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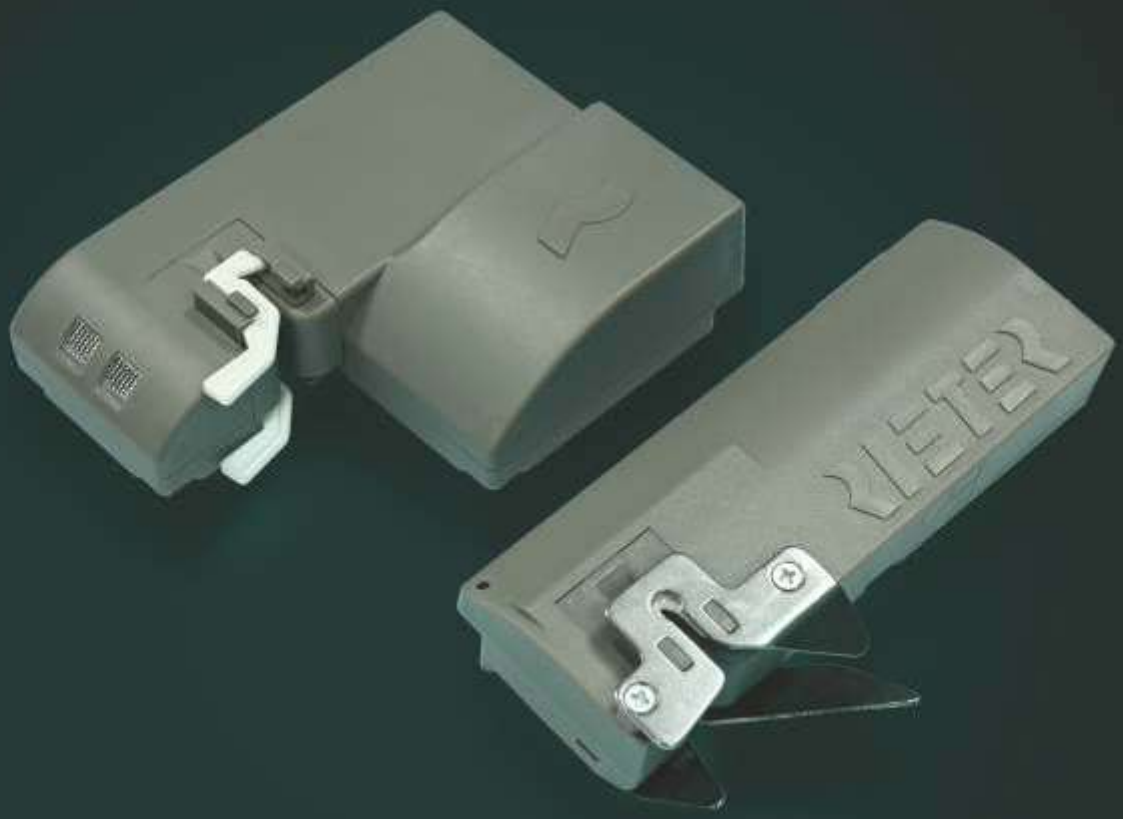

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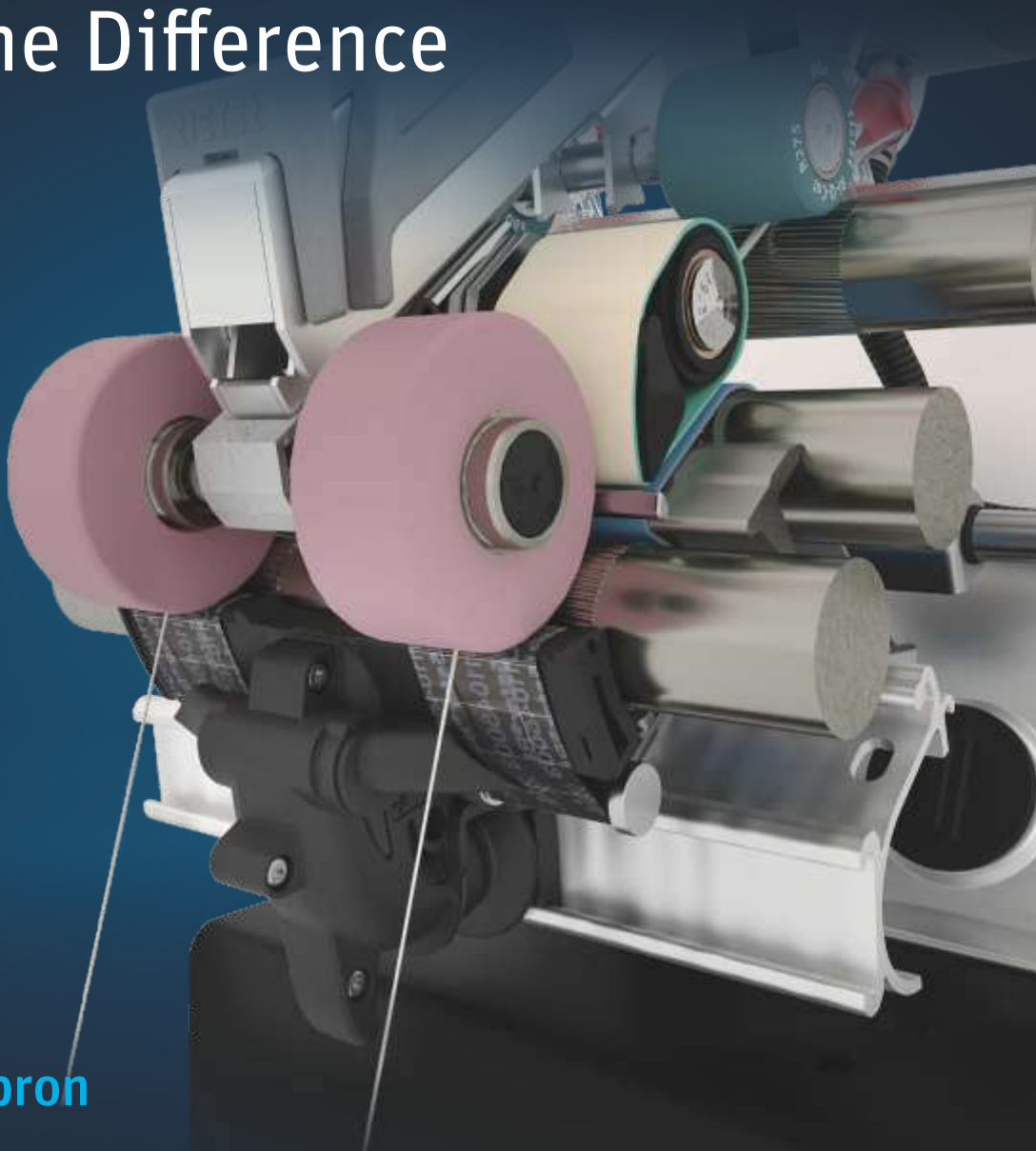

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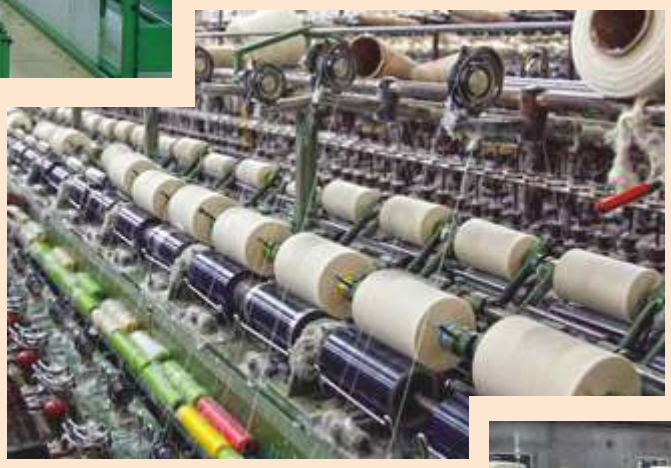

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Shri Suresh G. Vaidya

(01/04/1939 -12/04/2023)

A dynamic personality & an ideal leader Shri Suresh G. Vaidya passed away on Wednesday, 12-04-2023 at the age of 84 years at Pune residence. It is a great loss to all Fellow Textile Fraternity. We all lost a great man, a real gentleman, soft spoken, always smiling approach and inspiration of the textile industry. He was a guide, guru, encouragement and advisor.

Shri Vaidya is L.T.M., B.Text (Textiles) of 1965 Batch from Victoria Jubilee Technical Institute (VJTI), now known as Veer Jijamata Technical Institute. He was a General Secretary (Gymkhana), Secretary Textile Student Association, Secretary Marathi Wangmaya Mandal, Member Social Group. He was a recipient of Lions Club Award for "Most Noteworthy Extra Curricular Activities by a Student of Colleges in Mumbai".

Shri Vaidya has more than 58 years of Shop floor experience in Textile Industry before founding his consulting firm. He was a Founder and independent Director of self employed Vaidya and Associates, Textile and Management Consultant (1979). He has worked on various turnkey projects for reputed companies and also was an independent and Nominee Director on the Boards of more than 40 Public Limited Companies in the field of Textiles, Associations, Educational Institutes, BSE, BTRA, Engineering, Banks and the Financial Institutions in India and Abroad.

He had worked as Chairman of Maharashtra State Textile Corporation Ltd, (MSTC) for 3 years. He was a Director of Vastex Prima Industries, Bandung, Indonesia for 3 years. He was a General Manager for Gokak Mills Division, Gokak Patel Volkart Ltd. For 5 years. He was also responsible for the formation of P.T. Gokak Indonesia and commissioning of P.T. Vastra Indah, Batu, Malang, Indonesia. He was a General Manager for Osmanshai Mills, Nanded for 2 years.

Mr. Vaidya was a Factory Manager of Pratap Mills Ltd. (UAC), Dhule for 2 years, on the deputation for takeover and revival. He was a Special Officer for Raja Bahadur Motilal Poona Mills Ltd. For 3 years. He worked as a Technical Assistant to the Manager in D.B.R. Mills Ltd. He had wide experience of successfully reviving closed and loss making affluent textile mills. He also worked with Victoria Mills Ltd, The Pradip Metals Ltd, Piramal Spinning and Weaving Mills Ltd, Laxmi Vishnu Textile Mills Ltd., Binny Ltd, John Fleming Ltd. etc.

Mr. Vaidya was the recipient of honors and awarded with

- Lifetime Achievement Award issued by The Textile Association (India) in 2022
- Special Appreciation Award issued by ITAMMA in 2021
- Bhishma Pitamaha Award issued by The Textile Association (India) - Ahmedabad Unit during the celebration of its 80 years Anniversary in 2019
- Lifetime Achievement Award issued by The Textile Association (India) – Madhya Pradesh Unit
- ITAMMA felicitated him with 'Special Appreciation award' for his yeoman services to the Association

His contribution to the textile society and more particularly to the TAI Mumbai Unit and the Central is unforgettable. He had a great personality in textile profession and had association with many other institutions and the organizations for more than 5-6 decades. He was a guiding force to TAI and other institutes.

Shri Vaidya was a guiding force and helping nature for many students of VJTI. He was a godfather and an inspiration for many textile professionals. He was a veteran and a stalwart of the textile industry. He used to invite us for meals at CCI and Shivaji Park Gymkhana. He remembers and calls personally to wish us on the Birthdays or Anniversaries. A kind and humble soul, full of humility and always ready to help others.

Shri Suresh Vaidya was a President of ITAMMA during 2007-2008, former President (1989 to 1991) and Trustee of TAI Mumbai Unit (2015 to 2021). Also was one of the Board Members of Trustees of TAI Central (2017-2020).

On behalf of the Central Office of The Textile Association (India), we offer our heartfelt condolence and pray almighty to bestow eternal peace to the departed soul. We also pray almighty to give you all the courage to withstand irreparable loss.

We all miss you Vaidya Saheb. You will be forever in our many hearts.

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CONTENTS

THE TEXTILE ASSOCIATION (INDIA)
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Mr. R. K. Vij, President - TAI

What is "Atmanirbhar Bharat Abhiyan"?

Our Hon'ble Prime Minister started 'Atmanirbhar Bharat: A vibrant growth in Indian economy' The aim is to make the country along with their citizens Independent and Self reliant in all areas. The main important points of Atmanirbhar Bharat Abhiyan are;

1. Infrastructure, 2. Economy, 3. System, 4. Demand & 5. Demography.

Before Covid-19, India never thought of making Covid Vaccines and took challenge 'when Covid started' to make vaccines not only for Indian citizens but exported to more than 100 countries. India has rapidly progressed and now we are world's fifth largest economy country. The Reserve Bank of India estimates India's economy to reach 3.7 trillion USD by 2023.The World Bank's revision of Indian GDP growth is the projections from 6.4% to 6.9% in the current fiscal year. We feel proud to hold the prestigious G-20 summit and this brings so many opportunities for us and to strengthen our relations with the participating countries.

By the end of 2023, India will become the world's most popular country. According to IMF India will alone contribute 15% of the Global growth by the end of 2023. The main challenge for India at this moment is to continue its growth momentum. Turning India's 1.48 billion people into growth engine will transform not only this country, but the world as a whole. India is targeting the world's third largest economy by 2040.

The Government of India launches various schemes for the people every year for the development of individual or the nation as a whole. This Atmanirbhar scheme is to minimize imports, to increase export and to make India self-reliant. The mission is directly related to industrialization in technical, medical and scientific disciplines The mission is to first give choice to local products and to maintain cost and quality. The Indian Market was dependent on Chinese products with Atmanirbhar Bharat Abhiyan has boosted the county's economy and benefits to the employees, creating job opportunities and reducing unemployment. This is a step towards the one nation one market philosophy and will help India as a factory for the world also.

The Textile and fashion industry is constantly evolving and innovations in technology have brought significant changes in the textile industry. This technology creates endless possibilities for fashion design and can assist in the creation of sustainable fashion by using data to predict trends and consumer preferences.

Entrepreneurship and new start-up are fueling the engine of the Indian economy. The young and talented population of India has realized its potential which is directed through State initiatives towards the goal of making the best of India's diversity to make it a force to recognize in the world economic front.

The concept of Atmanirbhar Bharat is a visionary step to engage people in skilling, up-skilling and re-skilling to prepare them ready for future and reap the advantages of demographic dividends. As peak of demographic dividend to India will occur in 2031, its dire need to prepare youth of the nation to harness this opportunity by preparing them ready for Industry 4.0 as well as future requirements till the year 2055, when demographic dividends to India will cease. Few reports suggests that 78% of fresh hires in IT and related sectors requires skilling and training before they start their jobs and 40% of existing workforce will require re-skilling in next 5 years due to rapid changes in technology. National education policy also advocates skilling, up-skilling and re-skilling for holistic development and employability of students.

The whole textile industry at present from last three quarters is passing through rough phase. It is due to less export to USA & European Countries and same time more imports from Chinese Companies which are already surplus in India. The products which are in short supplies in India can be met through imports but some of downstream products like filaments and yarn, fabric which are already surplus in capacities should not be allowed to import. This will increase our domestic production & more employment under Atmanirbhar Bharat Abhiyan.

Government has to take a few steps to restrict "down grade quality" of export into India by implementing QCO's Scheme in next two to three months. This is the time Govt. should resolve the inverted duty structure in MM FIBRE to boost the Indian manufacturers. We have suggested to the GST council to make one GST rates of 12% at least on PTA, MEG, FIBRE, FILAMENTS & YARNS keeping Apparel, Fabric, Garments on EXISTING GST RATES of 5%. This will also increase the Indian capacity utilisations along with increase of TOTAL GST REVENUE and a step towards ease of doing business. Hope Govt. will look into the suggestion of Textile Industry. This will solve the inverted duty structure d without disturbing and increasing the cost of common man's Fabric and Garments.

Textile Ministry is already doing FREE TRADE AGREEMENTS with many countries to boost our exports. Textile Ministry has also announced Seven PM MITRA Parks to make textile hubs .PLI schemes will further increase our capacities to become ATAMNIRBHAR BHARAT and to boost PLI scheme. At the end the present downward trend cycle will be over by next quarter. We will see the same good time again which we saw immediate after Covid.

Same way Indian Textile producers should also reduce their cost of production with quality products for better export and to restrict import.

JAI HIND

Benefiting from the Art of Japanese Kirigami in Creating Contemporary Children`s wear

Amany E. El-Dosuky*

Ready-Made Garments Department, Faculty of Applied Arts, Damietta University, Egypt

Abstract:

Kirigami is seen as one of the Japanese traditional arts, it is the art of folding paper which is cut by scissors to make a flower, paper doll, paper snowflake, and other designs, It is quite similar to origami, for the main difference between the two arts is that origami does not allow for the use of anything but folding. Kirigami allows not only folding and cutting but even gluing and taping. Kirigami was first introduced in Japanese Buddhist temples. It represents elegance, wealth, and perfection.

