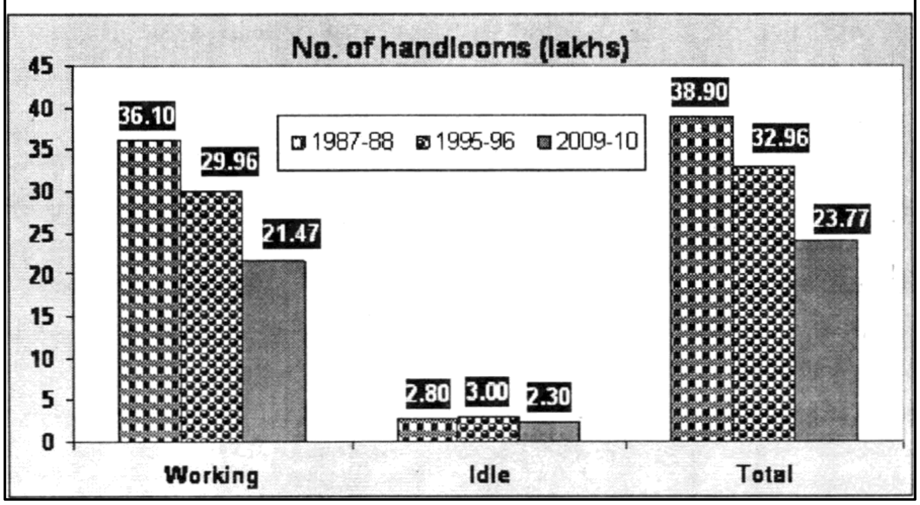


Table 2 shows the comparison of vital information between 2010 and 1995 census. Technology Upgradation Fund Scheme

The Technology Upgradation Fund Scheme launched in Apri11999 was well utilized by the spinning segment of the industry. Till the end of June 2010, an amount of Rs 85,091 crores have been sanctioned for 28302 projects having a total project cost of Rs 2,07,747 crores. On which, loans amounting to Rs 74,627 crores have been disbursed.

The industry has attracted over Rs.2 lakh crores of investment under Technology Upgradation Fund Scheme (TUFS) during the last decade. Fig.3 portrays the progress of TUFS. The scheme did not attract investment till 2003. The various proactive policies announced by the government during later years, made the investments double year after year. However, weaving and processing, the weakest links in the entire textile value chain did not attract the envisaged investments while spinning surpassed the target.

Fig.3 Progress of Technology Upgradation Fund Scheme

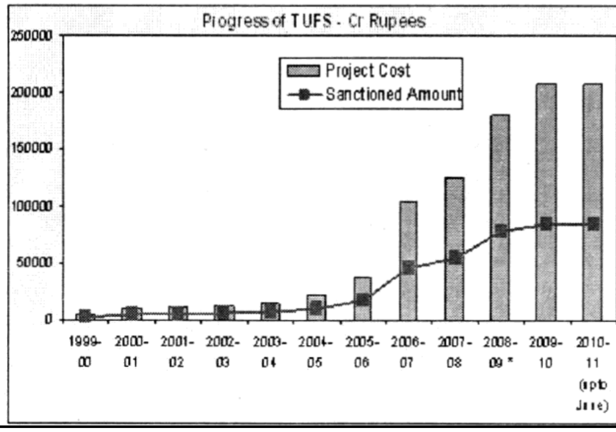


Table 2 : Handloom census data

Indicator	II Census (1995)	III Census (2010)
Handloom weaver households (lakhs)	25.25	22.68
No. of looms (lakhs)	32.96	23.77
Handloom weavers (lakhs)	34.71	29.09
Total mandays worked by weaver household during census year (lakhs)	4,977	5,313
Man-days worked per weaver household during census year	197	234
Share of full-time weavers to total weavers	44 %	64 %
Share of households reporting less than a metre production (weaving) per day	68 %	46 %
Share of weaver household reporting more than 60 % income from handlooms and related activities	31 %	35 %

