



Management

FOOTWEAR SECTOR IN INDIA: A ROLE OF ADVANCED TECHNOLOGIES

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Abstract

Footwear sector is a very significant segment of Leather and Non Leather products in India. The size of Indian Domestic Footwear Industry is estimated to be worth 1919 million pairs where leather and non-leather Footwear per capita consumption is estimated to be approx. 1.61 pairs.

The major component of footwear sector is a design, product development, clicking, closing, component, lasting & finishing. Advanced technologies in the area of shoe design systems, automation, cost savings and productivity improvements as well as enabling new developments in footwear sector in India.

Although today footwear is produced using many similar methods to those employed all those years ago, obvious technological innovations in machinery, raw materials, production and testing techniques have changed what was to all intents and purposes a cottage industry into a multi-billion dollar sector. At the same time, recent years have seen a distinct shift in factory location away from the traditional industrial heartlands of Europe and North America to the new lands of opportunity, primarily in Asia.

The purpose of this paper is to review the areas where advanced technologies can significantly affect the way of footwear sector is practiced. Strategies for implementation of the necessary changes in practice are also discussed.

Keywords: Advance Technology; Productivity Improvement; Opportunity; Quality Control.

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1. Introduction

The design and production of comfortable, long-lasting and well-made footwear have been the goal of shoemakers around the world for thousands of years. As with so many other industries

that have played a vital role in civilization, little changed in the way shoes and boots were made until the coming of the industrial revolution towards the end of the 19th century.

Although today footwear is produced using many similar methods to those employed all those years ago, obvious technological innovations in machinery, raw materials, production and testing techniques have changed what was to all intents and purposes a cottage industry into a multi-billion dollar sector. At the same time, recent years have seen a distinct shift in factory location away from the traditional industrial heartlands of Europe and North America to the new lands of opportunity, primarily in Asia.

Over the past 90 years, there have been major changes in shoemaking, some small and others significantly affecting the industry. The most development of the areas lasts, alternatives to leather, machinery, footwear testing and the location of manufacturing plants.

1.1. Footwear Making Process

- **Designing:** Designing of the shoe is most primary and important process of footwear manufacturing. It starts with sketching that showcase the creativity of the designer. The sketch is further converted into three dimensional shoes, considering all dimensions of the foot. The designers also specify the materials required for making the shoes.
- **Clicking or Cutting:** Clicking is the modern name of cutting. In this department, materials are cut in various designs. Materials mainly leather is cut manually or by machine. Material saving, quality & productivity are the most concerns of the department. The operation needs high level of skill as the expensive materials including leathers are cut here. Leathers may also have various defects on the surface which needs to be adjusted in the shoe components. 70% of the cost of the shoe are due the the cost of these cut materials.
- **Closing:** Here the cut component pieces are assembled and stitched together, as per the samples, so as to produce the three dimensional completed upper. Wide percentage of manpower is required in the process of upper making.
- **Lasting:** In this process, upper is further shaped in the form of shoe. There are various construction process in lasting to make the shoe like stuckon, stobel, string lasting etc.
- **Finishing:** Finishing is the process to enhance the apperance of the shoe. Special waxes, creams, crayons, solvents etc. are used.
- **Packing:** The shoe lift is inserted in the shoes to maintain the shape of the finished shoes. After this operation, the finished shoes are kept in the boxes.

2. Literature Review

According to Padmini Swaminath (1996) in her paper "Development Experiences: Gender Prospective on Industrial Growth, Employment, and Education" explains how the industrial development in India lacks the co-ordination between the govt/ industry and the labour. The paper attempts to assess the quality of state interventions and their impact on industry and labour. The author emphasizes the need for transforming the state interventions into strategic gender needs.

Mr. Refeeq Ahmed (1986) in his paper "development Perspectives of Indian Footwear Industry, The case of Indian footwear" highlights the importance of the Indian leather footwear industry's potentiality for exports. He brings out the need for popularizing brand name, strengthening training facilities particularly to women, and close linkages between industry, training, and educational institutions. The paper also emphasized the need to have the service of experts from developed countries to train the local artisans in particular lines.