As children have importance in society, as they represent a significant human and purchasing power, in addition to the fact that clothing constitutes an important part and an influential factor in the child's life, thought, and culture, Therefore, this paper focused on innovation in the field of designing children's clothing suitable for the age group 3–10 years through the application of some techniques of the art of kirigami as a new innovative approach that achieves creativity and diversity, attracts the child's attention, develops his ability to imagine, provides him with distinction and individuality, and raises the quality of the clothing industry and the purchasing level of the product and open new markets for children's clothing products that are able to achieve the competitive advantage.

Keywords: *Children clothes, Contemporary Kirigami Artists, Fashion design, Kirigami art, kirigami techniques, Paper cutting*

Citation: Amany E. El-Dosuky, "Benefiting from the Art of Japanese Kirigami in Creating Contemporary Children`s wear", *Journal of the Textile Association*, **83/6** (377-383), (March-April'23),

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1. Introduction

The physiology of the child is greatly influenced by clothing since children frequently tend to wear unusual and eye-catching attire. Children's clothing must have kid-friendly forms, elements, and units, including cartoon characters, animal shapes, and elements of nature in general[1]. In the middle childhood stage, the child tries to make his own clothing decisions in terms of color, shape, and embroidery because this enables him to improve his appearance and meet his needs, which makes it necessary to pay attention to the field of designing and manufacturing children's clothing in this period because it plays a role in creating his character [2], therefore, the current study examines ways to efficiently apply kirigami techniques, "the Japanese art of paper cutting," to children's clothing fabrics, and this opens a new field for creativity and innovation in the field of fashion design.

2. Kirigami Art

Kirigami comes from the Japanese words "kiru" (to cut) and "kami" (paper) [3]. The art of "kirigami" involves the combination of paper cutting and folding, where paper is cut with scissors to make various forms, including flowers, paper dolls, snowflakes, and other designs [4], traditionally, a single sheet of paper is sliced using scissors or a knife to create a figurative or abstract pattern. [5], in this situation, the visual emphasis might be on the sliced paper or the remaining "negative space." [6].

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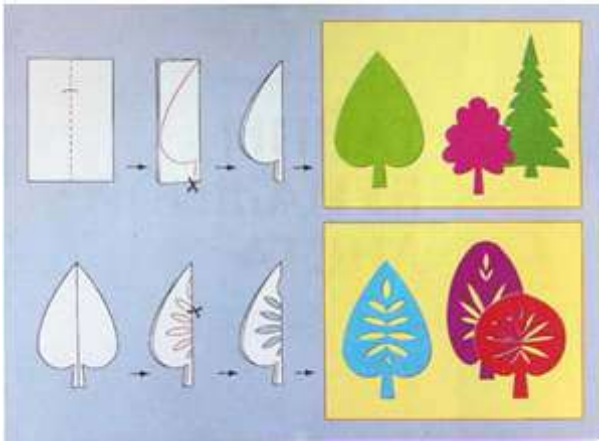

Figure 1 - The easy process of producing kirigami trees. This fantastic basic type of art produces magnificent designs that exhibit symmetry, consistency, and balance[4]

Kirigami involves both the "cutting" and "folding" processes [7], A sheet of paper is folded once or more times for various patterns, with cuts applied through all layers. An unexpected symmetric design, as seen in figure 2, is revealed when the paper is unfolded [8].

Figure 2 - Some forms of kirigami art resulting from the process of folding and cutting paper

Kirigami can be symmetrical or not, It is similar to origami in that some folding is included, but it is distinct in that the major way of making a pattern is the skilled cutting of paper. Florence Temko introduced the term "kirigami" to paper crafters in the United States in 1962 [3].

Kirigami and origami both words are Japanese terms that have made their way into the Western lexicon. Without cutting or gluing, a paper square is folded into an item or animal in origami, while paper can be cut and glued in kirigami, and sometimes it can also be folded before cutting. Both terms contain the Japanese word gami, which means "paper;" ori means "folding," and kiri means "cutting" [8].

3. The History of Kirigami

Paper cutting is one of the oldest crafts with strong cultural roots. Young children like cutting paper, particularly in the hands of skilled artists. Paper cutting may produce creative works of art. Historians associate paper cutting with shadow puppets, which are pierced silhouette forms produced from paper or paper-like materials [9].

While paper cuts may appear to be extremely contemporary, the practice of paper cutting has a long and rich history. The Chinese, who invented paper as we know it, began cutting paper more than a thousand years before most Europeans had even seen a piece of paper. The oldest existing paper cut is a simple symmetrical circle discovered in a far western Chinese province in the sixth century [10].

The art of paper-cutting goes from China to Korea and Japan. Origami (folded-paper sculpture) and kirigami (cut-paper stencils used for dyeing leather and textiles) were examples of Japanese paper art. As paper traveled from East to west, so did the techniques and styles of paper cutting, that took on different names Such as Sanjhi in India and scherenschnitte in Germany. Folk art paper-cutting traditions also flourished in Jewish communities. During celebrations and religious events, cut tissue paper, or paper picado, was also often used to decorate Mexican interiors and streets [11]. Paper cuts support the symbolizing, communication, and identity functions [12].

One of the oldest forms of folk art in China is paper cutting, which is both a type of handicraft and an artwork since it allows people to express ideas through patterns. To display happiness and good fortune, paper-cutting is used to decorate doors, windows, and walls. Artists use tools to cut the motif into the paper, and adept craftspeople may even freely cut out intricate drawings without stopping [13].

The paper-cutting art has achieved its pinnacle in China. The tenth century saw the first mention of paper cut-outs in Chinese writings [9].

Paper cutting took off in Germany, where it was known as Scherenschnitte (shear-n-shnit-a), which literally means "scissor cuts." It was commonly used to write love letters. Additionally, the Dutch carried out a lot of cutting known as

Figure 3 - Polish circular cut out[9]

Figure 4 - Chinese cut –outs[9]

knippen, which was frequently employed to embellish legal and religious documents, in Japan, creating stencils was a highly specialized field of paper cutting. Stencils were employed to make ornamental patterns on both the garments of farmers and the exquisite samurai uniforms. Paper cutting as a form of art in and of itself truly took off in Japan's Edo era (1615-1868) [10].

Figure (5) shows various paper cutting styles. Jianzhi is the Chinese art of paper cutting. Kirie is the Japanese art of paper cutting, while Kirigami, also called Monkiri, involves cutting and folding paper. The technique known as papel picado is the Mexican art of paper-cutting. The German and Swiss art of cutting paper is called scherenschnitte, which literally translates to "scissor cutting." Paper cutting in Poland is known as "wycinanki," sometimes known as "scissor cutting" [14].

Figure 5 - Various paper cutting styles [14]

Kirigami, like origami originated in China, where paper was created in approximately 105 CE, Chinese people started making ornamental cut-outs of colorful paper in the sixth century, a practice known as jinzh. These paper figures were originally made to pay homage to gods and ancestors. However, in the 14th century, jinzh changed, becoming a pastime activity for women and children. The Japanese started cutting paper into magnificent works of art in the 7th century, undoubtedly influenced by jinzh [15].

In Japan, it has long been customary for aristocratic families to have a distinguishing crest that is used on all of their possessions. During times of war, it was easy to distinguish between friends and enemies based on the crest on the armor or apparel. To this day, a family, business, or hotel crest may still be decorated on the front, back, and sleeves of a kimono. Mon-kiri, the art of cutting these crests (mon = crest, kiri = cutting), is taught in Japanese schools along with origami [9]

Figure 6- Japanese crests [9]

4. Contemporary Kirigami Artists

A Japanese artist named Kanako Yaguchi employs the kirigami method to make stencils and appliqué templates for clothing, accessories, and interior design items, as seen in Figure 7 [14]..

Figure 7- Some kirigami works by Kanako Yaguchi

Pippa Dyrlaga transforms ordinary sheets of paper into extraordinarily complex works of art using just a pencil and a scalpel. Her time spent" surrounded by the best of British wildlife" served as a major source of inspiration [15].

Kirigami has achieved a new level of international recognition In December 2018; Masayo Fukuda presented a detailed rendering of an octopus made from a single sheet of A2 paper [16].

Artist Kanako Abe finds inspiration in "everyday moments and thoughts." Abe is particularly well-known for her animal cut-outs with place a strong focus on the natural world [15].

Figure 8- Kirigami work by Pippa Dyrlag [15]

Figure 9- Kirigami work by Kanako Abe [15]

Figure 10- Kirigami work by Masayo Fukuda[16]

5. Kirigami in Fashion Design

Although the art of kirigami is not widely known in the fashion design sector, there are a few fashion designers who have used the art of kirigami in their design collections to find inspiration for creating clothing pieces that are characterized by elegance and creativity.

- Robert Ryan has taken kirigami one step further by layering a paper-cut design over top of a gown [17].
Marchesa Ready-to-Wear Spring 2010: A Touch of Japanese Fashion and Kirigami Paper Art [18].

Figure 11- Robert Ryan kirigami design[17]

Figure 12- Marchesa`s Laser-cut, Floral Kirigami dress[18]

Fashion Pakistan Week 2016 presented a display of Nida Azwer's 2016 collection, which was inspired by kirigami as seen in figure 13. Through layering, cutting, and embroidery in this collection, the art form on the canvas is translated. In this collection, sheer, luxury fabrics like organza are combined with opaque fabrics like silk [19].

Figure 13- Nida Azwer's 2016 design collection, inspired by kirigami art

6. How to Make a Kirigami Paper Art

6.1 Steps to Implement Circular Paper Dolls

1- Cut out a large circle from a sheet of paper
2- Fold the circle in half three times (in half, into quarters, and then into eights). You will get a pie-piece shape.
3- Draw out two half-figures as shown. In this example, half a man is on the left and half a woman is on the right
4- Cut out the figures and unfold. You will find 8 figures holding hands to form a complete circle. as seen in figure 15.

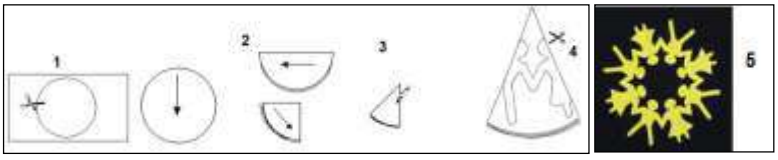

Figure 14 - Making circular paper dolls in kirigami art

6.2 Steps to Implement Kirigami Spider Web

1- Fold a piece of paper in half.
2- Fold in half again but only make a small crease to show the midpoint. Fold the bottom right corner upwards to make a 60° angle at the midpoint (begin to fold into thirds).
3- Fold the bottom left corner upwards to meet with the folded right-edge of the paper.
4- Cut the excess paper to form a triangle.
5- Cut slots on the triangle as shown. Be careful to keep the central column uncut so the paper does not fall apart.
6- Unfold the paper to find a paper spider web, as seen in figure 16.

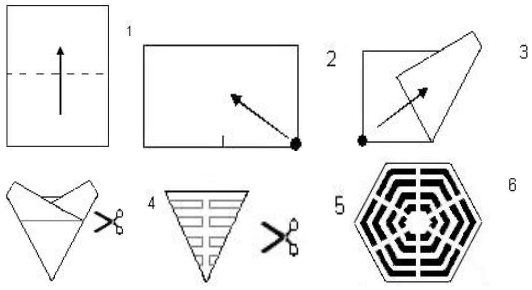

Figure 15- Making kirigami spider web

Figure 16- Different kirigami patterns [20, 21]

7. Other Techniques of Kirigami Art Applications

Figure 18 shows one of the application forms of the kirigami art, this shape, for example, can be applied to clothes in the sleeves or the back.

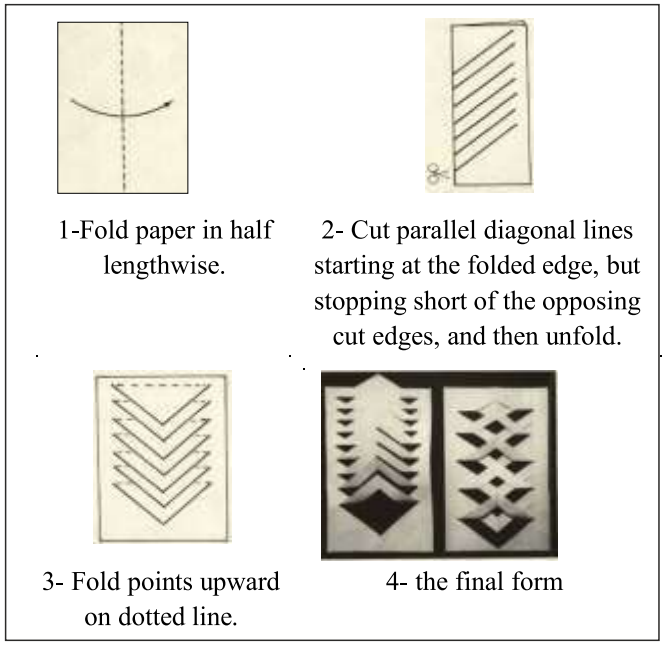

Figure 17- One of the application forms of the kirigami art [8]

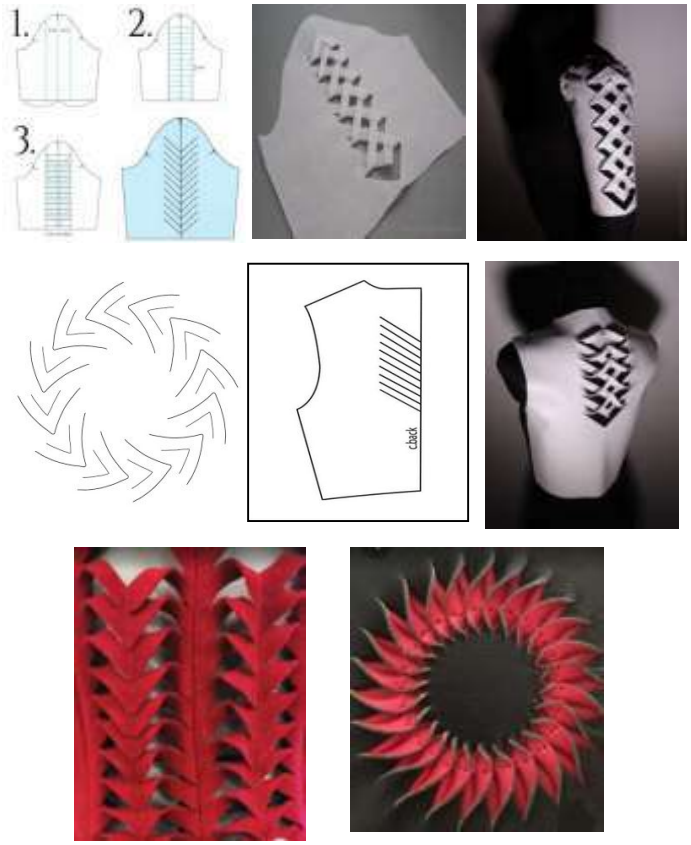

Figure 18- Examples of applying one of the kirigami techniques to clothes [22, 23]

8. The Effect of Kirigami Art on Children's wear

Studies suggest that, among other advantages, paper cutting increases manual dexterity by exercising and strengthening small motor muscles, as well as advancing the interconnection between hand and mind. Paper cutting gives children various challenges for various ages and different stages of development, so that kirigami helps children to develop their ability of design such as color sense and visual acuity.

The purpose of folding activities is to train the child's ability to fold mirror/mirror neatly and develop children's visual-spatial abilities [24].

folding paper also has benefits including a) the formation of more perfect motor skills in both hands, b) increased intellectual ability, c) increased creative power abilities; d) improve ability to focus attention (concentration), e) improve memory skills (memory), and f) exercise patience [25].

Physical Benefits: Development of fine motor skills, since most arts and crafts activities consist of moving fingers and hands, they help in developing fine motor skills [26].

Improvement of Hand-Eye Coordination: Paper folding activities aim to train eye and hand-muscle coordination. [27].

Cognitive Benefits: Artwork improves cognitive abilities because it improves social and perceptional skills, memory development, and self-awareness of children, Activities including colors, shapes, and crafts can increase children's cognitive abilities [28].

Enhances Dexterity: Arts and crafts activities can enhance the children's dexterity and agility. With the enhancement of fine motor skills and much practice, a child's manual dexterity, artistic skills, and speed will also increase [26].

In elementary schools in Japan, kirigami lessons are frequently a part of the curriculum. Kirigami assists in educating pupils about the significance of Japanese culture while they work on developing: Scissor skills, Fine motor skills, Visual-motor skills, planning abilities. The most well-known instance of kirigami for children is that Youngsters cut paper snowflakes to use as window decorations for Christmas [29].

9. The Applied Study

Figure 21 shows Kirigami patterns that were applied to different fabrics using laser cutting technology.