Fig.4 Segmentwise disbursement of TUF loans

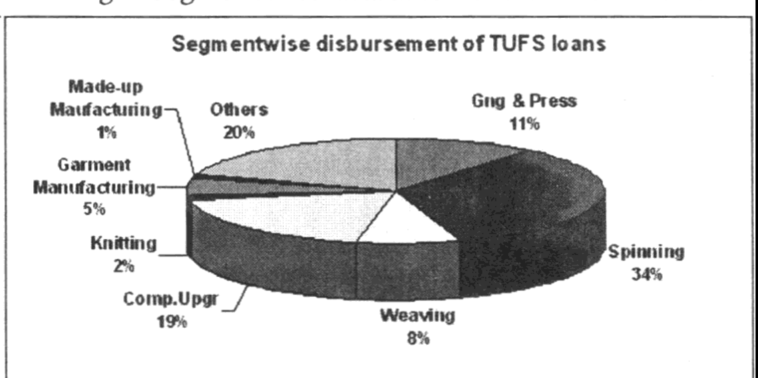


Fig.5 Statewise TUF loan disbursement

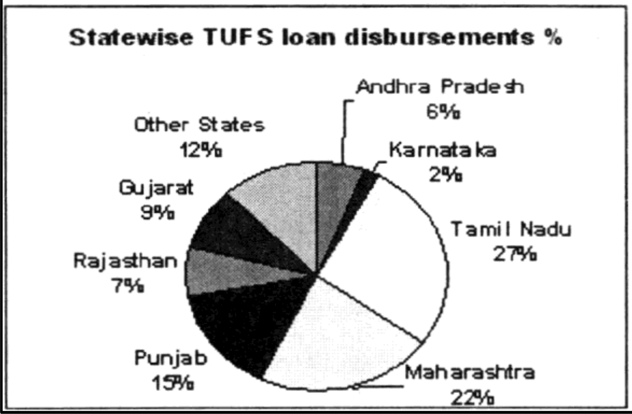
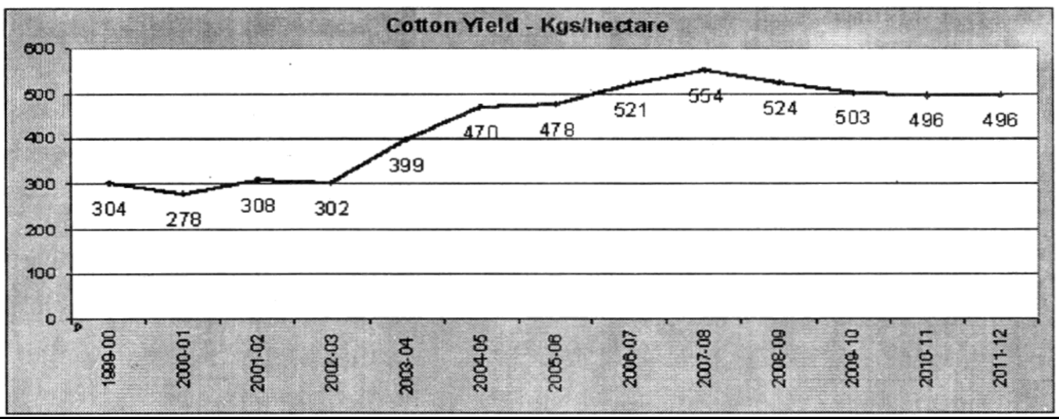


Fig.6 Cotton productivity



Tamil Nadu topped the list with 27 per cent of the disbursements followed by Maharashtra with 22 per cent and Punjab with 15 per cent. The TUF Scheme would continue during the 12th Five Year Plan period with more benefits for the weaving, processing and technical textile segments.

Raw Material

The Indian textile industry is predominantly cotton based. Around 74% of the spinning capacity is utilized to produce cotton yarn. The ratio of natural fibre to synthetic fibre consumption is 60:40 in India as against the reverse at global level.

The high cost of fibre, high import duty on synthetic fibre, etc., restrict the growth of the synthetic fibre consumption which makes the clothing cost dearer to the people below the poverty line. Though the government came out with a national fibre policy addressing the various anomalies relating the various raw material issue almost two years back, it is yet to be announced. It is very essential to make the domestic industry to get the raw material at a globally competitive rate to sustain the growth rate. High cost of working capital, high transportation cost, high import duty, speculative pricing behavior, etc., some of the critical issues to be addressed on raw material front.

Production of synthetic fibres and cellulosic fibres has increased to 1285 million kgs in 2010-11fromthe level of 782 million kgs in 1998-99 registering an increase of about 64 per cent and man-made filaments also increased to 150 million kgs from 850 million kgs registering an increase of about 82 per cent during the same period. The technology mission on cotton and introduction of Bt cotton have made the country net exporter of cotton during the last six years. The country has also made substantial progress in producing quality cotton. From March 2002, country's cotton production started increasing and the country has emerged as the second largest producer of cotton in 2006-07 over taking the US. With huge potential to enhance the yield from 500 kg per hectare to 800 kg per hectare in a decade will overtake China.

The domestic industry could attain a sustained growth rate during 2003-07 taking advantage of the stabilized cotton price and adequate availability cotton. It could not compete with the multinational cotton traders flooded with cheap funds on removal of cotton textiles from February 2008. The various trader friendly policies made the traders to speculate the prices. The industry suffered very seriously during the year 2011 due to high volatility in cotton and yarn prices which are caused due the lopsided export policies adopted by the government on cotton and cotton yarn export front. (Table 3).