Parmeshware S. (1990) has made the study on the impact of development agencies on cobblers of Athani town from a socio-political point of view.

3. Objective

- To evaluate the role of advance technology
- To understand the advantage of advance technology.

4. Research Methodology

Data are mostly collected through social science include censuses, government departments, organizational records desk research of online resources, research papers, conference documents, and other publications. Data from SATRA, Council from leather export has been used. Annual report on MSMEs, Annual report of the ministry of commerce and industry, various annual reports of State Financial Corporation, and various financial institutions have been used.

The data have been compiled from two types of sources:

- Published documents and reports
- The World Wide Web

4.1.Changing Styles Through the Decades

- **The 1910s:** The First World War of 1914-1918 saw millions of men going to fight around the world. With women filling the jobs left vacant by the men's absence, a desire for more practical women's shoes for use in the factories was born. However, as shortages started to bite, the idea of being wasteful was severely criticized. With a lack of fabrics, dresses became shorter and the same design of lace-up boot that had been worn at the turn of the century was now viewed as practical rather than 'old-fashioned'. A few footwear designers did try to create more interesting styles with, for example, leathers mixed with coloured canvas or gabardine, to create two-tone 'spectators'. Suede became popular, and ballet-style pumps were decorated with a variety of removable buckles made from steel and decorated with silver filigree, diamanté or marcasite. Once peace was declared, fashions quickly changed in an effort to throw off the depression of wartime austerity.
- **The 1920s:** The 1920s was a time of incredible change, during which more liberal views on acceptable dress codes were forged. Dance crazes like the Charleston, which demanded a securely-fastened shoe with a low heel and a closed toe, influenced standard shoe design tremendously.

The discovery of ancient Egyptian Pharaoh Tutankhamen's tomb in 1922 served to encourage a love of all things exotic, and this was reflected in shoe designs of the age.

Brilliantly-dyed leather, metallic finishes and bright fabrics were used to create never-before-seen designs, and rich brocades, satin, silk and velvet were often embellished with metallic overstitching, embroidery and fake gemstones. Heels were often decorated with crystals, often in Art Deco designs.

- **The 1930s:** This was a decade that saw the world plunged into a financial depression after the US stock market crash of 1929. As in the First World War years, footwear needed to last longer and somber colours such as black, brown, maroon and navy blue became standard. In an attempt to introduce a new fashion, platform shoes first appeared in the 1930s and, when the world went to war again in 1939, a shortage of leather and a ban on the use of rubber for non-essential requirements forced shoemakers to use wood, cork and other materials for these platforms.
- **The 1940s:** With the Second World War dominating everyone's life for much of the decade, footwear continued to be austere, and it was viewed as unpatriotic to be very fashionable during such a time of shortage. In much of the world, leather was reserved for military use, so shoemakers had to show initiative in their choice of raw materials. Reptile skins and mesh became popular alternatives. Rationing in the USA meant that shoe manufacturers could only use heels measuring one inch high or less, with a limited choice of colours.
- **The 1950s:** After the war, optimism was high and one of the great icons of fashion footwear – the stiletto heel – gained a massive following during the early part of the decade. Flat pumps based on the ballet shoe regained their popularity and were quickly available in an incredibly diverse colour range.
- **The 1960s:** Young people suddenly found themselves with more money to spend. This led to a decade of tremendous change, with highly experimental styles of fashion, music, art and literature. Hot pants and miniskirts took the Western youth market by storm, with flat-heeled high boots proving particularly popular. The hippie culture also became a major fashion and, as the race to be the first on the moon accelerated, new metallic 'space-age' materials (including coated plastic) were increasingly used by the world's shoemakers.
- **The 1970s:** Celebrities dressed to shock in the 1970s, with punk and glam rock encouraging dramatic styles that quickly found their way onto the high street. Footwear designers working for such well-known figures as David Bowie and Elton John let their imaginations run riot, producing styles that included eight-inch platform heels decorated with sequins. The birth of disco demanded comfortable dancing shoes, and strappy sandals became the choice of millions.
Almost as a deliberate contrast to these outlandish fashions was a return to Edwardian-style pumps and squared-off toes reminiscent of the 1940s, as well as neat court shoes for well-dressed businesswomen. For the first time, running became one of the world's most popular pastimes, and sports shoes started to sell by the million.
- **The 1980s:** A new group of ambitious consumers with money to spend – well-paid young professionals nicknamed 'Yuppies' – looked to designer labels to emphasize their wealthy status in life, and retailers were only too pleased to supply just what they wanted. Many 'new' styles were actually updated versions of popular shoes from the 40s and 50s, with menswear influencing women's fashions in the form of lace-up brogues. Moulded jellies were first made during the 1980s, and were marketed in a spectrum of colours.