The researcher implemented an example of using some forms of kirigami art in the dress of a three-year-old girl, where satin and tulle fabrics were used to implement the design, the following forms were unloaded using laser cutting technology to prevent the fabric from fraying.

Figure 19 - The implemented kirigami patterns

The researcher implemented an example of using some forms of kirigami art in the dress of a three-year-old girl, where satin and tulle fabrics were used to implement the design, the following forms were unloaded using laser cutting technology to prevent the fabric from fraying.

Figure 20- The implemented kirigami patterns

Figure 21- The implemented design

10. Conclusion

This research attempts to develop art appreciation for children through the use of a new art not widely known among fashion designers: " the Kirigami art " where Children's clothing styles can be developed by taking advantage of the aesthetics of kirigami art to obtain Contemporary clothing designs.

In the art of kirigami, paper is used to make beautiful patterns, in this research; Fabric was used instead of paper as the fabric is more durable, flexible, comfy, washable, and wearable more than paper, which is fragile and hard.

The benefits of this study can help stimulate the growth of creativity, motivation, and imagination of children in learning and developing themselves where kirigami art can develop children's visual abilities; it helps children to develop their ability of design such as color sense and visual acuity.

Kirigami is a new and innovative strategy that promotes creativity and diversity, attracts children's attention, enhances their imagination, and by integrating this art into the children's clothing industry, it will improve the quality of the clothing industry and raise the level of the product purchase.

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Journal of the TEXTILE Association

TECHNICAL TEXTILE

Effect of Layer and Angle on Mechanical Properties of Polyester Braided Composite Rods

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Abstract:

Fiber-reinforced polymers (FRPs) with their lightweight and very good mechanical properties have opened up the possibility to replace the steel bars used in civil structures which are being limited due to their corrosion vulnerability. The fibre-matrix system called braided composite rods (BCRs) can also make an impact in the civil industry with their inherent strength approachable structure and corrosion-resistant nature. In the present study, biaxial braided ropes were prepared on a braiding machine with a braid over braid method using high-tenacity multifilament polyester yarns. Prepared ropes were converted to BCRs by permeating and curing the resin solution through the braided ropes. Six different braided ropes were prepared with varying braid angles and the number of layers. Prepared BCRs were evaluated for their mechanical properties like tensile strength, flexural strength, and compressive strength. Interpretation of the results was carried out based on the effect of layers and braid angle on the mechanical properties. Developed BCRs may offer a suitable replacement for conventional building materials due to their less susceptibility to corrosion, catastrophic falls, good mechanical performance, and lightweight nature along with its at par mechanical properties.

Keywords : *Biaxial braided rope, Braid over braid, braided composite rods (BCRs), Corrosion resistant, Fibre-reinforced composites (FRCs)*

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1. Introduction

Fibre-reinforced composites (FRCs) are a type of engineered material, which exhibit high strength/weight and modulus/weight ratios than some metallic materials. FRCs with the highest specific properties typically have continuous fibre reinforcement embedded in a polymer matrix [1,2]. FRCs can be used to manufacture highway structures like guardrails, signboards, drainage systems, and bridge decks, along with auto skyways, utility poles, and pipelines for gas, water, and sewage [3,4]. Apart from this, it can also offer corrosion-resistant lightweight building materials [5]. Braided composite rods (BCRs) are one of the products which can be utilized as a replacement for iron/steel bars to obtain sustainable building materials [6].

Braiding is the method of interlacing three or more yarns or bias-cut cloth strips in such a way that they cross one another and are laid together in diagonal formation, forming a narrow strip of flat or tubular fabric [7,8]. A braided structure gives much better axial strength to the fabric which leads to better performance in the composite application [9]. Braided composites are specially designed to achieve extra strength, functionality, and durability [10]. Unlike other composites, in braided composites braids are used as a reinforcement material rather than fibres. In various studies, glass, carbon, polyethylene, and sisal fibers are taken for braid composite and have achieved good mechanical properties [11]. Generally, all kinds of yarn can be converted into a composite structure by treating it with a different matrix-like, like epoxy, polyester, vinyl ester, etc [12]. However, to attain the high tensile strength of a composite structure, the strength of reinforcement material and type plays a major role [13]. A single yarn cannot provide such tensile strength after becoming a composite. While the single yarns converted into braided ropes can offer exclusive properties which can further be emphasized by matrix when formed into braided composite rods.

The braiding process competes well with the filament winding, pultrusion, and tape lay-up [14,15]. Braiding compares favorably in terms of the structural integrity of components, design flexibility, damage tolerance, repair ability, and low manufacturing cost [10,16]. Many researchers have addressed several parameters which can affect the performance of braided ropes like braid geometry, crimp angle braid angle, etc [17-20]. However, none of the work reports the effect of layers along with their changing braid angle, which is of utmost importance since BCRs of different diameters are being subjected to varied loads in different directions.

Looking at the scope, this study aims to determine the effects of braid angle along with the increasing number of layers on the braided composite structure. Attainment for the high strength requirement of BCRs was achieved with special high-tenacity multifilament polyester yarn of high denier. Braided ropes were prepared from these yarns with the braid over braid method which was further treated with the matrix material to form BCRs. These rods were exclusively evaluated based on their tensile, bending, and flexural properties. Prepared BCRs can be utilized as a reinforcement material in concrete members to avail improved lifespan by using corrosion-resistant and high specific strength instead of conventional steel rebars. This may give a new dimension to solid biaxial braided rods.

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2. Materials and Methods

2.1 Materials

High-tenacity multifilament polyester yarn of 6000 denier was purchased from Reliance Industries Ltd., Vapi, India having a tenacity of 33.36 g/Tex for the preparation of braids. Epoxy resin and hardener were purchased from Composite Tomorrow, Vadodara, India, and were used without any modification.

2.1.1 Preparation of Biaxial Braided Composite Rods

Circular braided ropes were prepared on a Bharat and Brothers (B&B) braiding machine comprised of 16 carriers that work on a maypole principle. Six samples were prepared by employing two braid angles and three layers using the braid over braid method. Braid angles for the base braid or first braid layer were set by varying the take-up speed of the machine. An increase in the take-up speed will lead to a lower braid angle and vice versa. Further, for the preparation of the second and third layers over the first layer of braided rope, the take-up speed of the machine was kept constant. This was done to keep the braid angle constant within all layers of the braided rope. BCRs were prepared by impregnating the solutions of resin and hardener into the braided ropes by keeping the ratio of CTE556 (Epoxy resin): CTAH951 (hardener) at 10:1. Table 1 shows the sample abbreviations and the parameters for each sample.

Table 1 : Sample Description

Braid Angle on Machine	Sample Code					
A - 33°	First Layer		Second Layer		Third Layer	
	BCR A1		BCR A2		BCR A3	
	Diameter (mm)	Angle achieved	Diameter (mm)	Angle achieved	Diameter (mm)	Angle achieved
	5.5	33°	7.0	43°	8.5	53°
B - 38°	First Layer		Second Layer		Third Layer	
	BCR B1		BCR B2		BCR B3	
	Diameter (mm)	Angle achieved	Diameter (mm)	Angle achieved	Diameter (mm)	Angle achieved
	6.0	38°	7.0	41°	8.5	47°

2.2.2 Test Standards

- Tensile test was performed on a universal testing machine (UTM) STS 481 using ASTM standard D 638 with an extension rate of 5 mm/min.
- Test for flexural strength was carried out on a UTM STS 481 in accordance with ASTM standard D 790.
- Compressive strength was characterized on Instron compressive test machine using ASTM standard D 695.

3. Results and Discussion

Braided composite rods were characterized for their mechanical properties such as tensile, bending, and flexural rigidity using ASTM standards at Ahmedabad Textile Industry's Research Association (ATIRA). All BCRs were studied for the effect of the number of layers and braid angle on their mechanical properties. Fig.1 shows the technique for the measurement of the braid angle from the braid axis [21] and the results of the tests have been reported in Table 2. As shown in Table 1, it should be noted that although no variations were kept for the setting of the braid angle while producing the second and third layers, but higher braid angles were obtained for each layer due to the larger base obtained thanks to braid-over-braid manufacturing technique.

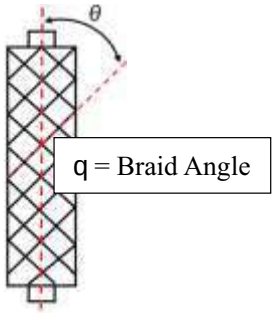

Figure 1 - Braid angle measurement

3.1 Tensile Strength

Tensile strength of each BCR obtained from the tensile test has been reported in Table 2. It can be observed that the tensile strength of BCR A1 is slightly higher than BCR B1. This shall be due to higher braid angle of BCR B1. Studies state that high strength in the yarn is obtained when fibres/filaments are aligned in direction of loading [22]. However, in the case of a high braid angle, the filaments are away from the yarn axis which may have led to lesser strength.

Table 2 : Mechanical properties of braided composite rods

Braid Angle	Samples	Tensile Test		Flexural Test		Bending Test	
		Tensile Strength (Newton)	Tensile Stress (Mpa)	Flexural Strength (Newton)	Flexural Stress (Mpa)	Compressive Strength (Newton)	Compressive Stress (Mpa)
33°	BCR A1	4750	187.23	71.90	93.81	730	35.48
	BCR A2	7710	214.58	154.87	140.64	1360	32.66
	BCR A3	8530	146.33	206.53	124.71	3430	59.03
38°	BCR B1	4540	183.09	117.19	175.60	1400	47.28
	BCR B2	9170	238.95	219.45	188.94	1940	58.35
	BCR B3	14100	268.74	283.31	159.55	2860	52.77

Fig.2 shows the effect of layers on tensile strength for both braid angles. It can be seen that the tensile strength of BCRs increases with an increase in the number of layers. It is also observed that the percentage increase in tensile strength of BCR B-type rods is much higher than BCR A-type rods. This is attributed to a change in braid angle, as seen in Table 1 braid angle of BCR B3 is 47° whereas the braid angle of BCR A3 is 53°, this leads to lesser strength.

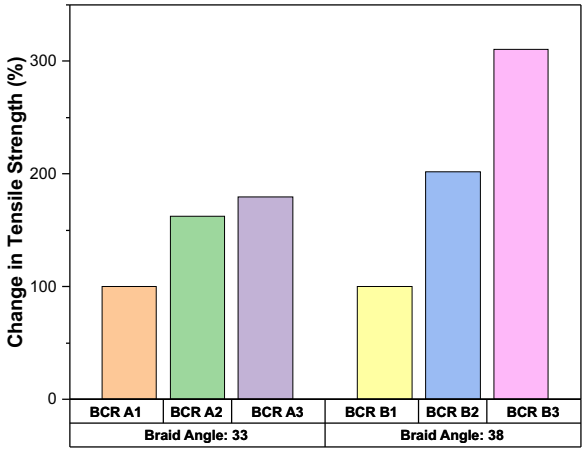

Figure 2 - Effect of layers on tensile strength

The values of tensile stress were also obtained as shown in Table 2 , which shows that the tensile stress increases as the number of layers increases. However, BCR A3 shows a slight decrease in tensile stress compared to BCR A2. This can be due to a limited increase in tensile strength with respect to its diameter.

3.2 Flexural Strength

Flexural strength is the load applied in the perpendicular direction of the rod axis to measure static three-point flexural performance. Test results of flexural strength have been enumerated in . It can be observed that BCR B1 shows higher flexural strength than BCR A1. This may be due to the higher braid angle of BCR B1 [23]. Fig.3 shows the percentage change in flexural strength while increasing the number of layers, as the number of layers increases the flexural strength of BCRs also increases. It can also be noted that the percentage increase in flexural strength of the BCR A type rod is quite higher than the BCR B type rod. This can be due to the higher outer braid angle obtained for BCR A-type rods [23]. Flexural stress also increases as the number of layers increases, however, decrement was observed for the third layer for both the base braid angle. This is due to a limited increase in flexural strength with respect to its diameter.

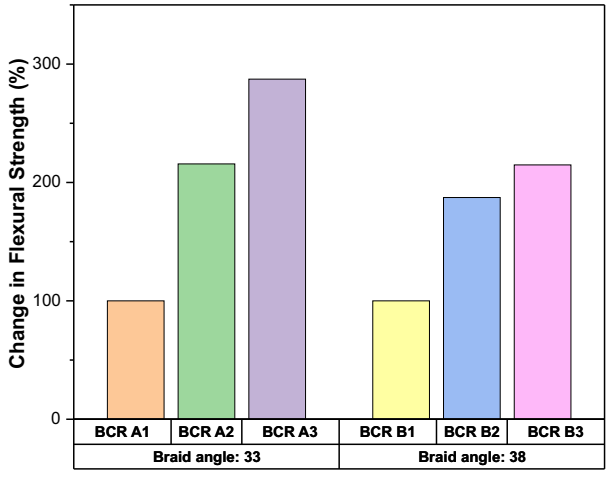

Figure 3 - Effect of layers on flexural strength

3.3 Compressive Strength

Compression strength is the ability of the material to withstand external forces that push on it. It is one of the most important parameters for the column structure as it is subjected to compressive load. Generally, the rope-like structure can support a large amount of tension but has virtually no compression strength. However, the compression strength measured for the BCRs shows good feasibility for the textile-based material to support the compression strength. The results of the compression test are reported in Table 2. The results show that the BCRs of a higher braid angle offer better compressive strength than a lower braid angle. This can be due to the specific structure of braiding that supports the compression load. Fig.4 shows the effect of layers on compression strength which shows the increase in resistance to compression as the number of layers increases. The maximum compressive strength was achieved with the sample BCR A3, which can be attributed to the maximum braid angle. No specific trend was observed for the compressive stress. The maximum compressive stress was also obtained with BCR A3.

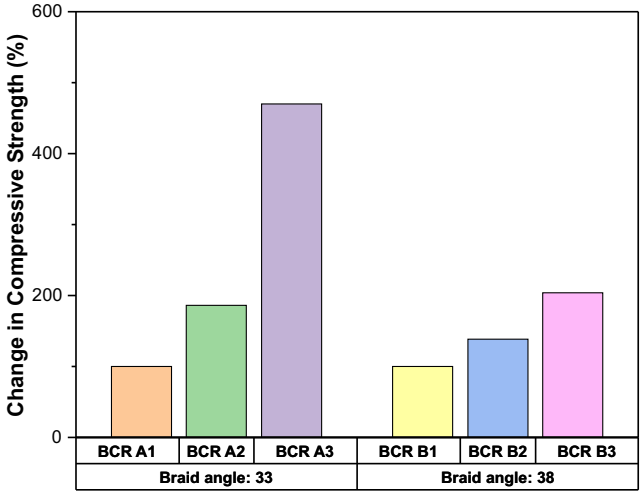

Figure 4 - Effect of layers on compressive strength

4. Conclusion

Braided composite rods (BCRs) were prepared by impregnating resin solution into the braided ropes with a specific ratio of resin to hardener of 10:1. Different braid angles and layers were involved to analyse the effect of layers along with the braid angle. Tensile strength, flexural strength, and compressive strength increase as the number of layers increases. BCRs of lower braid angle perform well in the tensile test. The flexural strength and compressive strength can be enhanced with the higher braid angle. Tensile stress and flexural stress also increase as the number of layers increases. However, as there was no marginal increase in the strength as compared to its diameter, tensile stress and

flexural stress were decreased for the third layer. Compressive stress has not given a specific trend as the layers increase. The analysis also shows that controlling braid angle is easier in single layer than multi-layer braided ropes.

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Journal of the TEXTILE Association

TECHNICAL TEXTILE

Flax-Carbon and Flax-Glass Hybrid Composites for Automotive and Aerospace Industries

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Abstract

The manufacture of cost-effective and environmentally friendly composites may be accomplished by using natural fibres as reinforcement, which is an intriguing alternative. When compared to glass fibre -reinforced composites, natural fibres composites have higher specific strength and stiffness because of their lower specific weight. Additionally, natural fibres offer safer handling and working conditions. They can significantly lower costs and are non-abrasive to mixing with carbon, glass, or Kevlar as per required .properties.

The study's first section provides information on natural fibres and natural fibre composites, then moves on to the tools and techniques employed. Our study led to the development of the most efficient hybrid composite for the development of automotive and aerospace industries using flax, carbon, and glass fibres. In our study, hand layup technique was used to create a hybrid composite. These panels were tested on an Instron tensile mechanical tester to determine the best combination of mechanical and thermal properties.

Recent work, developments, and applications are discussed in the final section of this article. This section of the essay will provide you with a quick overview of how the European automobile industry is using and developing flax fibre composites from a sustainable standpoint.