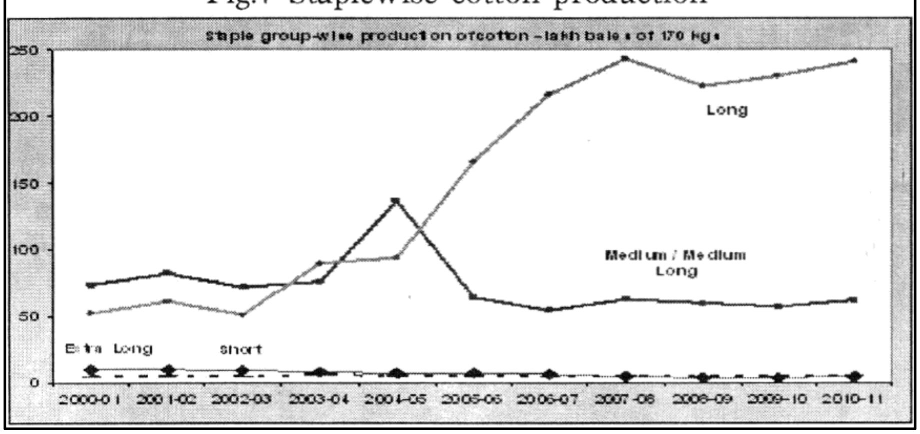
The cotton yield which reached a high of 554 kgs/hectare in 2007-08, registered negative growth and works out to 496 kgs/hectare for 2010-11 and expected to be at the same level in 2011-12.

Fig.7 shows staple group wise production of cotton. It may be observed that in the last decade only the production of long staple has registered positive growth while the production of other groups (short, medium/medium long and extra long) does not register positive growths.

Table 3 CAB estimates of cotton crop - lakh bales of 170 kgs each

As on	Opening	Supply			Demand			Closing
	Stock	Production	Imports	Total	Consumption	Exports	Total	Stock
1999-00	36.50	156.00	22.01	214.51	173.36	0.65	174.01	40.50
2000-01	40.50	140.00	22.00	202.50	172.90	0.60	173.50	29.00
2001-02	29.00	158.00	25.26	212.26	171.76	0.50	172.26	40.00
2002-03	40.00	136.00	17.67	193.67	168.83	0.84	169.67	24.00
2003-04	24.00	177.00	7.21	208.21	173.96	13.25	187.21	21.00
2004-05	21.00	243.00	12.17	276.17	195.03	9.14	204.17	72.00
2005-06	72.00	241.00	5.00	318.00	219.00	47.00	266.00	52.00
2006-07	52.00	280.00	5.53	337.53	232.03	58.00	290.03	47.50
2007-08	47.50	307.00	6.38	360.88	236.88	88.50	325.38	35.50
2008-09	35.50	290.00	10.00	335.50	229.00	35.00	264.00	71.50
2009-10 ®	71.50	305.00	6.00	382.50	262.00	80.00	342.00	40.50
2010-11 ®	40.50	339.00	5.00	384.50	267.40	68.80	336.20	48.30
2011-12 ®	48.30	345.00	6.00	399.30	260.00	84.00	344.00	55.30

Fig.7 Staplewise cotton production



The government and research institutes are taking aggressive steps to address this issue and also to increase the productivity.

Power

India has been facing power shortage for a quite number of years due to the sudden increase in the per capita energy consumption, free electricity scheme, exponential industry growth, etc. The Southern States are the worst affected as these States failed to integrate the southern grid corridor with national grid. Further, most of the states have not segregated the industrial feeder. Hence, the industrial units are not in a position to take advantage of the open access and private power purchase system. Due to political reasons, the governments continue to load the cross subsidy on the industrial consumers making them uncompetitive. The power position is very alarming in Tamil Nadu. Even at the end of 12th Plan period, Tamil would continue to face power shortage. As the State governments are not fully refunding the cross subsidy amount, most of the electricity boards in the country are into severe financial crunch and have huge accumulated losses. Currently, Tamil Nadu is facing over 45 % power shortage while AP has imposed two weekly power holidays for the HT industry.