- **The 1990s:** While some glittering styles continued to hit the high street, the excesses of previous decades were replaced by more sombre designs before the end of the millennium. A number of shoe fashion revivals took place, with 1970s-style chunky platform shoes regaining their popularity and pastel-coloured ballet pumps once again proving to be the best buy. A perceptible change was seen in purchasing trends, with buyers of fashion footwear starting to look for more than simply attractive styling. Perhaps for the first time since the shortages of wartime, shoppers began to demand comfort as well as looks.
- **The 2000s:** Heels began to rise once more at the beginning of the 21st century, and the popularity of designer labels showed no signs of flagging. Embellishment of shoes with crystals, beads, and embroidery and exotic leathers arrived yet again – and has since proved to be a regular part of the footwear designer’s palette.

The next 90 years?

The footwear industry, which for centuries had used traditional methods of manufacture, has clearly taken technology to heart in recent decades, and this has greatly benefited both shoemakers and shoe wearers. Many changes have been evident – in all aspects of design, materials, and manufacture – but perhaps the greatest difference is where most of the world’s footwear is now made. Many European and North American companies in shoemaking and ancillary trades have either closed down or moved their plants to the Far East. Despite current tough economic conditions, feedback from delegates at recent footwear trade shows has been quite buoyant. As long as manufacturers continue to design well and test their new concepts and existing styles carefully, they will provide what customers want – and that bodes well for the future of footwear.

4.2.Advance Technology & Their Role

4.2.1. Designing

- 1) Foot Measuring Software
- 2) Shoe Design Software
- 3) Sole Design Software
- 4) Last Design Software
- 5) Plotters
- 6) Digitizers
- 7) 3D Printing

CAD/CAM in the footwear industry is the use of computers and graphics software for designing and grading of shoe upper patterns and, for manufacturing of cutting dies, shoe lasts, and sole moulds. CAD/CAM software is a PC-based system, which is made up of program modules. Today, there are 2D and 3D versions of CAD/CAM systems in the shoe industry.

Computer aided design was introduced in the shoe industry in the 1970s. Initially, it was used primarily for pattern grading. It enabled manufacturers to perform complex grading relatively easily and quickly. CAD systems today have been developed with a much wider range of functions. Logos, textures and other decorations can be incorporated into product designs of both

the uppers and soles to help reinforce branding on all areas of the model. It automates routine procedures, increasing speed and consistency whilst reducing the possibility of mistakes. CAD data can now be used effectively for a wide variety of activities across footwear manufacturing business. CAD/CAM generates data at the design stage, which can be used right through the planning and manufacturing stages.

Latest improvements in the CAD/CAM technology are:

- Graphics capabilities and interconnectivity have improved enormously,
- Software developments have progressively made systems more intuitive and easier to use,
- With 2D sketch and paint modules, a serviceable sketch can be produced and then colour and texture can be added.
- 3D systems enable the last and design to be viewed from any perspective and several angles even simultaneously.

With CAD/CAM software, footwear manufacturers can cut their time to market dramatically and so increase market share and profitability. In addition, the power and flexibility of the software can overcome restrictions to the designer's creativity imposed by traditional methods.

CAD/CAM software can be used to generate machining data for shoe sole models and moulds. Shoe sole mould makers are able to strengthen their capabilities of mould design and production techniques to meet the market demands for shorter product life cycle, quality improvement and handling versatile pattern design. This helps especially sports shoe producers to manufacture products rapidly and to introduce them earlier than their competitors.