Keywords: *Carbon composites, Flax fibre, Flax fibre composites, Glass composites. Hybrid composites, Mechanical testing*

Citation: Shubham Patil , "Flax-Carbon and Flax-Glass Hybrid Composites for Automotive and Aerospace Industries", *Journal of the Textile Association,* **83**/6 (388-395), (March-April, 2023), https://doi.org/10.56716/4/1485

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1. Introduction

The matrix's role is to keep the fibres together, carry the shear stresses, and serve as a coating in a fibre-reinforced polymer, where the fibres function as reinforcement and must therefore demonstrate high tensile strength and stiffness. In comparison to synthetic fibres, natural fibres have a competitive edge and may eventually displace them in a number of industrial applications. Growing environmental worries about widespread pollution caused by non-degradable materials, especially long-lasting plastics, encouraged a trend toward the replacement of natural fibre composites with synthetic fibre composites. Natural fibres as an alternative to synthetic fibres in composites have been the subject of numerous reviews and research articles. Many industries such as the construction, automotive, and aerospace industries, have used natural fibre-reinforced polymers.

Composites made of fiber-reinforced polymers are used in the construction, automotive, and aerospace industries (FRP). The use of fiber-reinforced composite materials instead of metal materials has been strongly determined by their lower weight-to-strength ratio. The usage of plastics in automobiles has taken on an entirely new level with the development of composite materials, which combine a polymer matrix with fibre reinforcements.

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Polymer as well as fiber reinforced composites have a superior stiffness-to-weight ratio than metals since they are cheaper to produce, lighter, and have equivalent impact resistance to their metal or steel counterparts. These composites can be uniquely constructed to satisfy the requirements of the application because they are made up of fibre and polymer matrix. Another advantage of composites is that weak points in the structure can be reinforced with unidirectional reinforcements. These various components, when combined, provide the eventual composite material with improved qualities that exceed those of the individual constituents. To produce composites for a wide range of engineering applications, natural fibres are a very common choice of reinforcing. Due to their sustainability and unique properties, these fibres are gradually taking the role of synthetic fibres in several applications but not in full scale. Selection of natural fibers is facing some problems due to their compatibility for some particular applications [19]. High-performance composites are those that are built with synthetic fibres like carbon or glass. Numerous researches discussed the difficulties with recycling synthetic fibre composites and the environmental risks these fibres posed. On the other hand, researchers suggested that natural fibres, particularly plant fibres, could take the place of synthetic fibres in some situations.

1.1 Motivation of natural fibre in composites

From a materials science perspective, greener, more environmentally friendly materials are becoming more popular. When it comes to composites, use of natural fibers is

one option is to employ instead of the more conventional glass and carbon fibres. Such natural fibre composite (NFC) potential environmental benefits could be linked to life cycle analysis as follow

- Lower pollution levels during production.
- The energy required for fibre production is less than that required for glass and carbon production; this may reduce the cost of the product.
- CO2 neutral: the amount of CO2 neutralized during fibre plant growth equals the amount emitted during processing [1].
- There is no denying the benefits of natural fibres because
- Natural fibres are biodegradable, but this can be a disadvantage over the course of a product's lifetime; they are also renewable resources.
- It can be possible to create completely biodegradable composite materials by using biodegradable polymers as the matrix. Because they are less dense, healthier to use due to their natural origins, and less damaging to processing equipment than synthetic fibres [1].

Natural fibres' main advantage is their low density, which results in lower transportation costs and fuel usage. The fibres' stiffness and strength serve as the foundation for reinforcement, but interfacial strength (adhesion) is also essential for effective reinforcement.

1.2 Classification of natural fibre

Where the average daily temperature is below 30°C, flax plants are frequently grown throughout Western Europe. However, Argentina, Canada, India, China, and Southern Europe are also countries that grow flax.

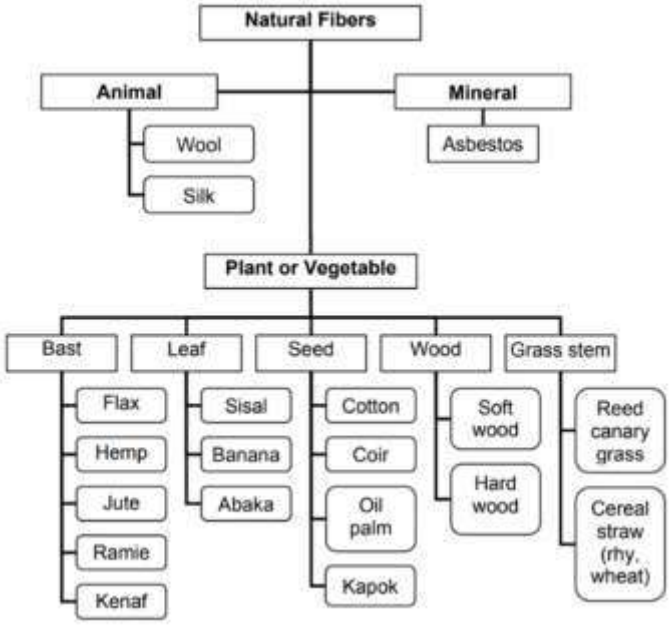

Figure 1 - Classification of natural fibres

Natural fibres can be categorized as either plant, mineral, or animal fibres, depending on their source. Cellulosic fibres are a common word for plant or vegetable fibres. These fibres can be classified into wood and non-wood natural fibres for further subdivision. Natural fibres other than wood can be broken down into bast, leaf, seed, straw, and grass fibres. Plant fibres are the types of natural fibres that are most frequently utilised as reinforcement in composite materials.

Table 1 – Advantages & Disadvantages of natural fibre

Advantages	Disadvantages
Low specific weight = high specific strength	Variation in fibre quality
Renewable source	Moisture sensitive
Less production cost and energy	Low heat & fire resistance
Good acoustic, insulation, and vibration prop	

1.3 Natural fibre composites

Regarding composite reinforcement, flax fibre is regarded as the most significant member of the bast family due to its distinct characteristics. Flax fibre has essential properties that make it particularly attractive in composite research including its naturally high strength, stiffness, and low elongation to failure [2].

Cellulose Materials	Application Industries	Example: Application Areas
Hemp, Oil palm, Wood, Flax, Rice husk, Bagasse, Sisal, Stalk, Coconut, Bamboo	Construction/Civil	Window/Door frame, Roofing, Panels, Pipelines, Bricks
Flax, Coir, Hemp, Jute, Sisal, Kenaf	Automobile	Car roof, Door handles, Dashboard, Door panels
Kenaf, Flax, Sisal	Aerospace	Interior cabin, Secondary structure, blades
Hemp, Cellulose	Electronics	Sensors, Energy storage units, Coatings, Circuit components
Lignin nanoparticles, Hydroxyapatite (HA)/collagen alginate, Xyloglucan,	Biomedical	Tissue engineering, Drug delivery, Gene therapy
Flax	Sports	Tennis racket, Bicycle frame
Hemp, Kenaf, Cotton, Coir, Ramie, Coconut, Bamboo	Household	Textile, Home furnishing

Figure 2 - Application of natural fiber composites

High toughness, improved moisture resistance, quick processing, limitless shelf life and higher recyclability are all characteristics of thermoplastics. As a result, research efforts have concentrated on a variety of high-temperature polymers including poly (ether imide), poly (phenylenesulphone), poly (ether sulphone), and poly (ether ketone) (PEEK). Due to their high cost and processing requirements, applications for these high-performance materials are typically restricted to specialised industries like aerospace [5]. Nowadays PP is

Material	Density (g/cm²)	Tensile strength (M Pa)	Young modulus (G Pa)	Failure strain (%)
Flax	1.45	500-900	50-70	1.5-4.0
Hemp	1.48	350-800	30-60	1.6-4.0
Jute	1.3	300-700	20-50	1.2-3.0
Bamboo	1.4	500-700	30-50	2
Coir	1.2	150-180	4-6	20-40
Sisal	1.5	300-500	10-30	2-5

Figure 3 - Properties of natural fiber composites

readily accessible in a variety of grades and is easily processed and recycled. The gap between ordinary PP and engineering thermoplastics has been successfully closed by recent studies focusing on increasing stiffness, strength, and thermal stability. Plastic parts for automobiles, spacecraft and motorsports employ polypropylene. The mechanical qualities of thermoplastic-based composites are limited and while they are less expensive and recyclable, they require more expensive tooling [2]. NFCs are typically manufactured by extrusion, compression moulding, injection moulding, resin transfer moulding (RTM), and autoclave. The variables that affect characteristics are temperature, pressure, and process speed [20].

Thermosetting matrices have various benefits including being inexpensive, simple to prepare and requiring lower processing temperatures. Additionally, because fibre impregnation is simpler, the production process needs less pressure and allows for a higher fibre loading. Epoxy is unquestionably the resin that is utilised the most in the manufacturing of flax fibre composites. Numerous advantages are offered by the epoxy-based resins used in the production process. Epoxy exhibits excellent mechanical and chemical properties. Additionally, it is quite durable and has outstanding heat and water resistance qualities. When compared to vinyl esters and polyesters the shrinkage that is linked with epoxy resins is incredibly minimal. Furthermore, it has great adhesive qualities and is simple to use and cure. Unlike phenolic, polyester and vinyl ester resin the curing process produces have no volatile substances which are a significant advantage [3, 4].

2. Flax Composites in Recent Automotive application

The metal and plastic injection-moulded components of the production sports car are replaced by flax composites. The natural-fibre composite materials used in non-structural components are equivalent to carbon-fibre composites (CFRP) in terms of weight and stiffness and adhere to the same strict safety and quality criteria.

2.1. Automotive Headliner – Flower Project 2022

A Life Cycle Analysis (LCA) using the "Cradle-to-Gate" methodology was conducted during the product development to assess the environmental impact of switching from glass to flax fibres. The outcomes revealed a reduction in the influence on all examined environmental markers. This research demonstrates the interest in using flax [6]

Figure 4 - Automotive headliner using Flax Nonwoven

A Life Cycle Analysis (LCA) using the "Cradle-to-Gate" methodology was conducted during the product development to assess the environmental impact of switching from glass to flax fibres. The outcomes revealed a reduction in the influence on all examined environmental markers. This research demonstrates the interest in using flax [6].

2.2. McLaren F1 Seat

It has proven feasible to create a seat with the necessary strength and rigidity by using fabric architecture to optimise the mechanical properties of flax fibres. This seat has a 75% lower carbon footprint than its carbon fibre predecessor.

Figure 5 - McLaren F1 car seat frame – Flax prepreg

2.3. Lightweight Hybrid car door

It was constructed utilising a cutting-edge hybrid carbon/flax micro-sandwich that combines the mechanical advantages of carbon with the additional benefits of flax's lower weight, cost and NVH.

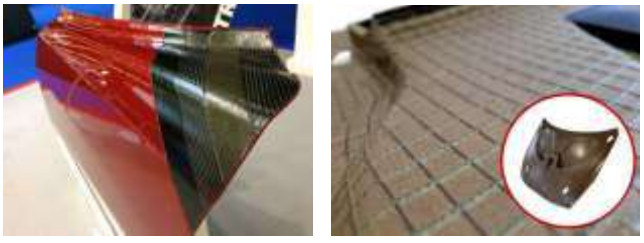

Figure 6 - Flax prepreg Door and Bonet

2.4. BMW

The new M4 GT4 from BMW has more flax fibre components than any other GT racing vehicle currently being produced in the series.

In place of the traditional covering material, the ampliTexTM – (Bcomp Flax reinforcement) reinforcements add a visible layer of flax fibres to achieve carbon neutrality. Combining the two materials enables interior paneling plastic usage to be reduced by up to 70% while also reducing CO2 emissions by as much as 60%. The end product is more environmentally friendly automotive parts whose failure mode also improves safety compared to conventional composites. The natural fibre composites are also well suited for use with traditional motorsport accessories like those from the line of BMW M Performance Parts.

Figure 7 - Use of flax prepregs in BMW race car

2.5. Porsche

For the Nürburgring 24-Hour Race, Porsche adopts a sustainable alternative to carbon fibres. The compact series racing vehicle's two doors and rear wing have been made by Porsche out of a natural-fibre blend, mostly made from renewable raw materials since the beginning of 2019. This regenerative material is now used for the first time in the front and rear aprons, front spoilers, front and rear lids, mudguards, diffusers, and aerodynamic fins.

Figure 8 - Porsche car Front and rear body- Flax composite

3. Methods

3.1Material & Manufacturing

These hybrid composite panels are constructed using the hand layup method. Epoxy resins are utilised in the ratio of 70:30 resin to hardener to manufacture composites.

EL2 Epoxy resin and AT30 Harder is used to build the composite panels for this .study. EL2 is a high-performance epoxy laminating resin appropriate for hand-laying up reinforcements such carbon fibre, aramid, and glass fibre. EL2 is a very popular choice in motorsport, boat construction, model making, and general composites because to its mechanical performance, quick wet-out, easy handling, and excellent price [15]. Carbon, Glass and flax reinforcements are used from easy composites [16].

The panels are 1.5 mm thick. Four different types of layups are used as follows;
C = Carbon, F = Flax, G = Glass
I. 60%C + 40%F = CFCFC
II. 60%F + 40%C = FCFCF
III. 60%G + 40%F = GFGFG
IV. 60%F + 40%G = FGFGF

Figure 9 – Material used to build composites

Hand layup is the easiest way to create a composite component using dry fabric and prepregs is through hand lay-up. Composite panes are manufactured by using hand layup .method. Processing parameters are as follows Pressure 90 psi and consolidation time 24 hr.

3.2 Composite Testing

3.2.1 Tensile strength Test

This aspect decides what a material's maximum strength is. The uniaxial tensile test is the most typical test. Measurements of tensile strength can also be used to estimate a material's stiffness and maximum load capacity [21, 22].

Figure 10 - Instron Tensile Strength Instrument

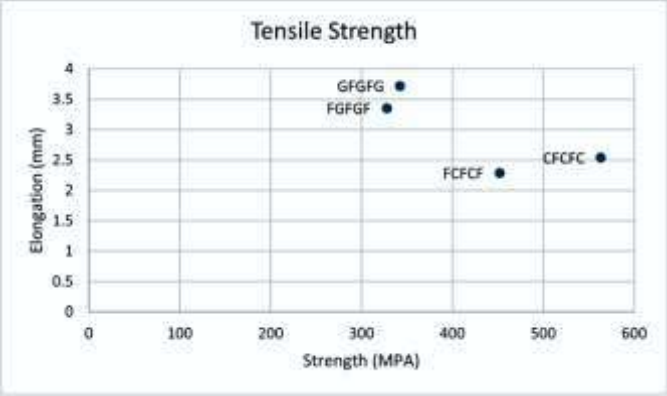

Figure 11 - Tensile Strength result

The CFCFC and FCFCF have the best ability to manage loads in this situation, according to the graph shown above, Carbon-based composites are likely the most effective materials for applying toughness because the above result shows that glass-based composites perform better in terms of elongation results than strength. Flax is naturally dense and when the resin is applied it absorbs more resin which, when combined with the strength of carbon fibre makes it even stronger. Both flax and carbon will be more brittle in physical state after resin apply. As a result, these composites won't elongate under load before breaking. Although glass is elastic combining it with flax will increase flax fibre elongation and produce flexible composites that are superior in some applications.

3.2.2 Point bending

The method used to assess a material's ductility. It is a qualitative test. In this process, a coupon is bent at a specific three-point angle, the bend's exterior is plastically damaged, and the coupon prematurely fails to reveal the specimen of the material. Bend tests are another method for assessing a material's resistance to fracture and fracture strength [21]

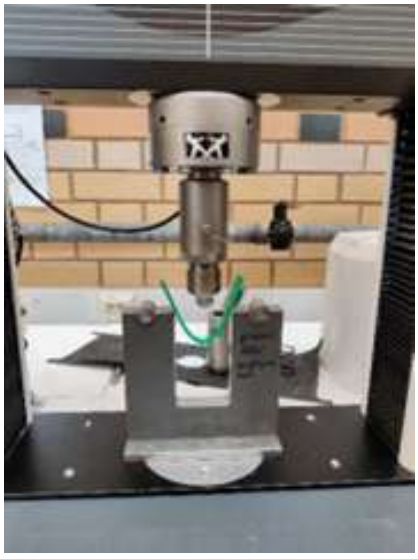

Figure 12 – 3-point bending test instrument

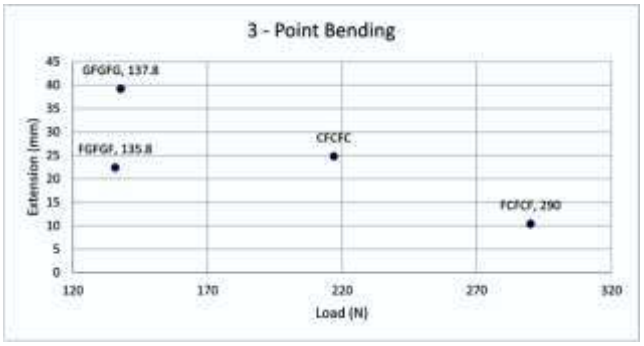

Figure 13 - Point bending test result

According to the above graph all materials have an average extension while applying load except a high percentage of flax fibre composite. Flax fibres are more resin absorbent, so it results in more brittleness. Glass-Flax panels are outperforming carbon-based composites in terms of elongation. While bending, GFGFG displays the best elasticity followed by CFCFC and FGFGF.