The highly capital and power intensive spinning sector has to operate their machinery at 90 per cent of utilization to achieve breakeven. In Tamil Nadu, the textile industry is the largest consumer of electricity accounting 26 per cent of the energy consumption and 45 of the revenue. As per Electricity Act 2003, the TNERC should follow "Cost to Sell" policy while fixing the energy tariff. The study conducted by SIMA reveal that cost of power supply to the spinning mills for the TANGEDCO is less than Rs.3.25 per unit as the spinning sector consume energy at a constant load, round the clock and seven days a week. Whereas the current net grid tariff rate is around Rs.5 per unit. Now the government has proposed a further increase of Rs.1.1 per unit including peak hour surcharges (it has been proposed to increase the evening peak period by 2 hours) in Tamil Nadu and Rs.1.50 per unit in AP. The spinning mills normally consume over 900 units per MW per hour as against 400 to 600 units by the other industrial sectors. Hence, separate tariff has to be fixed for the textile industry to remain globally competitive. Tamil Nadu has to strengthen the grid capacity and power sub stations and also segregate the industrial feeder on a war footing to sustain the survival of the industries in the State. The wind power should be fully evacuated (currently over 25 % power is wasted) to make the wind power projects viable and also to tide over the power crisis.

Human Resource

The textile industry is facing shortage of man power. The wage rates have doubled in the last two years. The attractive wages offered by the construction and other engineering sectors coupled with MGNREGA schemes are posing severe challenges to retain or attract the work force for textile jobs. The system of retirement concept is no more valid in the textile industry. The average tenure of service of a textile employee is less than ten years. The absenteeism is very high. In addition, the skill gap is also widening. The Government of India has established National Skill Development Corporation and the textile industry is one of the stake holders of the scheme. In addition, the Ministry of Textiles has also announced the Integrated Skill Development Scheme for skill development in the textile industry. The industry should use these schemes effectively to overcome the challenges relating to human resource.

Finance

The Indian textile industry which operates on a wafer thin margin (3 to 6 per cent on sales turnover) is unable to manage the high cost of funding. Frequent hike in bank rates (RBI hiked the bank rate 13th time in October 2011 since March 2010 for containing the inflationary pressures on the economy) affects the textile industry very seriously. The interest rate has almost doubled during the Eleventh Five Year Plan Period (from 7.5% to 14%). The predominantly cotton based textile industry needs huge working capital to procure cotton during the season (within three to four months) for the entire year. Since the interest rate is over 14%, margin money requirement is 25% and also due to the limited availability of credit limit, the cotton spinning sector is not in a position to compete with the multinational cotton traders who are 'flooded with funds at less than 2 % interest rate. A special working capital package consisting of loan at 7% interest rate, 15% margin money and nine months credit, etc., are essential to sustain the competitive edge of the Indian cotton textile industry.

The Future Raw Material

Cotton yarn production has been projected to be at 433 lakh bales by the end of 12th Five Year Plan from 345 lakh bales at the terminal year of 11th Five Year Plan. Similarly, production of manmade fibre has been estimated to go to 2197 million kgs from the present plan level of 1525 million kgs and filament yarn production level to 3643 million kgs from the present level of 2194 million kgs. Table 4 and Table 5 show projections on cotton and manmade fibre & filaments during the 12th Five Year Plan.

Table 4 : Cotton Balance Sheet - Lakh Bales

Year	Opening Stock	Supply Production	Demand Imports	Total	Consumption*	Exports	Total
2012-13	79	355	5	439	315	64	379
2013-14	60	373	5	438	332	42	374
2014-15	64	392	5	461	350	43	393
2015-16	68	412	5	485	370	43	413
2016-17	72	433	5	510	391	43	434

Table 5 : Manmade Fibre / Filament Yarn Production - Mn Kg

Fibre/ Filament Yarn	XI Plan Projection	XI Plan Actual	XII Plan Projection
Ployester Staple	1214	1100	1600
Viscose Staple	294	330	460
Acrylic Staple	211	92	133
Polyprpylene Staple	3	3	4
Nylon Staple	-	-	-
Polyester FY	1973	2100	3500
Viscose FY	59	45	70
Nylon FY	48	30.35	48
Polyproylene FY	19	19	25

Yarn and Fabrics Production

Yarn production has been projected to reach the level of 5,340 million kgs by the end of 12th Five Year Plan consisting of Cotton yarn production at 4,994 million kgs and blended yarn to 311 million kgs and fabrics production to reach the level of 101 billion square metres. Table 6 shows projections of yarn production and fabrics during the next plan period.

Investments

An amount of Rs 1,44,592 crores has been estimated as investment requirement during the 12th Five Year Plan to achieve the above production levels. Huge investment has to be made in the processing segment. Table 7 shows sector wise projection of investment and workers requirement during the 12th Five Year Plan.

Textile size

The size of textiles and clothing industry has been projected to increase to USD 122 billion at the end of the 12th Five Year Plan from USD 57 billion at the end of the 11th Five Year Plan period. Domestic consumption is projected to go up by 122%; garment exports by 107% and made-up exports by 60%. Table 8 shows the projected consumption pattern during 2011-12 to 2016-17.