3D CAD/CAM is the core technology for shoe sole mould in the footwear industry and develops towards specialization.

Benefits of CAD/CAM in the mould manufacturing are:

- Total modeling for rapid generation of design concepts and variations,
- Reverse engineering from existing models or parts,
- Easy design modification and morphing capability,
- Completely accurate designs regardless of complexity,
- Group grading of soles and uppers,
- Advanced decorating techniques,
- Realistic onscreen visualization,
- Rapid generation of molds from product designs.

4.2.2. New Technology in Last Design

The first stage in the footwear manufacturing process is the production of the last. In pre-first world war Europe, lasts were often made from cast iron. As the war started to use up significant amounts of metal, wood was used more often and became the preferred material from 1919. This was often maple, sourced from Canadian forests that in many cases were owned by the last

manufacturers themselves. Copy lathes allowed lasts to be produced rapidly following the creation of a correctly-sized model.

There was no significant further change in the way lasts were made until the Second World War when the first commercial plastics started to be made. Following the end of the war, brittle thermoplastics were used to make lasts until the early 1960s. At that time, polyethylene was used for the first time, which proved to be a durable and tough material. Later, injection moulding speeded up the process, with a roughly-shaped block being turned down to an accurate last. Between 50 per cent and 60 per cent of the material was cut away during this process, but this was reusable.

Today, manufacture of lasts is a fast process. Computerized digitizing allows for the scanning of a model last so it can be reproduced accurately on the screen. The software can be used to manipulate the last in digital form, altering such elements as the heel height or adding an allowance for an insock. Data stored in a program can be used to cut accurate lasts quickly, with modern machinery allowing a number of different sizes to be formed at the same time. In addition, digitized last information can be shared by e-mail between last manufacturers around the world. The last making was once a craft needing the trained skills of a foundry worker and a carpenter.

At the beginning of the 20th century, cast iron lasts were made in a number of sections which were then often fixed together with interlocking pins. This allowed for the last to be taken apart in order to remove it from the partly-finished footwear without causing too much damage. Wooden lasts also were designed to be broken down, with removable 'scoop blocks' held in place by screws or brass springs. Today, plastic lasts are normally hinged to allow removal after the shoemaking process, although in the Far East, lasts are very often made of solid polyethylene to speed up the process.

In the early part of the 20th century, a well-made last would stay in use for 25 years and may have remained in an individual shoe being manufactured for three to six months. Because of this, a lot of lasts was needed. Today, a typical shoe stays on a last for a maximum of 20-30 minutes, due to the use of a heat-setting process during footwear production.

4.2.3. The Arrival of Alternatives to Leather

Animal skins have long been used by man as a protective covering. When skins were first tanned to produce leather, this new material combined a level of water resistance with good insulation and wind resistance, water vapour permeability and high absorbency, as well as being flexible enough to be formed and set into the desired shape.

Demand for good-quality leather, along with rumors of a potential shortage, led some companies to explore the possibility of producing an affordable alternative to this traditional material, which could match the properties of leather. After the Second World War, a wide range of synthetic materials derived from the petrochemical industry appeared on the market. Inexpensively made, these had consistent properties. An early attempt to produce a leather-like material involved bonding a textile base to a polymeric coating. One of the first of these was PVC polymer coated

fabrics (PVCCFs), which gave an imitation of the flesh and grain of the leather. Such early materials had good abrasion resistance, but low water vapour permeability, poor flex crack resistance and were cold to the touch.

Polyurethane coated fabrics (PUCFs) were developed in the 1960s and were an improvement on PVCCF. Originally, the materials were made by casting a polyurethane film, which was then stuck to the fabric base with an adhesive tie coat. These materials had more of the feel and appearance of leather, and also had a degree of water vapour permeability.

Further advances were made by using a brushed fabric as the substrate to give improved appearance and handle. One of these developments was coagulated PUCF, in which an organic solvent solution of PU was applied to a brushed fabric. It was then immersed in a non-solvent for coagulation, which resulted in the formation of a porous structure. This increased both the flexibility and water vapour permeability and gave a more leatherlike appearance.