A material with a high elastic property will retain its original shape after releasing force whereas a material with a low elastic property will break instead of returning to its original shape after applying force. The material may break if it is rigid and lacks elasticity. Flax fibre is stiff and has little elasticity. It can hybridise flax fibres with glass or carbon to achieve the required elasticity but for properties such as elasticity, glass fibre is always the best option. The material's low extension, however, suggests that even when subjected to heavy loads it won't experience significant surface pressures so it's better to use elastic material in load-bearing applications.

3.2.3 TGA - Thermogravimetric analysis

It establishes the volatile constituents of the specimen as well as a material's thermal stability. The specimens' thermal stability, oxidation, combustion, or TGA kinetics can all be ascertained using the test findings. The temperature was initially set at 30 degrees Celsius, rising by 10 degrees per minute to a maximum of 500 degrees. A minimum 1 mg sample is collected, and a furnace is heated to 500 degrees Celsius with a steady or controlled gas flow. It keeps track of both the rise in temperature and the change in weight [21].

Figure 14 - TGA Testing and Analysis instrument

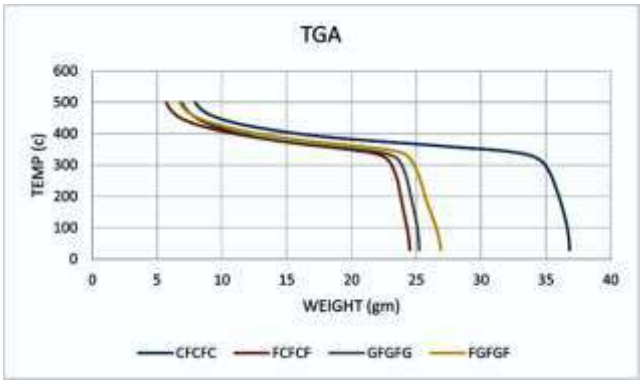

Figure 15 - TGA Result

This test runs at the following settings:
- Heat from 30.00°C to 500.00°C at 10.00°C/min.
- Gas to Nitrogen at 20.0 ml/min

As shown in the graph above, Composites begin to lose weight once the temperature reaches 300°C. All materials have a reduced weight and are very close to one another when the temperature is between 0 and 300 degrees.
Glass and carbon can withstand temperatures of 300 degrees Celsius, but flax is a natural fibre and has the ability to do so. At temperatures up to 400 degrees FCFCF, GFGFG and FGFGF all exhibit the same weight-based degrease, but at 500 degrees a composite made with 60% flax degrades more quickly than the others. Glass-Flax hybrid panels are producing average results, while Carbon-Flax panels perform better than the others. CFCFC is the best composite for applications requiring high heat resistance in the automotive and aerospace industries due to its high-temperature resistance. From the result, it is clear that natural fibre reinforcement needs blending with carbon or glass-like high-performance fibres to match heat resistance.

3.2.4 SEM (Scanning Electron Microscopy)

With this technique, an electron beam examines the sample and produces a magnified image for analysis. The method is frequently employed for compound microanalyses as well as failure analyses of solid organic and inorganic materials. This method creates a two-dimensional image that contains details on the sample's exterior morphology, EDS characteristics, chemical compositions, and several other details.

Figure 16 - SEM Testing machine

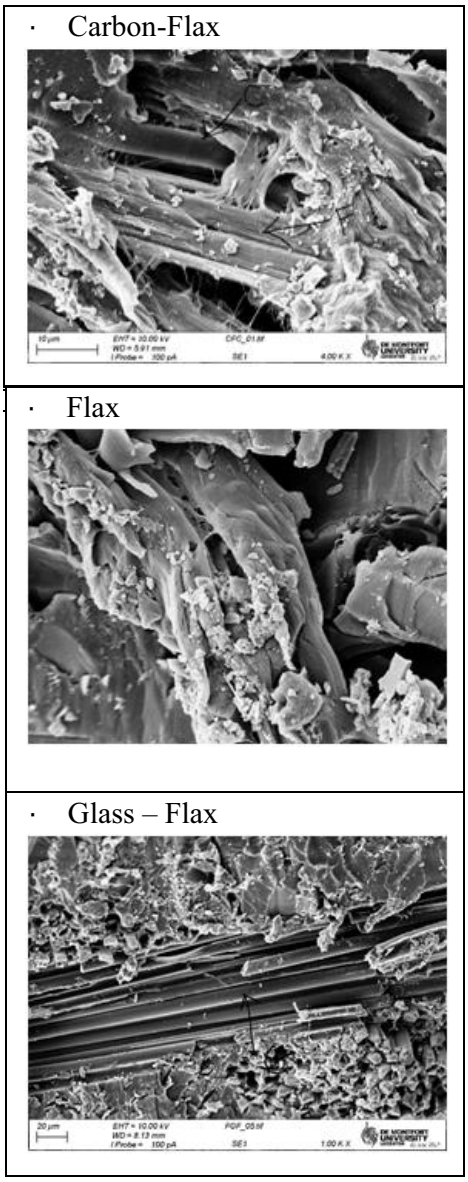

Figure 17 - SEM results

This test is carried out under the following settings –
- Sample mounted on 12.5mm aluminum pin stub with double-sided carbon tab
- Samples are sputter coated with 15nm gold
- Lenses used – Evo Ls 15 Carl Zeiss

The SEM results mentioned above make it abundantly clear that flax fibre absorbs more resin than glass and carbon fibre. In the first and third images, the resin can be seen adhering to the surface of carbon and glass fibres, but the second image demonstrates how flax fibres are absorbing resin which leads to fibre fracture. Glass fibre demonstrates the poor interaction between the fibres and the epoxy. The uniformity of resin spread results from flax fabric absorbing more epoxy than carbon and glass does inside the structure which prevents the formation of a uniform layer. Glass and carbon show uniform adhesion between fibre and resin which results in a good and uniform surface.

	· Carbon twill outer ply with flax fibre backing plies. · Visual flax twill outer ply with flax fibre backing plies. · Body colour painted flax fibre components.

Figure 18 - Advanced Flax prepreg [8]

4.2.2 Composite Evolution/Bcomp

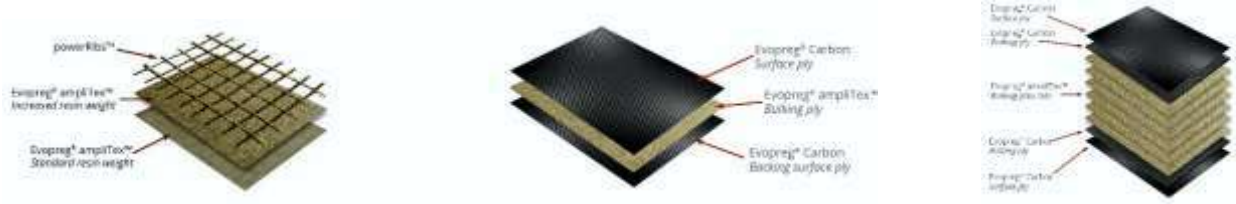

Figure 19 - Flax-Carbon hybrid prepreg [9]

4.2.3 Econ Core

Figure 20 - Flax prepreg + PET core for Electric formula car

5. Sustainability and Health point of view

Pyrolysis and solvolysis procedures are mostly utilised to extract the fibre and resin from composite waste when recycling composites are in mind. Because flax fibres are biodegraded there is no landfill waste when the product is finished. Glass and carbon demand enormous amounts of energy which is expensive for production while flax does not require any high-temperature production [14].

A Life Cycle Analysis can be used to look at a product's environmental impact, method of assessment (LCA). Natural-fibre composites can be manufactured more economically and with less energy. The LCA technique is concerned with a product's whole life cycle from the procurement of raw materials through its eventual disposal. Particularly if the component is used in a transport application, flax fibre-reinforced material might help reduce the part's environmental effect. When a glass fibre-reinforced part is replaced with a flax fibre-reinforced part the fuel consumption of a vehicle may be reduced due to the decreased weight, provided that the replacement part is stiffness-designed. In the end-of-life phase using flax instead of glass fibres may be advantageous [13].

6. Result and Discussion

It is evident from the results above that only flax fibres lack the necessary characteristics to withstand high loads or temperatures required in the automotive or aerospace industry. It is cleared from SEM results that, when flax and epoxy mix, it becomes brittle. However, this brittleness can be rendered flexible by the glass's excellent elastic qualities While carbon and glass have good adhesion with the resin and form a homogenous layer of the resin are on the surface of the fibres., Flax fibres have a porous surface and absorb a significant amount of resin, which causes the fibre to fracture which won't give desired properties, it is because of luminal holes and other hollow structures in fibres and yarns, as well as low fibre wettability, low plant fibre compatibility, and the presence of air during processing. [17]. Flax and glass work better together in terms of flexural strength and bending strength, whereas flax and carbon perform better together in terms of thermal stability and tensile strength. Dry flax fibres are not compactable with composite manufacturing because SEM photos showed that the flax fibre becomes damaged after resin application. Flax prepreg would be the best solution since the amount of resin can be controlled. This study uses epoxy resin which is extensively used in the composites sector to produce but flax and thermoplastics combination which are more environmentally friendly.

7. Conclusion

This study mentioned above demonstrates the flax hybrid composites with carbon and glass test reports. It shows the benefits of using natural fibre in the automotive sector. Natural fibres are preferable from a sustainability standpoint since they are made from natural resources use less energy to produce and produce fewer emissions. Flax fibres need be blended with glass or carbon fibre to acquire the proper properties for the finished product because they don't have enough of those attributes on their own.

The flax prepregs and flax material have undergone significant progress to achieve higher and better attributes. Large automotive manufacturers are now adopting flax composites, which are very well covered in the aforementioned study, in the current market. At the moment front and rear bonnets, interior components, sports vehicle components, and aerospace components are made of flax composites.

In terms of tensile strength and thermal resistance CFCFC and FCFCF are performing better whereas GFGFG is performing better in the bending test. The hybrid composite combinations examined in this study would be applied based on the attributes that the final product would need. Hybrid composites combinations can be created depending on whether a component is crucial or not. In the automobile sector, each component has specific desirable qualities that must be met; thus, it is best to find the right combination. From this, it can be concluded that the Carbon flax combination is better for the parts which require strength, and the glass flax combination is better for the parts which need flexibility application.

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Journal of the TEXTILE Association

FABRIC

Preserving Heritage Textiles - Developing Novel Preservative Fabric for Long-Term Conservation

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Abstract

Textiles are very delicate and hard to preserve, especially in tropical countries like India, due to the ease with which they can be damaged and the rate of deterioration. Natural fabrics such as cotton, linen, jute, leather, silk, wool, and others, being made up of cellulose and proteins are attractive to microbes, resulting in biological deterioration. Some natural compounds, such as essential oils, can act as biocides, like Azadirachta Indica (commonly known as neem) which has a broad-spectrum antimicrobial action. This study aims to create fabric that will preserve historical textiles when used as a wrapping material in museum storages, lining, backing, and covering material for shelving, drawers, and boxes, and as padding for hangers and rollers used for exhibits. For that purpose, neem essential oil nanoparticles of an average size of 189 nm with 78% entrapment efficiency (EE) and 8.83% loading capacity (LC) were formulated using nano-emulsion and ionic gelation technique and applied to cotton and polyester fabric to give them antibacterial properties. SEM analysis was also performed to understand the surface structure of the nanoparticles. Additionally, stability of the nanoparticle coated fabric over a time period of two months in different storage conditions was also tested. The study also compares the efficiency of the finish applied on cotton and polyester fabric.

Keywords: *Deterioration, Essential oil, Heritage textiles, Nanoparticles, Preservative fabric*

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1. Introduction

Textiles are integral to the lives and customs of people from all cultures, and a museum collection typically displays objects that document the past and present of human life, cultural values, and artistic creations. Many traditional textiles are made from natural fibers, which make them vulnerable to degradation due to a range of biological, chemical and physical factors, such as light, temperature and humidity levels, dust, mishandling, and improper restoration methods [1]. This is especially true for cellulose, silk, and wool fibers, as they provide a favorable environment for microorganisms, insects, and other living organisms. These variables often result in discoloration, brittleness, corrosion of metallic components, a sweet or musty odor, and small irregular holes, which accelerate aging and result in irreversible damage [1,2]. In order to protect textiles from damage, conservators and curators utilize natural and synthetic compounds as biocides and insect repellents. In India, a traditional practice for preserving textiles involves using herbs and spices like clove, cinnamon, carom seeds, camphor, neem leaves, tobacco, tulsi, and eucalyptus [3,4,5]. Although these substances have biocidal and insect repellent properties due to the presence of active compounds, they do not create an extensive protective environment over a large circumference area. Additionally, these compounds are sensitive to light and cannot be applied directly to fabrics or surfaces. Nano encapsulation of essential oils is a potential solution to this issue, as it allows for controlled release of the active compounds and protects them from oxidation and UV degradation [6]. In encapsulation, chitosan, a polysaccharide derived from chitin has been used widely as a wall material.A cross-linking agent is usually employed as a connection between the ionic polymer and the ion with an opposite charge to create nanoparticles.

This research is conducted with the goal of forming chitosan nanoparticles with neem essential oil, utilizing tripolyphosphate (TPP) for cross-linking. This finish is then coated on a separate fabric for the purpose of wrapping, or using as a lining, padding, or to cover the heritage textiles. This comprehensive approach of having antimicrobial agents leach out of the fabric is necessary for slowing down the degradation process and preserving the distinctive characteristics of heritage textiles and making sure they remain intact for future generations.

2. Materials and Methods

2.1 Materials

Neem oil was purchased from Sigma Aldrich Co. Chitosan well known for its use in encapsulating essential oils and its antimicrobial and mucoadhesive properties, was chosen as the wall material/shell due to its great matrix capabilities. A medium molecular weight chitosan of 84.8% degree of deacetylation purchased from HIMEDIA was selected for the study. Tripolyphosphate (TPP), Tween 80, Glacial acetic

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acid and solvents such as Dichloromethane, Methanol were also purchased from Sigma Aldrich Co.

2.2 Preparation of neem essential oil chitosan nanoparticles

A two-step process of Nano-emulsion and Ionic gelation was used to make nanoparticles with an essential oil core and a chitosan polymeric shell. Figure 1 outlines the procedure. Dissolving chitosan in 1% acetic acid (v/v) and stirring the solution on a magnetic stirrer for eight hours at 25℃ ensured complete dissolution. Afterward, Tween 80 surfactant with different concentrations (0.5, 0.75, 1, and 2%) was added to the chitosan solution and was left to stir for one hour. Different chitosan/essential oil ratios (1:1, 1:2, and 1:3) were then prepared in 10 ml of dichloromethane by adding the oil and solvent solution to the chitosan surfactant solution drop by drop using a syringe. This mixture was stirred on a high shear homogenizer at 13000RPM for 10 minutes and then agitated on a magnetic stirrer at 1800 RPM for two hours until the solvent evaporated completely. Subsequently, different concentrations (1, 2, and 3 %) of tripolyphosphate (TPP) were added to the solution drop wise using a syringe and stirred for one hour.