Table 6 : Cotton & Blended Yarn Production

Item	2012-13	2013-14	2014-15	2015-16	2016-17
Cotton yarn - Mn Kg	3801	4065	4351	4660	4994
Blended Yarn - Mn Kg	221	241	262	285	311
Total - Mn Kg	4022	4306	4613	4945	5304
Fabrics (bn sq mtrs)	74	80	86	93	101

Table 7 : Investments - Projections for 2012-17

Sector	Investment - Cr Rs	Workers
Spinning	41,750	233800
Weaving	23939	
Knitting	2503	1376394
Processing	64400	
Garmenting	12000	1320000
Total	144592	2930194

Table 8 : Clothing, Apparel & Made ups - US$ Bn.

Item	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Domestic Consumption	40	46	53	62	74	89
Garment Exports	12	14	16	19	22	25
Made up Exports	5	5	6	6	7	8
Total	57	65	75	87	103	122

Conclusion

Though the industry has been passing through one of the very challenging periods in the history and looking out for fiscal measures like restructuring of loans, moratorium on payment of loans and interest, logistics cost, etc., with the global population projected to increase at the rate of 80 million each year and likely to reach 8 billion in 2015 and 9 billion in 2050, the demand for textile items likely to register positive growths year after year. Indian Textile Industry is taking various initiatives like technical textiles (innovation of application based products apart from regular textiles and clothing) with the support of Technology Mission on Technical Textiles, reduction of trade barriers in the global trade (leaving market forces to determine the price), increased efforts in R&D, conducive policies of the government, etc., would make the Indian Textile Industry a leading player in the global textile trade.

Statistical Applications for Textile Industry

Dr A Peer Mohammed

Department of Textile Technology, Anna University Chennai

Objective

Understanding the basic concepts which enables one

- To take decision in the textile industry by limiting the error to the permissible level
- To identify the most influential parameters in a process
- To arrive at the optimum levels of these parameters
- To achieve the best quality with the least cost by controlling the process

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Phenomenon

- **Deterministic phenomenon**

  Repeated measurements under identical conditions give the same value.

  Example: atomic mass of an element

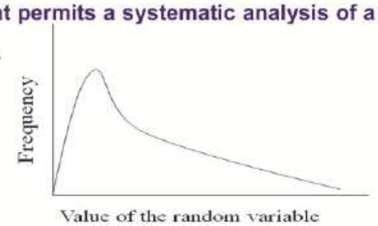
- **Probabilistic phenomenon**

  Repeated measurements under identical conditions will not give the same value.

  Example: count of the yarn, strength of the yarn

Random Variable

- **The parameter associated with 'probabilistic phenomenon' is called 'random variable'.**
- **Its value cannot be predicted in advance**
- **It exhibits a recognizable pattern that is stable for large number observations. This pattern is the 'statistical regularity' that permits a systematic analysis of a random phenomenon.**



Deterministic vs Probabilistic variables

- **Deterministic variable – explained by assigning a single value**
- **Probabilistic variable – cannot be defined by a single value; requires a distribution**

Statistical Models

- **Poison model**

$$P(X = x) = \frac{e^{-\lambda}.\ \lambda^{x}}{x!}$$

- **Normal model**

$$f(x) = \frac{1}{\sqrt{2\pi}\,\sigma}\, e^{-\frac{1}{2}\left[\frac{x-\mu}{\sigma}\right]^2}$$

Central Aim

- The central aim of the statistical analysis is to construct a statistical model for a phenomenon on the basis of the available incomplete information.

- The general purpose of the constructing such a model is to draw objective conclusions about the behaviour of the random variable of an underlying phenomenon.

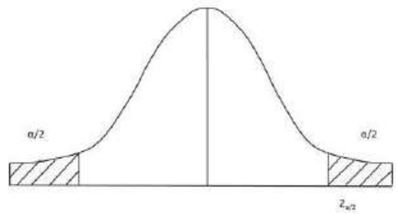
Population Parameters

- Each distribution will have its own parameters like μ, σ
- The main task of experimenter is estimating the value for the parameters from incomplete data

Sample Size

- Estimation of Population Parameters:

$$n = \left(Z_{\alpha/2} \times CV(\%)\right)^2 \div \left(\mathrm{E}(\%)\right)^2$$



Implications of Estimation

- **The sample mean calculated is a 'random variable' and need not be equal to the population mean.**
- **There is an error involved in the estimation and the maximum error committed is E%.**
- **Further the maximum error will be limited to E% on (100- α%) occasions out of 100 occasions.**
- **On the remaining α% occasions, the error committed will be more than E%.**
- **One will not know on which occasion the error is more than E% or less than E%.**