Poromerics (micro porous synthetic leather substitutes) were developed in the 1960s and 1970s and were intended to be an improvement over coated fabrics. They were defined by SATRA in their introduction as ‘a man-made shoe upper material, which is generally similar in nature and appearance to leather and, in particular, has comparable water vapour permeability’.

The application of coated fabrics was limited by the properties of the knitted or woven base fabrics. Poromerics used a nonwoven fabric impregnated with the polymer (usually PU), thus producing a more leatherlike material. A wide range of poromerics with diverse structures was developed. The nonwoven substrate offered the closest simulation to the fibre structure of leather but required significant levels of the binder. The aim was to increase the degree of interweaving and reduce the need for impregnation. Advances continue, with the development of micro-denier fibres, which are being used to produce materials with characteristics much closer to leather.

Later developments include the use of hydrophilic fibres to enhance comfort by producing more absorbent materials, permeable but abrasion-resistant topcoats to mimic the grain, new impregnation techniques, hydrophilic PU formulations and water-based systems.

As well as being selected for the majority of footwear uppers, the leather had been the material of choice for solings until it initially encountered serious competition from rubber in the 1930s. At first, soles were cut from natural crepe rubber – a material formed from natural latex tapped from rubber trees – which has low levels of resistance to solvents and oils, but is both durable and flexible.

Quite soon thereafter, units were being made from vulcanized natural rubber compounds formed using heat and pressure. Vulcanized synthetic rubbers such as styrene-butadiene rubber were then developed, as was rubber reinforced with high-styrene resins (resin rubbers) which provided hard, thin sheet solings that were leather like in both feel and appearance.

In the 1960s, thermoplastic solings began to be developed. The first of these – PVC (polyvinyl chloride) and TR (thermoplastic rubber) – allowed sole production with faster and cheaper processes than were required by vulcanized rubber.

Polyurethane (PU) solings were introduced at the end of the 1960s. Most familiar in reaction-moulded lightweight microcellular form, polyurethane is also used in thermoplastic grades (TPU). Since the late 1970s, microcellular EVA – ethylene vinyl acetate – in cross-linked form has proved popular as a lightweight soling material. Developments during the last two decades of the 20th century saw the introduction of soft vulcanized rubber ('latex' rubber) as an alternative to TR, and polyolefin elastomers (POE) – elastomeric forms of polypropylene mixed with ethylene-propylene rubber.

4.2.4. Developing New Machinery

The demands made by innovative designers of modern footwear have forced the development of new technology – from the introduction of large automatic footwear-moulding machines to an improvement in the quality and strength of some of the smallest elements of the shoemaking process – such as the needles used in the stitching process and threads which also have more colour resistance than those used in years gone by.

There were a number of ingenious and quite sophisticated shoemaking machines invented by 1910. These included various heel building and heel attaching machines, stiffener moulders, and sole moulders, finishing machines, buttonhole sewing machines, eyeletters and skivers. To a greater or lesser degree, these processes have remained very similar even into the 21st century. After cement sole attaching systems were introduced in the mid-1920s, various sole and shoe bottom roughing and cementing machines were developed, as well as a wide variety of attaching presses.

Between 1950 and 1960, high-pressure rubber moulding and vulcanizing machines, combined with the introduction of the pre-finished sole, as well as Louis heel and sole units, made considerable impact on the footwear industry.

The decade leading up to 1970 saw the introduction of PVC injection moulding systems, which were followed by the polyurethane reaction injection moulding (RIM) process. The arrival of moist heat setting, invented by SATRA (and for which the Technology Centre received the Queen's Award for Industry in 1969), dramatically reduced the setting time – and hence, the number of lasts required – and is recognized as one of the great landmarks in footwear manufacture.

In the field of upper preparation, the wider use of man-made materials led to the use of travelling head cutting presses and, in turn, to processes involving high-frequency cutting, welding, and embossing.

In lasting, the introduction of back-part moulding and seat lasting machines accompanied by developments in forepart pulling and lasting machines – both now with built-in hot-melt cement systems – have also done much to alter the look of the modern shoe factory.