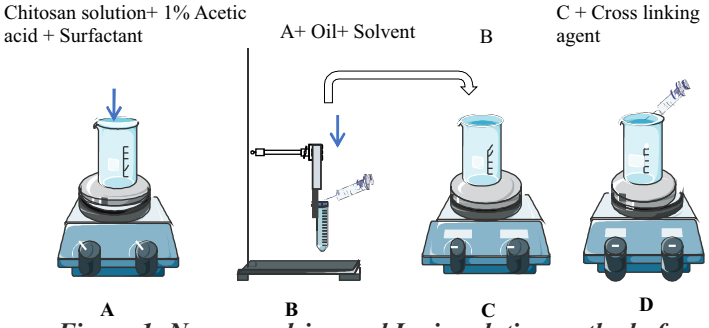

Figure 1: Nano-emulsion and Ionic gelation method of preparation of nanoparticles

2.3 Characterization of nanoparticles:

For determiningthe entrapment efficiency and loading capacity, in 100 µL of freshly prepared essential oil loaded chitosan nanoparticles, 900 µL of the solvent suitable for the essential oil was added to make up 1 ml. This solution was then centrifuged at 18000 rpm for 30 min. The supernatant was separated to estimate drug loading efficiency. Further, the free amount of oil was calculated by measuring the absorbance of all the essential oils at its significant wavelength (nm) using UV–vis spectrophotometer. This was then compared with their standard curve. The drug encapsulation efficiency and drug loading capacity were calculated using the formula below:

$$efficiency\,(EE) = \frac{Total\ oil - Free\ oil}{Total\ oil}\ X\ 100$$

$$Loading\ capacity\,(LC) = \frac{Total\ oil - Free\ oil}{Total\ content}\ X\ 100$$

100 µL of freshly prepared nanoparticles was centrifuged at 18000 rpm for 15 minutes. The supernatant was diluted with distilled water to a concentration of (1 mg/mL), and viewed under a Zetasizer by Malvern in order to assess the particle size through dynamic light scattering (DLS).The nanoparticles obtained at optimized conditions were lyophilised and observed under SEM to understand the surface structure. The Minimum Inhibitory Concentration (MIC) was then calculated using two-fold dilutions in a 96-well plate containing Mueller Hinton broth (MHB). A series of dilutions of the nanoparticles (125 ppm) were prepared in a 96-well plate using Mueller Hinton broth (MHB). Bacterial suspensions were created and diluted in MHB until a turbidity of 0.5 McFarland was achieved, then added to each well. The plates were then incubated at 37°C for 24 hours. The lowest concentration that prevented visible growth of the test strains were then applied to scoured cotton and polyester fabrics with a citric acid binder via spraying and padding. The antibacterial activity of the fabrics was assessed using the AATCC 147 Parallel streak method against Bacillus cereus, Staphylococcus aureus, Pseudomonas, and Escherichia Coli. The stability of the nanoparticles was tracked over a time period of two months in different storage conditions. 2X2 cm of the nanoparticle coated cotton fabric was evaluated for 1 and 2 months. One set of samples was kept in a closed environment in a large petri dish, while the other set was exposed to an open environment at 25 ± 2°C. The amount of oil released from the nanoparticle-coated samples was determined by soaking them in a suitable solvent for 24 hours, and the absorbance was calculated using a UV spectrophotometer at278 nm and compared to that of the initial sample.

3. Results and Discussion

Neem essential oil chitosan nanoparticles were prepared using nano-emulsion followed by ionic gelation method. Chitosan was selected as a wall material to encapsulate the essential oil because of its ability of being biodegradable, cationic charge and being muco-adhesive nature proving best candidate to encapsulate. Negative charge TPP was used as a cross-linking agent to form the nanoparticles. It is important for the nanoparticle system to be successful that it has high entrapment efficiency, which allows the drug to be administered at smaller or more effective doses while reducing the amount of matrix components [6]. Therefore, the effect of change in the amount of chitosan, neem essential oil, Tween 80, and TPPwas optimized on the basis of highest entrapment efficiency of the neem essential oil observed in the nanoparticles.

3.1 Effect of Chitosan concentration on entrapment efficiency

By varying the chitosan concentration between 0.5, 1, 1.5 and 2 %, and while keeping the surfactant and TPP constant at 0.75% and 1% respectively. The percent entrapment efficiency of the neem essential oil was seen to be highest at 1% concentration with 79.24 ± 2.34 (Figure 2A). There was an increase of 7% in entrapment when compared to 0.5 % concentration, suggesting that with the increase of polymer, more oil could be encapsulated in the emulsion. However, further increase of chitosan concentration led to decreased entrapment efficiency. This could be attributed to the

increased viscosity of the solution caused by the higher concentration of polymer, which impeded the formation of the emulsion.Nguyen,G., and Le, X. (2021) noted a similar trend for Palmarosa essential oil encapsulated with chitosan; the efficiency of encapsulation increased from 22.8% to 34.0% when the concentration of chitosan ranged from 5.0 to 10.0 g/L, then decreased to 26.1% at 12.5 g/L [8].

3.2 Effect of % surfactant on the entrapment efficiency

Tween 80 was added at different concentrations (0.5, 0.75, 1, and 2%) to the chitosan solution. Tween 80 is a non-ionic surfactant that aids in the formation of uniform oil dispersion by reducing the interfacial tension between the oil and the aqueous phase. This allows for a greater degree of oil droplet formation and stabilization, resulting in improved entrapment efficiency.Sun, W., et al. in their research demonstrated that when tween 80 is added, it results in a minor increase in the effectiveness of the encapsulation [9]. This occurs because tween 80 is adsorbed onto the surface.As observed in figure 2B, the encapsulation efficiency had an initial growth from 71.55 % to 80.36% which could be because of the adsorption of Tween 80 which might have caused decrease in surface tension leading to high entrapment efficiency. However, reduction to 64.61% and 54.38% at %1 and 2% surfactant concentration was observed with further increase of Tween 80. Formation of foam was noted by the researcher with the increase in 2% of Tween 80. This might have caused a barrier around the nanoparticles, leading to less entrapment efficiency.

3.3 Effect of polymer: oil ratio on entrapment efficiency

Oil concentration is one of the factors that affect the entrapment efficiency of oil-loaded nanoparticles. Three different concentration of neem essential oil was used to encapsulate with 1% chitosan concentration. the highest entrapment efficiency was observed at 1% oil concentration (78.65 ± 1.28), according to the figure 2C. As the oil concentration increased to 2% and 3%, the entrapment efficiency drastically decreased to 69.36 ± 2.54 and 62.12 ± 2.71, respectively. This decrease in efficiency at higher oil concentrations can be attributed to the oil droplets becoming more difficult to encapsulate within the nanoparticle matrix. With higher oil concentrations, the likelihood of oil droplets coalescing or merging increases, leading to larger droplets that are more challenging to encapsulate. This ultimately reduces the overall efficiency of the encapsulation process, resulting in lower entrapment efficiency. Several studies have investigated the effect of oil concentration on the entrapment efficiency of oil-loaded nanoparticles. For example, a study by Wong et al. (2010) investigated the effect of oil concentration on the EE of poly(lactic-co-glycolic acid) (PLGA) nanoparticles loaded with curcumin. They found that the EE decreased from 75% to 50% as the oil concentration increased from 0.5% to 2.5% (w/v) [11].

3.4 Impact of % TPP on the entrapment efficiency

Three concentrations of TPP (1,2, and 3%) was added as a crosslinking agent to the chitosan neem oil solution. The entrapment efficiency of 78.65% was highest when 1% of TPP solution was added as a crosslinking agent to the chitosan neem oil solution (Figure 2D). This could have been caused by the presence of a greater amount of cross-link bonds, which enhanced the amount of oil inside the chitosan capsules. As the concentration of TPP was increased to 2 and 3%, the encapsulation efficiency decreased to 69.36% and 62.12% respectively. This could be due to the formation of a more compact and cohesive structure, leading to a reduction in the size of the pores [8].

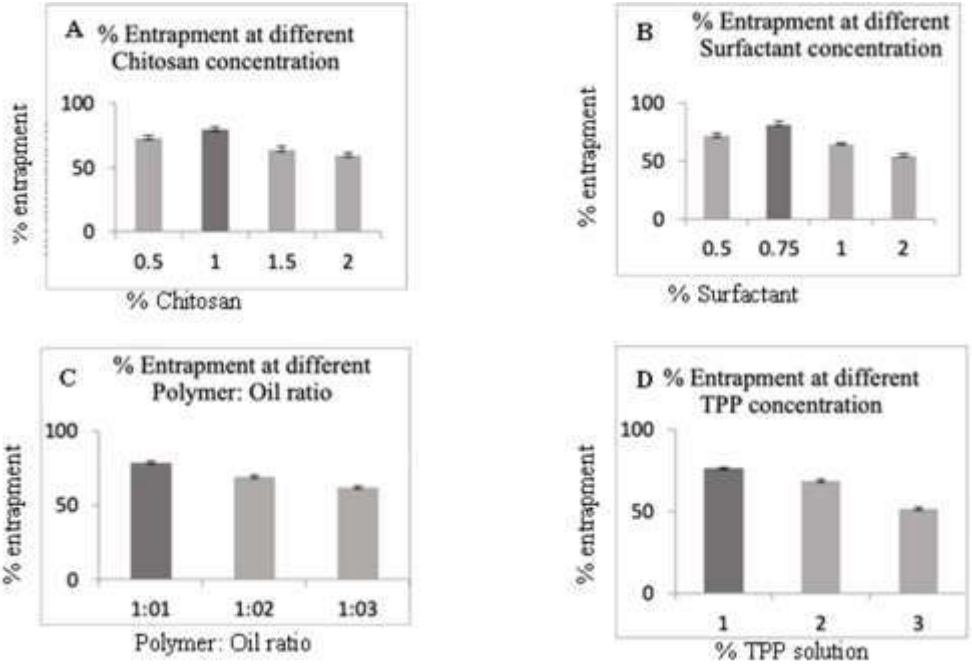

Figure 2: Impact of different parameters on entrapment efficiency of neem essential oil (Fig. 2A: %entrapment efficiency at different chitosan concentration, Fig.2B: % entrapment efficiency at different surfactant concentration, Fig. 2C: % entrapment efficiency at different oil concentration, and Fig.2D: % entrapment efficiency at different TPP concentration)

3.5 Characterization of the neem essential oil chitosan nanoparticles

The neem essential oil chitosan nanoparticles obtained at the optimized conditions when observed under scanning electron microscopeshowed spherical structures, absence of cracks and formation of a continuous wall layer (Figure 3). The average size of the nanoparticles was observed as 189 ± 26 nm.The average polydispersity index (PDI) detected was 0.2±3 using zetasizer, suggesting that the majority of the nanoparticles in the samples are relatively uniform in size Whereas, the loading capacity was8.83±1.24.Table 1 represents values that are the mean of triplicate measurements of the entire test performed.

Figure 3: SEM image of Neem oil chitosan nanoparticles

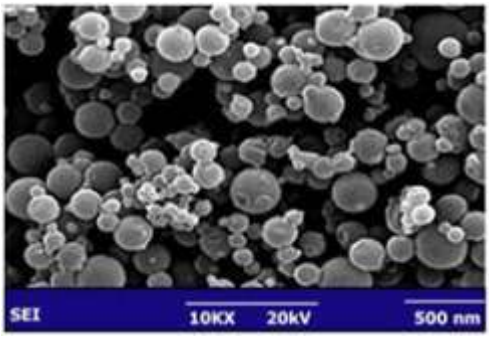

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Table 1: Characteristic features of neem essential oil nanoparticle at optimized conditions

Essential oil Nanoparticles				Results						
Polymer: Oil Concentration	Surfactant (Tween 80) %	TPP %	RPM	Size (nm)	% EE	% LC	Antimicrobial Activity in Zone of inhibition-(mm)for cotton fabric			
							BC	SA	EC	PD
1:1	0.75	1	13000	189 ± 26	78.42 ± 1.56	8.83± 1.24	2.25 ±0.5	1.45± 0.39	0.57± 0.32	0.65± 0.3

3.6 Antibacterial assessment

The test bacteria used in this study includes two Gram-positive bacteria Bacillus cereus(BC), and

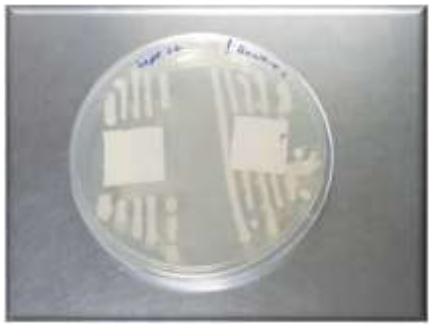

Figure 4: Activity of Neem chitosan nanoparticle against Bacillus cereus on treated cotton fabric (left) and polyester fabric (right) side of the petri dish

Staphylococcus aureus (SA) and Gram-negative bacteria Escherichia coli (EC), and Pseudomonas (PD).Table 1 shows that the largest zone of inhibition observed was 2.25 mm against Bacillus cereus (BC). Figure 4 displays the antibacterial activity of neem chitosan nanoparticle-treated cotton fabric (on the left) and the no bacterial repellency on polyester fabric (on the right), as indicated by the absence of a zone of inhibition indicating no absorbance of the finish on the polyester fabric because of its hydrophobic nature. Staphylococcus aureus displayed 1.45 mm of inhibition, while both Gram-negative bacteria exhibited very little zone of inhibition.The limited zone of inhibition observed in Gram-negative bacteria may be attributed to their rigid and complex outer membrane, hindering the diffusion of hydrophobic compounds through it.In contrast, Gram-positive bacteria lack this extra complex membrane and instead have a wall that is not dense enough to resist small antimicrobial molecules, allowing for easier access to the cell membrane [10].

3.7 Effect of storage conditions on % oil retention

The % oil retention of neem chitosan nanoparticle treated cotton fabric was assessed with regards to its

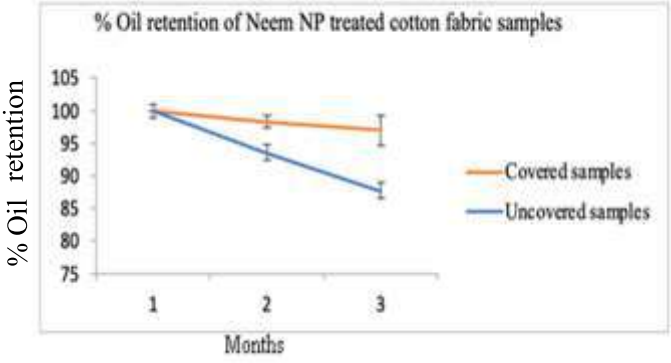

Figure5: % oil retention of the treated cotton fabric when stored in both covered and uncovered conditions

end use in both open and enclosed environments such as drawers or shelves, at room temperature referring the closed and open petri dish condition. The calculation

was done after two months and compared to the initial zero time (after nanoparticle preparation). The findings revealed that the treated fabric samples that were kept covered in a petri dish demonstrated better stability compared to the ones left uncovered and exposed to the environment. The nanoparticles showed a 2.7% change in entrapment efficiency after two months in a covered condition and a 12.8% change in uncovered conditions.

4. Conclusion

Neem essential oil was successfully loaded in the chitosan nanoparticle. As mentioned by Supraba, W., et al.,the good percentage of entrapment efficiency has to be more than 60% [7], the current study has observed entrapment efficiency of 78.42 ± 1.56 % with 189 ± 26 nm as an average size of the nanoparticle. The treated cotton fabric showed satisfactory antibacterial activity. Due to the control and release mechanism, the finish showed satisfactory stability in an open environment. Thus, the treated cotton fabric can be use as a preservative fabric for covering heritage textiles to protect from microbes. The fabric can also be used as a backing or a lining material when stored flat in shelves or drawers or as a padding on hangers and rollers. By doing so, it prevents direct application of the finish causing stress to the ancient textiles and helps preserve them for future generations.

5. Acknowledgement

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Journal of the TEXTILE Association

MANAGEMENT

Lean Manufacturing and Sustainable Production for Hand Block Printing – A Case Study

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Abstract

Hand block printed fabrics have been in demand in different part of the globe due to its unique fusion of traditional designs, arts and exclusive color patterns. The global acceptance has increased the demand of hand block printed fabrics as well as increased sustainability challenges for artisans to rethink their production process. This paper demonstrates a case study conducted at a hand block printing unit who is preparing to introduce lean and enhancing sustainability in the production phase where different lean tools were applied such as Value Stream Mapping, Gemba, etc. The data was collected through observations and time and action study.

Further the study explains the specific problems and value acted as a foundation for further analysis and improvement potentials identification to reach a future lean and sustainable state in the production, which resulted in enhancing the firm´s lean and sustainability performances.

A main contribution is the developed guidelines for creating a lean and sustainable production roadmap for artisans, which result in leveraged benefits satisfying both the lean and sustainable needs.

Keywords: *Hand Block Printing, Lean Manufacturing, Sustainable Innovation, Fashion Production, Rural Medium Sized Manufacturers, Efficiency, Productivity, Continuous Improvement.*

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1. Introduction

1.1 Overall Aims and Purpose

Recently, the modern manufacturing systems are expected to be lean and sustainable, in order for medium sized manufacturers to achieve goals like being competitive, responsive to the increased customer demands, in addition to responding to the rising sustainability challenge, it is important to provide them with methods and tools within their capabilities and hold substantial improvement potentials. The overall aim of this thesis is to investigate how medium sized manufacturers can increase their production efficiency and move strategically towards sustainability. Thus, provide them with guidance to improve their production and sustainability performances using appropriate and adopted tools from the literature of lean manufacturing and sustainable development.

Artisanal skills are passed from one generation to the next, they are only second-hand in modern times. Generations of artisans are reluctant to give up their family occupation. They see their parents struggling to find work. The market and fair price of their products are not taught in schools' curriculum. Craft is important and these occupations can be regarded as traditional and old age craftspeople are exempted for being the major.