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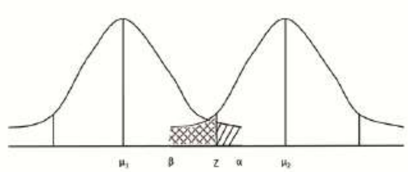
Acceptance of Lot

$$n = \left[\sigma^2 \times \left(Z_\alpha - Z_\beta\right)^2\right] \div (\mu_2 - \mu_1)^2$$

$$n = [(\sigma \times Z_\alpha) \div (c - \mu_1)]^2$$



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Errors

- α is the probability of rejecting a good product
- β is the probability of accepting a wrong product

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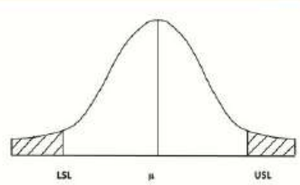
Acceptance Quality Level

$$Z_\alpha = \{(c - \mu_1)\sqrt{n} \div \sigma\}$$
$$Z_\beta = \{(c - \mu_2)\sqrt{n} \div \sigma\}$$
$$C = [Z_\alpha \times \mu_2 - Z_\beta \times \mu_1] \div (Z_\alpha - Z_\beta)$$

C – Acceptance Quality level

Process Capability Ratio



$$C_P = \frac{USL - LSL}{6\sigma}$$

USL – Upper specification limits
LSL – Lower specification limits

$$C_{PU} = \frac{USL - \mu}{3\sigma}$$

$$C_{PL} = \frac{\mu - LSL}{3\sigma}$$

C_{PK} = 2 means 3.4 defects per million

$$C_{PK} = Min\,(C_{PU}, C_{PL})$$

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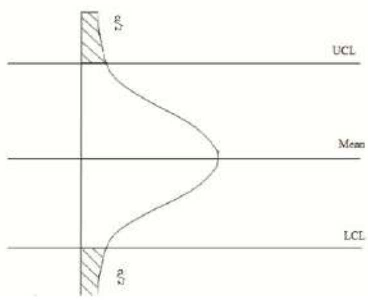
While controlling a process

$$n = \left[\sigma^2 \times \left(Z_{\alpha/2} - Z_{\beta}\right)^2\right] \div (\mu_2 - \mu_1)^2$$

α is the probability of getting 'wrong indication' that the process has gone out of control when it is actually in control.

β is the probability of failure to notice the 'shift' in the process mean.

Process Control



Selection of 'α' value

The average number of tests carried out before a wrong signal is inferred is known as ARL_i

$$ARL_i = 1 \div \alpha$$

Selection of 'β' value

- If an observer wants to notice the shift of the population mean from μ_1 to μ_2 when the process goes out of control within a particular number of observations itself on an average (called average run length ARL_o), the relationship is

$$ARL_0 = 1 \div (1 - \beta)$$

Selection of α value and β value

- Cost of investigation and correction of the process in response to out of control signals and this cost influences the selection of α value
- Cost associated with the nonconformity product when it is failed to notice the shift in the process and this cost influences the selection of β value.

Sensitizing Rules

- One point plots outside the three-sigma control limits;
- Two out of three consecutive points plot beyond the two-sigma warning limits;
- Four out of five consecutive points plot at a distance of one-sigma or beyond from the centre line;

or

- Eight consecutive points plot on one side of the centre line.

Process Optimization

- Identifying the most influential variables (x's) on the response (y) under consideration
- Selecting the suitable level for each of the influential variables, which give the most desirable value for y.

Regression Equations

$$y = \beta_0 + \sum \beta_i x_i + \sum \beta_{ii} x_i^2 + \sum\sum \beta_{ij} x_i x_j$$

β_0 - Constant

β - regression coefficients

β_i - linear regression coefficients

β_{ii} - quadratic regression coefficients

β_{ij} - interactive regression coefficients

Experimental Design

- **Replication**

  Helps to estimate the variance of the random error.
- **Randomization**

  Helps to avoid the bias caused by noise factors.
- **Blocking**

  Helps in eliminating the variability caused by the nuisance factors.