In recent years, computerized machines controlling such processes as pattern cutting and decorative stitching are very common around the world. Little had altered in stitching machinery for more than half of the 20th century. Up until the 1970s, operatives used electric clutch-driven

machines, which took great skill and experience to achieve the correct speed. Things changed in the 1970s when the first electronic stitching machines were introduced, allowing the operator to vary the stitching speed by using a foot pedal.

4.2.5. *Testing Comes of Age*

Chemical testing of footwear and components plays a vital role in the production of well-made shoes and boots. Perhaps surprisingly, a laboratory from the 1940s would have looked little different from one in the 1960s, with traditional wet chemistry, using burettes, flasks, and Bunsen burners being the order of the day.

Things started to change in the mid-1960s, with the introduction of the first infrared testing equipment. Many new test methods – previously impractical to perform – were developed during this period, taking advantage of the availability of more sophisticated analysis techniques. At last, polymers could be accurately identified, as could surface contaminants. Such quickly gained knowledge brought impressive benefits – for example, the improvement of chemical adhesion – and, in the mid-1980s, chemical testing was further revolutionized with the introduction of chromatography. Bigger and better equipment mainly developed in the pharmaceutical and petrochemical industries quickly found an application in footwear and leather testing.

One of the noticeable changes in chemical testing today is the ability to detect incredibly minute quantities of certain substances. Twenty years ago, heavy metals could be identified to 0.01 per cent. Modern, highly-sensitive equipment can today find heavy metals in parts per million. Also, whereas analysis of organic chemicals was previously very rudimentary, now the detection of pesticides, fungicides, antioxidants, dyestuffs and flame retardants is normal practice – both qualitatively and quantitatively.

SATRA's work in the field of chemical testing (particularly on discoloration in footwear and detection of banned chemicals) continues to be of great help to our members. "SATRA enables members to stay abreast of current chemical tests, and we are a world leader in test expertise," says Richard Turner, who helped develop SATRA's chemical and analytical technology facility before his recent retirement. "We have the best-restricted substances list in the world and are viewed by many as the 'fount of all knowledge' when it comes to such checks.

"Some types of analysis, such as for extractable fat in leather, still use traditional wet test methods, and it is likely that technology will become even more sophisticated in the future," he continues. "Legislation is getting ever tighter, with some tests looking for results in parts per billion!"

Physical testing of whole footwear and components has also improved beyond recognition in recent years. From its establishment in 1919, SATRA has been identifying and solving testing problems faced by footwear manufacturers. In recent decades, modern technology has superseded simple mechanical testing of many items, providing access to computerized tests and giving exceptionally accurate results.

Sophisticated whole-shoe tests, such as the Advanced Moisture Management Test (AMMT) and PEDATRON sole abrasion test have been developed by SATRA, providing rapid analysis of footwear problems that previously took months of wear trials to establish. SATRA remains at the forefront of test machinery development and continues to introduce new developments into the footwear industry.

4.3. Factories on the Move

For most of the 20th century, the main footwear-producing companies were located in Europe and the USA. Whilst there was a small proportion of the overall global shoe production coming from Asia, the traditional strongholds of Italy, France, the UK, Spain, the USA, and Germany produced the majority of footwear until the early 1970s. Then, India, South Korea, and Taiwan opened up to the Western-style mass production of high-quality leathersgoods, followed soon afterwards by China.

5. Conclusions

Advanced technologies in the area of footwear design, footwear construction, maintenance, and operation of footwear technology. New tools and techniques have the potential of achieving cost savings and productivity improvements as well as enabling new developments in Footwear sector. There is a general feeling the footwear industrialist that the much of the future growth and development in footwear sector would depend upon how effectively these new technologies are adopted in the footwear sector.

The basic purpose of the paper was to review the areas where advanced technologies can significantly affect the way footwear industrials is practiced. Advance technology is also responsible for the productivity improvement. Now a day the working condition is very fast. The quality as well quantity of the product is also improved through the advance technology; it is also reducing the manpower requirement in the industry.

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