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The handicraft sector faces many challenges, including those that are not addressed. Financial constraints, low education level, lack of empowerment, low wage and highly unorganized sector, inadequate infrastructure and dearth technology, lack of quality raw material, fierce competition from machine-made products, limited access to markets and low demand, inadequate census data [1].

1.2 Research Questions

The objective of this thesis is to identify the leading factors affecting the productivity in Hand block printing and applying lean Manufacturing tools to achieve higher productivity resulting in creating customer value and exploring more commercial opportunities based on the objective of the thesis following research questions have been formulated in order to explore the application of lean manufacturing tools in Hand Block Printing.

- RQ (1): Which are the factors affecting sustainability and productivity in Indian Hand Block Printing?
- RQ (2): Which are the lean manufacturing tools to increase the productivity in Indian Hand Block Printing?

1.3 Limitations

- Productivity improvement can be achieved by applying "7 tools of quality", apparel management software's, total quality control (TQM). This research work will be based on lean manufacturing tools as other approaches are outside the thesis scope.
- This thesis is based on one of the seven lean wastes i.e.

inventory others being Overproduction, transportation, Over processing, defects, motion and waiting. The other lean waste is outside the thesis scope.

- The study is based on products made from hand block printed fabric hence the scope of the study is limited to the manufacturing of the apparels and not focusing on hand block printing process i.e. dye marking process to hand block printing process of the fabric.

1.4 The "Lean" Concept and Objectives

Lean Production is therefore defined as a systematic waste removal from every value stream part. "Value stream" can be defined as the whole set of activities to obtain a finished product from raw materials [2]. Lean Production implementation provides several benefits, among which: cost reduction, productivity increase, quality improvement, lead time reduction, supplies reduction, flexibility and customer satisfaction improvement.

2. Materials and Methods

2.1 Scientific Approach

The scientific approach in this thesis starts as deductive since the approach is based on existing theories, based on literature review about lean principles, Value Stream Mapping, sustainability and sustainable development. The literature review was the basis for further data collection through case studies, interviews and observations. However, the thesis tends towards an adductive approach at a later stage, where a perspective approach was taken and some tools were adapted to fit the study purpose of generating the roadmap guidelines.

2.2 Research Method

The chosen research method for this research paper is a mix of both quantitative and qualitative. Quantitative methods include time measurements and calculations. Data was collected regarding WIP, lead times, and cycle times to provide a holistic production overview and expose waste. Qualitative data includes interviews, semi structured interviews, dialogues, and observations that have been used to understand the studied production system from the arrival of materials to the facility until the products are shipped in order to create a clear structure of the value stream analysis and as a starting point for the creation of the maps. Furthermore, qualitative data was used in order to understand the reasons of wastes in the system, the current sustainability situation, and to find appropriate solutions for the identified problems and gaps.

2.3 Research Approach

The approach chosen for the research at hand is mainly an exploratory/descriptive single case study which leans towards a prescriptive study at a later stage in the analysis and in developing the lean and sustainable production roadmap guidelines

The research took place at a medium sized manufacturer "Aavaran" that is presented in the following section. The company is looking for solutions to cope with the increased demands from their retailer customer to improve the production and sustainability performances. However, the management has rough ideas about the problem areas in their production and good intuition on where the efforts should be focused.

The research took place at a medium sized manufacturer "Aavaran" based in Udaipur, Rajasthan in June 2019 that is presented in the following section. The company is looking for solutions to cope with the increased demands from their retailer customer to improve the production and sustainability performances. However, the management has rough ideas about the problem areas in their production and good intuition on where the efforts should be focused.

Through the research the following sources of data were used:

- Primary data: Semi structured interviews, direct observations, participant´s observation, dialogues, and time measurements.
- Secondary data: Literature review, archival data and documentation at the company.

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- Secondary data: Literature review, archival data and documentation at the company.

2.5 Value Stream Mapping

Value stream mapping is to attempt to solve all of the problems of an organization but it can be solved by addressing the issues one by one. A collective approach towards all problems at once typically would leads to failure. To avoid failures lean practitioners often utilize specific tools and techniques that lead them to the best candidate(s) for value stream mapping. Specifically, the two main tools are Product Quantity (PQ) and Product Routing (PR) Analysis/Matrix. The main premise behind a PQ matrix is that it helps guide to the product families with the highest volume. Targeting higher volume product families leads to maximization of return on investment.

In some cases the results of a PQ analysis do not deliver a decisive message as to which product family to map first. In this situation a Product Routing (PR) Analysis/Matrix can become extremely effective. The PR Matrix is a powerful tool that allows better understands which product families share common processing steps. If two different product families share the same or very similar processing steps then mapping both product families can be addressed in one value stream mapping exercise.

For the case study both PQ and PR Analysis were combined which refer to as a PQPR analysis with from the sales report Jan- May 2019 where in apparels contributed 70% to the total units sold Figure 1 as well as it contributed 73% towards revenue earned Figure 2.

Figure 1: Units sold

Figure 2: Revenue earned

Through the PQPR analysis it is clear that the product category for applying the VSM is apparels although it is important to apply VSM to all the products to add value and reduce waste in the process.

2.6 Current Value Stream Map

Before transferring the information and process flows into the value stream map diagram, it is important to introduce some general process information regarding customer demand and available working hours to grasp a holistic understanding of the process and enable upcoming analysis. Starting with the customer demand, there are three different levels of demand throughout the year, which are categorized into low, medium and high demand periods. However, currently the production is at a demand rate of 700 pieces per week i.e. 24 pieces of daily demand. Further average monthly demand was calculated to derive the daily demand.

Calculating working time and takt time

The factory works on one shift per day, with nine hours per shift. In each shift there is two breaks; the first one lasts for 30 minutes, the second one for sixty minutes which accounts for 90 minutes break time for each shift.

Formula for calculating the *Takt Time* =

$$\frac{\textit{Available working time per day}}{\textit{Customer demand rate per day}}$$

Therefore the working time is 540 minutes and takt time to producing each piece is 18.1 minutes.

The next step in drawing the VSM after describing the processes steps and the information flow, is to calculate the level of inventory accumulating between work stations. While creating the VSM According to the VSM literature, to get valid data it is best to personally do the measurements, thus the work in progress levels were counted manually where they exist, which is after fabric received in the fabric store room then transferring the fabric to hand block printing once the fabric is printed then it is processes to the cutting department. Once the cutting department bundles all the cut parts then it is send for assembling and stitching, the stitched garments are send for initial quality check there after the garments are processed of hand embroidery. Post embellishing the garment is send for finishing where in the loose threads, oil stains, etc. is cut and removed. Finally the garment is sending for ironing and final quality check prior sending to stock room. The entire above step in the VSM is added to a timeline. The timeline differentiates the value added time and the non- value added time. In high volume value streams, the value added time is considered to be the processing time, which is the time a part is being processed by an operator or is actually on a machine, the processing time is considered to be fully value added time, while Non-value added time mostly consist of inventory time between processes. The cycle time measurements were taken five times for each process using a stopwatch and then the average times were calculated. Afterwards the measured cycle times have been cross checked with documented process data to ensure the accuracy of the collected data. Furthermore, the changeover times were measured if they were witnessed during the observation period and indicated on the relative process information box. Finally, the cycle time for each garment is calculated by adding up the different processes was based on the data collected by time and motion study. All the earlier presented process information is integrated and visualized in the following VSM diagram in Figure 3. The diagram presents the production for hand block printed garment to provide a holistic understanding of the material and information flows inside the manufacturing unit and how they interact. The current state VSM is shown in Figure 3 below, with VSM icons.

2.7 Analyzing the Current Value Stream Map

1) As can be seen from the current VSM there are two main production planning and control (PPC) departments which are controlled by the Operations head. The both the PPC Dept. are coordinating with ten sub departments. Further the merchandise is shipped to the customers by downstream process. Further the product cycle efficiency (PCE) was calculated.

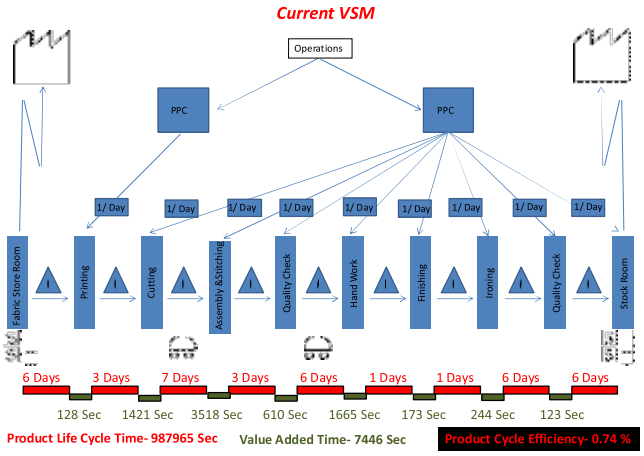

Figure 3: The Current State VSM

1) As can be seen from the current VSM there are two main production planning and control (PPC) departments which are controlled by the Operations head. The both the PPC Dept. are coordinating with ten sub departments. Further the merchandise is shipped to the customers by downstream process. Further the product cycle efficiency (PCE) was calculated.

$$PCE = \frac{\text{Value added time (VAT)}}{\text{Product Life Cycle Time (PCLT)}}$$

PCLT was calculated to be 987965 Seconds and VAT was calculated to be 7881 Seconds.

Therefore PCE= 0.80 % which means after comparing the VAT to the PCLT, the value added time portion is found to be minimal which is less than 1% of the lead time, which means that great lean improvement potentials could be achieved through implementing a lean strategy. In the current state value stream mapping "Aavaran" follow Material Requirement Planning (MRP) flow where in the Operations head flows in day to day information to two of its PPC departments thereafter these two departments flow the information separately to the functional departments in silos Figure 3 provides an info graphical flow of information, which results in disconnect between each departments leading to underutilization of the information causing challenging issues and problems for the processes and developments in the organization.

2) It was observed due the existing flow of information the information was flown every 3 hours that to individually, therefore a constant update of information was required which resulted in bullwhip effect due to constant change in customer demand. It is very important for an organization to implement a constructive information system as it can increase competitiveness and help to enhance towards better information for decision making.

3)Further to the observations the organization follows MRP flow resulting in holding excess inventory at each level as well as finished goods without considering the customer demands as shown in figure 4.8. The excess inventory at each department was calculated to be 38 days of supply (DOS) i.e. 38 Days X 7.3 working hrs. Per day X 3600 conversion to seconds= 987965 seconds of work in progress (WIP). This excess inventory and finished goods is due to MRP flow where in push mechanism of work is followed as it does not consider the customer demands while manufacturing the products.

4)The existing production system follows push system, resulting in inventory building up in the next department irrespective of their needs as well as non-synchronized work flow where in the departments are not concerned with the pace of preceding and succeeding departments results in excess WIP. There are a number of issues which constitute the ability of the organization to achieve effective utilization of information, like lack of communication about the information, deviations from actual information, psychological barriers, lack of system follow-up, less value build-up, organization's behavior and structures, formal and informal communications and organizational hierarchy.

5) Another aspect of production system is application of batch flow, in batch flow the production is designed in such a way that it flows to each department in batches such as 5 plies each ply containing 7 meter of fabric i.e. 35 meters of fabric was considered to be as one batch. Time and motion study was conducted to capture the process time of each batch where in 5 consecutive process cycles were recorded for one batch the results reveled at every 15 garment pieces would be out of production after 2955 minutes refer Figure 4 i.e. approx. 5 working days out of which 22% contributed to inventory hold between each department due to non-synchronized work flow where in the departments are not concerned with the pace of preceding and succeeding departments.

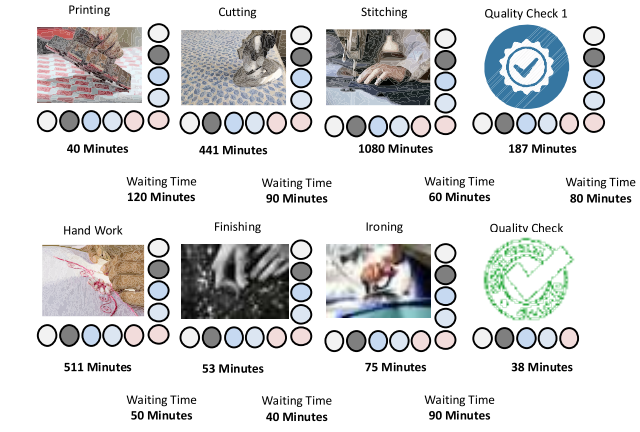

Figure 4: Production Flow

6) Further the production was following lot production system where the organization simultaneously manufactures a broad assortment of products of the same kind and the production process is repeated over a long period of time. The monthly production plan consisted lots of sarees, dupatta's and garment's. The lots were planned in such a way

that if the customer buys 5 Dupattas in a week then the organization had to keep inventory of Dupattas or else lose the order. If the customer doesn't buy as much as garments as planned then it resulted in inventory hold in the stock room till the customer places a new order. The production process for saris, dupatta's & garments are different which results in more burden on the production one day while the next day they will be slower refer Figure 5.

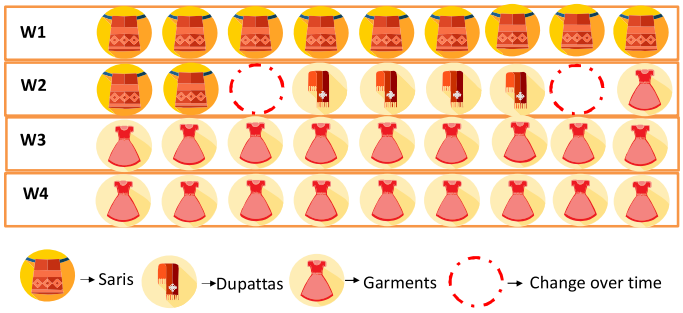

Figure 5: Production Process

2.8 Current State Cycle Time/Takt Time

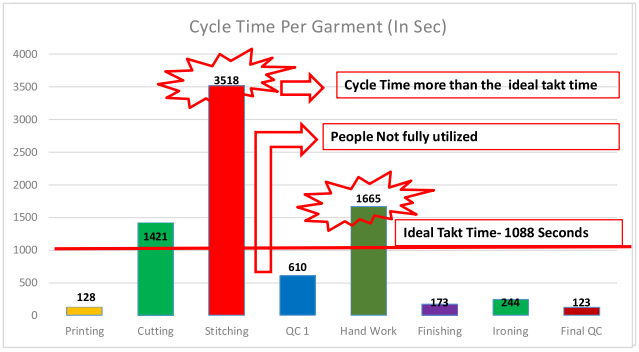

Figure 6: Current State Cycle

7) "Takt" is German for "pace" or "rhythm", and is often associated with the pace a conductor sets for an orchestra so they play in unison. Takt time is sometimes referred to as the heartbeat of a lean production system, since it is used to match the pace of work to the average pace of customer demand. Currently the organization does not have a constant demand throughout the year therefore it is important for all the departments to work at an ideal pace /takt time. As per cycle time per garment Figure 6 represent the cycle times of the different processes in relation to the takt time. Departments which are under paced are printing, cutting, quality control 1, finishing, ironing and final quality control whereas the stitching, hand work are performing their task beyond the ideal talk time i.e. 985 Seconds. Answers to findings 1-7: the future value stream map. The future VSM as shown in Figure 7 will provides directions towards eliminating waste and adding value to the future state of processes. It guides the organization to achieve the ideal state through the VSM implementation journey as well as future VSM brings accountability to the organization since each department know their KPIS'S.

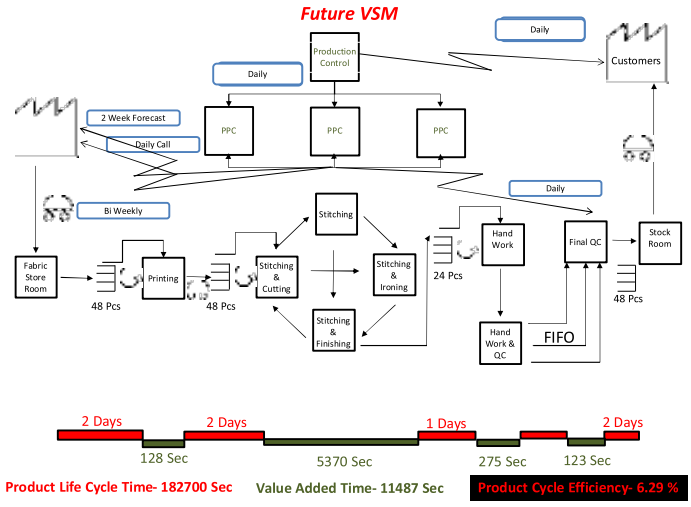

Figure 7: The Future State VSM

2.9 Key Aspects of Future Value Stream Map

Implementations towards findings

1) Adopting downstream pull where the information is flown to the last department who schedules the other departments with a set the right mix and quantity of products to be produced. Figure 7 display the a strong communication mode where in the operation head is coordinating with the three PPC department collectively on daily basis there after the PPC department is transmitting information via electronic mode to the pace maker department i.e. final quality control department on a daily mode. It is equally important for the operation head to constantly coordinate with the external stakeholders i.e. the customers on a daily basis this communication should be via electronic mode such as database, sales report and other MIS applications. Further the PPC departments should share and receive information from the fabric suppliers via electronic mode on a daily basis and the avoid any delays in receiving the fabric a minimum of two weeks of forecast needs to be shared.