Experimental Design

- **Number of experiments**

  The minimum number of experiments = number of coefficients to be estimated

- **Levels of experiments**

  A minimum of two levels is necessary

- **Combinations of experiments**

  Full factorial combinations for all the variables at least at two levels is preferred

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Box and Hunter Model

Sl.No.	X_1	X_2	X_3
1	-1	-1	-1
2	+1	-1	-1
3	-1	+1	-1
4	+1	+1	-1
5	-1	-1	+1
6	+1	-1	+1
7	-1	+1	+1
8	+1	+1	+1
9	-α	0	0
10	+α	0	0
11	0	-α	0
12	0	+α	0
13	0	0	-α
14	0	0	+α
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0

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Formation of Regression Equation

- After designing and conducting the experiments, the measurements on response are made.
- Using the method of least squares, the estimate b's of the regression coefficients β's are estimated.
- After substituting the estimates the equation now becomes

$$y = b_0 + \sum b_i x_i + \sum b_{ii} x_i^2 + \sum \sum b_{ij} x_i x_j$$

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Statistical Analysis

- Coefficients of the regression equation- Tested by Student t-test
- Insignificant estimated coefficients are dropped from the regression equation
- The remaining estimated coefficients are recalculated
- The final regression equation is tested for its adequacy (goodness of fit) by applying F test.

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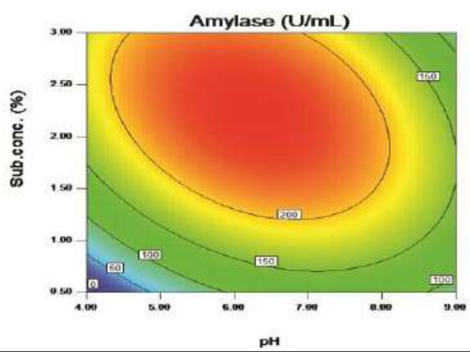
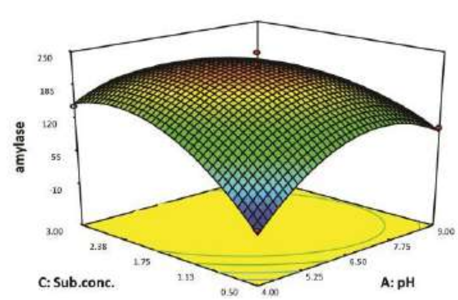
Contour Plot



3 D Graph



Optimization

If one wishes to find the levels of x's that optimize the response, this point will be a set of x's obtained by equating the partial derivatives of the regression equation to zero.

Concluding Remarks

From the explanations given so far, one could have understood the basic concepts which will enable him

- To take decision in the textile industry by limiting the error to the permissible level
- To identify the most influential parameters in a process
- To arrive at the optimum levels of these parameters
- To achieve the best quality with the least cost by controlling the process

Bhaduri as Leader Manager

Shri Ashok Garde

Former Director, ATIRA, Ahmedabad

It was a pleasant surprise for me when Shri P B Jhala, my ex-colleague at ATIRA, invited me to give this year's S.

N. Bhaduri Memorial Lecture. I was delighted to avail this opportunity to express my heartfelt regards for my ex-boss who was an exceptionally good leader manager. My sincere thanks to the Textile Engineering Division Board of the Institution of Engineers (India) for asking me to deliver this 6th lecture in their biennial series, and the first at Ahmedabad, which was SN Bhaduri's karma-bhoomi.

Three alternatives themes for this talk could be: the textile scenario today, Bhaduri's great contribution to furthering the quality and productivity in composite textile mills, and the way Bhaduri nurtured many a textile graduates to become good scientists and consultants. I was fortunate to have him as a boss right from the beginning of my career at ATIRA and so I am in a unique position to describe his role as a leader manager.

Leadership Style

Bhaduri did not give advice on 'how to' for any task: he exemplified how to perform through his own performance. He was a motivator, a coach, a listener and a good consultant,

As Motivator, he empowered through trust and delegation of giving increasingly tougher tasks. Example: In 4th year, he gave me, a mere graduate, an assignment to evaluate a Doctoral thesis that he had received as external examiner. And then added a few more points to what I had found!

As Coach, he guided gently to improve performance, never blamed for any mistake or failure. Example: I spoke for 58 minutes in my first internal seminar and bored every listener without realising it! "Garde, just because you have worked for one full year, you do not have to describe it all. Any topic can be covered in 20 minutes or less."

As Listener, he was always responsive to new ideas from any one. A junior officer drew his notice to a 2-page leaflet from a Research Association in UK, and suggested that ATIRA may bring out such leaflets useful to mills. He accepted the idea, pushed it through: different divisions together made over 100 Technical Leaflets in the next 20 years!

As Consultant, he could interact appropriately at the levels of technical supervisors, departmental heads and managing directors with equal ease: unassuming, friendly, specific and assertive. When it became necessary to depute me to do work in a mill at Kanpur, I was only 4 years old in ATIRA. He briefed me on 'how to' manage interactions, especially with the General Manager of the mill. This and also input by the Director, Dr. TS Subramanian made the visit successful in raising the image of ATIRA.

Just one example has been quoted under each heading above my own experience can easily cite 5-6 more examples for each. AND similar were the experiences of over 15 officers groomed by SN Bhaduri to become good scientists and consultants in spinning and weaving during his 22 years-long first stint in ATIRA.

Personality Traits

In the context of work, he exhibited humility, assertiveness, punctuality and sportsmanship.

He was free from any hierarchical superiority, was assertive without getting angry, and would pull up an officer for not being punctual. When he found an officer not coming up to expectations, he asked his next in line Shri TA Subramanian to do the job. When once I was late by 5-6 minutes, his remark was; "Garde, you have wasted my 6 full minutes. Let this not happen again when I call you by giving a specific time."

He was the president of Staff Club for several years, played volley ball with staff, took part in plays etc. These hierarchy free community activities in the ATIRA colony of around 100 quarters was a great help in free, up and down communication and team building at work.

He was jovial, had a good sense of humor. All these traits made him popular among the staff. When he decided to go to Iran for job, we all gave him a hearty farewell. Over 50 from staff took him in a procession from his quarter to the auditorium where the function was to be held. Shri TA Subramanian gave a farewell speech in Hindi for the non-officer staff. This outburst of his popularity moved him “If only I knew I was so well liked, I might not have thought of going for this highly paid job in Iran”.

In Conclusion

When he returned from Iran after 3 years, in 1975, ATIRA requested him to re-join as a Consultant to meet the heavy demand for techno-economic viability reports for textile mills. He gladly accepted and did a great job. I, several years his junior, happened to be the head of the Mechanical Processing Division which he had established. His self-esteem was so high, and humility so well entrenched that he did not mind taking assignments via me; and he never once interfered with the working of the division.

ATIRA lost an excellent leader, a pioneer in establishing statistical quality control and experimentation in mills, in his sudden unexpected demise in1977 at the prime of his life, at 51 years. In 1979, ATIRA instituted Bhaduri memorial Lectures but this activity stopped after 6 lectures when ATIRA itself went into a very turbulent period. We from ATIRA are therefore very thankful to the Institute of Engineers (India) for these Bahduri memorial lectures.

Personally, I owe Satyendra Nath Bhaduri a lot for my career growth in ATIRA. With this contribution to the series, I feel I have partly paid my tribute to my ‘boss who never did any bossing at all’.

About Textile Engineering Division Board

The Institution of Engineers (India) has established Textile Engineering Division in the year 1978. This Division consists of quite a large number of corporate members from Government, Public, Private sectors, Academia and R&D Organizations. Various types of technical activities organized by the Textile Engineering Division include All India Seminars, All India Workshops, Lectures, Panel Discussions etc., which are held at various State/Local Centres of the Institution. Apart from these, National Convention of Textile Engineers, an Apex activity of this Division is also organized each year on a particular theme approved by the Council of the Institution. In the National Convention, several technical sessions are arranged on the basis of different sub-themes along with the Memorial Lectures in the memory of '**S N Bhaduri**', the eminent Textile Engineer in India and '**Dr B K Chakrabarti**', the eminent Textile Scientist in the country, which are delivered alternatively by the experts in this field.

In order to promote the research and developmental work taking place in the field of textile engineering, the Institution also publishes Textile Engineering Division Journal twice in a year, where mainly the researches and its findings are focused. Due to multi-level activities related to this engineering discipline, this division covers different sub-areas such as:-

- Advancements in Knitting Technology
- Advancement of Spinning and Weaving Technology
- Application of Biotechnology for Textiles
- Coating & Laminating for functional finish (Defence application)
- Entrepreneurship and Management in Textile (Start ups in Textile)
- Fibre Reinforced Textiles (FRT)
- Industrial Applications of natural fibres like Jute, Coir etc.
- Innovation & Advancements in Garment Technology
- Innovative Techniques in Dyeing, Printing & Finishing
- Nano-textiles and its application
- Natural Dyeing and Finishing
- Production techniques for Non-woven Fabrics
- Ropes for Faster and Safer Offshore Pipe-laying
- Silk Technology
- Smart Fabrics and Smart Textiles
- Technical Textiles
- Textiles for Thermal Insulation
- Wool and its' impact on Dyes and Dying

In order to promote the research and developmental work in the field of Textile Engineering, the Institution also publishes '**Journal of The Institution of Engineers (India): Series E**' in collaboration with Springer, which is an internationally peer reviewed and Scopus Indexed journal & UGC-CARE listed. The journal is published twice in a year and serves the national and international engineering community through dissemination of scientific knowledge on practical engineering and design methodologies pertaining to chemical and textile engineering.

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