2) Adopting pull mechanism ensures smooth flow of material in a continuous flow system. This can be done by placing production Kanban cards in a Heijunka box, often at the beginning of each shift. These production instructions then are sent to the process at the upstream end of the value stream. This can be done in the form of a "sequence list," sometimes called a "sequential tablet." Each department simply produces in sequence the items delivered to it by the preceding upstream process. FIFO of individual products must be maintained throughout. In this mechanism the last department is called as a pace maker since it sets the pace of preceding departments.

3) Continuous flow could be attempted by the introduction of FIFO as shown in Figure 7 lane system at the processes between handwork and QC 1 and Final QC stations so that the operators will not work in a batch mode, rather they would make the first product that arrives right away. This solution will not only reduce the WIP accumulating before and after the handwork and QC which is resulting in over 44

minutes of inventory time for each. But will also result in increased ergonomics for the operators as they are currently carrying the garment pieces from the handwork to QC 1 then to final QC to the previous and next station continuously for relatively long distances. The conveyor moving time between stations is estimated to be just above the cycle times of the connected processes, taking into account the distance between the stations as well.

The remainder of processes is more efficient to run as batch operations because of the processes nature, cycle time differences and the physical distances between the stations, which make the one-piece flow difficult to apply.

4) Stoppage in work in process contradicts the lean principles hence it's important to set supermarkets in each department holding 1-2 days of inventory in hand. A supermarket pull system can be attempted after each department which will hold an average inventory of 1-2 days as shown in Figure 7 the supermarket will hold products for Product preceding department enough for approximately one day of production. The proposed supermarket pull system will reduce the waste of overproduction significantly, which will respectively result in less inventory time and cost. As a long term solution and after fully implementing the ERP system, it could be possible to replace the regular Kanban posts and supermarket with a digital Kanban signals for an increased efficiency and accuracy, where all operators can log into the system and the shift leader will receive a signal when a refill is needed.

5) Adopting Continuous flow (one piece batch flow) where in producing one unit at a time, passing each to the next process without any delay results in better utilization of resources, better quality control, minimizes overproduction as a result shown in figure 10. Application of one piece batch flow resulted in no inventory hold in department to as a result 15 pieces were produced in 1970 minutes i.e. 3 working days as compared to the current VSM where in 15 pieces were produced in 5 working days.

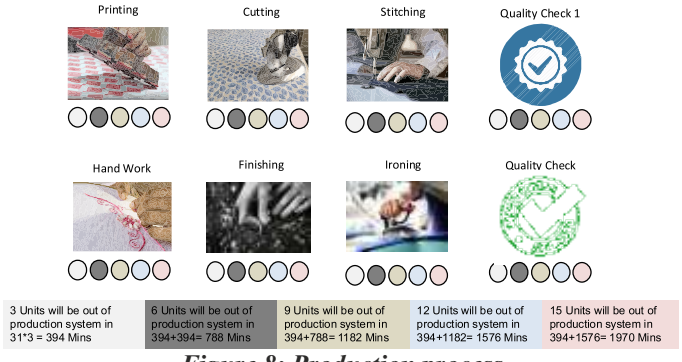

Figure 8: Production process

6) It is proposed that the existing production systems needs to be redesigned on the bases of leveled production concept known as heijunka as shown on figure 11 heijunka reduces the bullwhip effect but aligning the resources as per the daily production requirements. It allows to manufacture what the customer wants (JIT), reduces drastically slow moving or obsolete inventory, levels the work load in the organization encounters uneven customer demand (Mura) due to which directly overburdens the employee and equipment's (Muri).Production leveling facilitate to establish standard work processes and reduces cost and increases the quality of the product resulting in smooth the supply chain as shown in Figure 8.

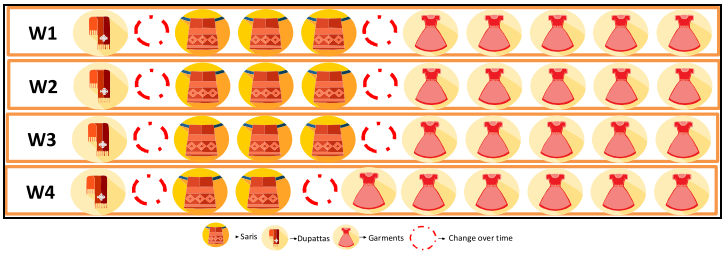

Figure 9: Production Process

Based on the concept of production leveling the monthly production plan was aligned as where in the products were phased out as per the customers demand and keeping the product factors. Resulting of the production is shortened, product quality is improved, labor productivity is raised, and costs are lowered as shown in Figure 9.

7) To achieve the ideal takt time across all the department the cycle time of each department was combined and the workplace was rearranged which further simplified the process by eliminating unnecessary processes and activities which were not adding value to the product. Such as combining stitching and ironing, stitching and finishing, stitching and cutting lastly handwork and quality control 1, by combining these activities the departments were able to set a pace i.e. achieving ideal takt time of 985 seconds as shown in Figure 10.

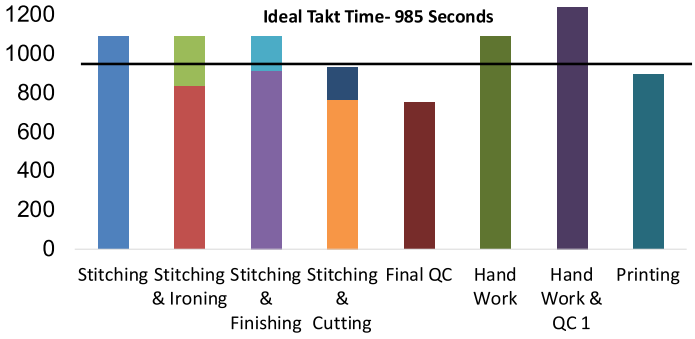

Figure 10: Ideal Takt Time

$$PCE = \frac{\text{Value added time (VAT)}}{\text{Product Life Cycle Time (PCLT)}}$$

PCLT was calculated to be 182700 Seconds and VAT was calculated to be 11487 Seconds resulting to PCE at 6.29% as compared to current PCE at 0.74% Table 1

3. Results and Discussion

Table 1 – Performance Indicators

Performance Indicators	Current	Future	Increase/ decrease
Product life cycle time	987965	182700	- 805265
Production time	980519	171213	-809306
Value added time	7446	11487	+ 4041
Product cycle efficiency	0.74%	6.29%	+ 5.55%

Post implementation of various lean tools the processing time (value added time) has increased and production time (non-value added time) has decreased resulting to higher product cycle efficiency.

In the current VSM the production lead time is calculated to be 274.4 hours, and the value added time is 2.06 hours. Comparing the value added time to the lead time; the value added time portion is found to be minimal, accumulating for less than 0.8 % of the lead time, which means that great lean improvement potentials could be achieved through implementing a lean strategy.

In the future VSM the production lead time is calculated to be 50.7 hours and the value added time is 3.19 hours. Comparing the value added time to lead time, the value added time portion is found to be substantially increased to 6% resulting higher product cycle efficiency.PCE improvement increases the employee satisfaction, teamwork and group dynamics an impacting positively to employees working environment.

The lean and sustainability actions required to achieve the future state VSM and SCI levels were discussed in close collaboration with the management, production operators, and the production development team to assure the feasibility and applicability of the proposed solutions as well as VSM managers were appointed to strive towards continues improvement.

4. Conclusion

Research question

The purpose of this thesis was to identify leading factors affecting the productivity in Hand block printing at Aavaran and applying lean Manufacturing tools to achieve higher productivity resulting in creating customer value and exploring more commercial opportunities based on the objective of the thesis following research questions have been formulated in order to explore the application of lean manufacturing tools in Hand Block Printing.

To answer the main research question, two sub research questions were proposed:

RQ (1): Which are the factors affecting sustainability and productivity in Indian Hand Block Printing?

Factors such as inventory, overproduction, and transportation, over processing, defects, motion and waiting are the factors affecting the sustainability and productivity of the Indian hand block printing this thesis explores the inventory factor and there is a substantial scope to further study and reduce the waste in other factors listed above.

RQ (2): Which are the lean manufacturing tools to increase the productivity in Indian Hand Block Printing?

VSM is one of the lean tools to increase the productivity where in the first step before drawing the map is to define the value from the customer perspective. This is done in order to determine at a later stage which activities add value to the product and which does not and thus can be eliminated. It can be concluded from the analysis that the value to the customer is based on the four main factors identified [3], which are the costs, quality, flexibility and delivery performances.

Next step is the identification of the value stream through selection of a product family that is of great value to both the manufacturer and customer, which is followed by mapping the physical flows concerned with the processes. And information flow concerned with frequency of orders and shipments along with the information exchange in the company. After this step the value added and non-value added activities can be recognized, and the identification of the seven lean wastes in the production processes takes place through direct observations of the workplace and having interviews and dialogues with operators. In the case company, the seven Lean wastes were investigated in the processes, and for each identified waste a proposed solution was provided to reduce the waste sources in the production. The next step of analysis is answering the eight guiding questions developed [4]. Combining the seven wastes analysis with the eight questions is essential and results in a proposed future state of the production processes.

Comparing the proposed future state with the current state in the case company provided an insight in the potential improvement this approach has on different parameters such as lead time, and non-value added time, with more than 63% reduction in lead time and around 64% decrease in non-value added time.

5. Acknowledgment

This journey has been full of challenges, hits and misses from the start till the end. The learning while executing the research paper has been insightful and probably not been possible without the support and guidance I received.

I would like to thank Dr. Bhawana Chanana, Director, Amity School of Fashion Design & Technology, Amity University, Mumbai, India and Dr. Sitthichai Smanchat, Associate Professor, Ubon Ratchathani University, Ubon Ratchathani, Thailand to have been supervising and motivating me throughout my research journey and I extend my gratitude to the Founder Ms. Alka Sharma and her team at Aavaran for giving this opportunity as big as this and for her continuous guidance and support through this lean journey.

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Journal of the TEXTILE Association

NFT and Metaverse - The Future of the Luxury Fashion Industry

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Abstract:
Polylactic glycolic acid (PLGA) is the most important polymer in biomedical applications and the degradation kinetics is modified by the co-polymerization ratio of the monomer. In this interest, Biodegradable and biocompatible polymers are used in controlled drug delivery systems, in the form of implant devices for skin bone, and dental repairs. With microwave synthesis polycondensation, free and controlled radical polymerization, and ring-opening polymerization (ROP) can be done. The characterization of Polycaprolactone was done by Fourier Transform Infrared Spectrophotometer (FT-IR), scanning electron microscopy (SEM), the polymer interactions were checked by differential scanning calorimetric (DSC) and the XRD analysis was carried out to determine structural changes PLA/PCL nanofabrication done by electrospinning Technique for biomedical applications. PLGA synthesis is done by the conventional method, with the study of various parameters such as time, temperature, monomer, and catalyst ration. Important characteristics such as melting temperature, glass transition temperature, thermal stability, FTIR, and NMR were studied for this. These results helped to study the effect of monomer, and catalyst on reaction. The PLGA microparticles are one of the most successful new drug delivery systems (DDS) in labs and clinics. Because of their good biocompatibility and biodegradability, they can be used in various areas, such as long-term release systems and tissue engineering.

Keywords: *Biocompatible, Biodegradable, Electrospinning, Melt spinning, Polymerization, Synthesis*

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1. Introduction

With the advent of technology and the world hit by the pandemic, another revolution in digital technology is just about to begin. The new digital era has led to such a transformation, on digital investments and digital currencies. Cryptocurrency has turned into a huge industry that has increased demand from investors across the country willing to invest in these digital assets and cryptocurrencies. Everything is now publicly displayed online as a result of the digital revolution [12]. The digital platform has negatively impacted the creation and innovation of original artists as people have no idea about the writers or creators of the works that are presented online. The notional worth of an artist's or creator's work is all that is left when security and authenticity are absent. This is what the NFTs aim to solve, that represent a unique ownership of item which is then attached to a token via the blockchain.

NFTs and the Metaverse bring up new areas of risk and possibility for the economy. Luxury fashion has always been an industry obsessed with what's new and what's next, and in 2022 It's nearly difficult to discuss the future without mentioning the Metaverse and NFTs The metaverse is viewed as a special technology that offers more advantages and prospects for luxury clothing companies. The adoption of such cutting-edge technology allows premium fashion firms to simply stand out from the competitors. Heading towards the mainstream art world, 2020 saw a boom in the market for NFTs, climbing from $41 million to a market cap of almost $338 million in 2018 A new generation of traders is being observed in the NFT market, i.e., digitally native people with accumulated reputation and wealth who are willing to invest in asset classes outside of the established investment markets

1.1 What are NFTs?

Digital assets known as NFT (non-fungible tokens) represent tangible or digital works of art or intellectual property, such as music, video clips, gifs, games, and more. They are therefore special, one-of-a-kind assets that cannot be traded or duplicated for value In an NFT, the term "non-fungible" refers to the fact that individual token is a distinct entity that represents a single particular thing and cannot be exchanged for another token. These tokens, which are made up of electronic data stored in the form of media, can be valued using cryptocurrencies. Rapid technology development and progress provide more security and authenticity threats. The non-fungibility and distinctiveness of NFTs make it easy to determine who owns an asset and put an end to the problems of forgery and widespread counterfeiting. Tokens are digitally signed by their owners, making it easy to verify their legitimacy. Additionally, it deals with the issue of misleading people into buying fake goods, such tickets or pieces of art. In order to guarantee a legit sale, customers can simply locate the sellers themselves. In the modern era of digital enterprises, artistic businesses have typically found it difficult to develop web storefronts due to the absence of exclusive rights of ownership. This is evolving now, however, thanks to NFTs. NFTs, which were previously only familiar to a subset of the blockchain industry, have recently emerged as a separate market and have the potential to generate up to $1.2 billion by July 2022.1 (Insider, 2021).

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Although NFT is still a young field of study, it has already seen substantial growth. NFT's usability is expanding beyond the realm of digital assets, with the emergence of several new utilisation cases.

1.2 Luxury Fashion in Metaverse

Since Facebook became meta, the metaverse, an immersive technology, has grown, and Apple and Microsoft have followed suit. Meta focuses on future-oriented virtual world construction and shaping. Experts say it provides a 3D virtual reality environment where people from around the world may engage, marking the next step in social interaction. In a more specific explanation, the Metaverse will allow users to share their 2D experiences with other users from around the world in a 3D virtual environment where they are truly complete with their own avatars, such as shopping on a computer or smartphone, attending concerts, or watching movies (3D replicas of themselves). So, clients may now easily visit a 3D virtual store utilising the same digital technology that lets them buy on 2D devices like phones and computers [2]. Internet use affects many parts of life. Information, international communication, and social media interaction are still done online. The metaverse has made these interactions more immersive, boosting online relationships. Augmented and virtual reality allow humans to live in a digital world, making this possible. Metaverse activity involves users. Metaverse luxury fashion is evolving. Anyone can use a computer to explore a website for clothes and buy them. This depicts internet user engagement. Metaverse users can try on clothes at virtual boutiques before buying. Products can be viewed from all sides. Customers can virtually test on items by dragging photos. To replicate the retail experience in the metaverse, you may need to bring the fitting room home. Fashion and the metaverse interact most clearly in the formation of fashion-related NFTs.

1.3 Luxury fashion consumption in the age of Metaverse through NFT's

Luxury fashion retailers are using NFTs for marketing and advertising [10]. As these companies digitise more, their products become more unique in the digital world, driving demand for digital fashion. In addition to their web presence, companies that sell garments that can only be worn in the digital realm will elevate premium fashion. As metaverses become more integrated in people's daily lives, clothing is expected to become more significant in both the virtual and actual worlds. Cryptocurrencies are becoming more popular and meeting luxury fashion's commercial needs. In fact, high-end manufacturers have started integrating NFTs in their online clothes. Metaverse's target demographic, the younger generation of the vast fashion market, like to experiment with new technology. These businesses are finding new ways to engage with the younger generation as the Metaverse grows in popularity.

New digital technology will improve consumer experience and product understanding in fashion. In 2022, NFTs will rule the runway. NFTs are becoming more important in the fashion industry since technology allows fashion enterprises to collect detailed data on manufacturing processes and consumer preferences. Technology has had a big impact on fashion worldwide. NFTs' ownership, stability, and royalty acquisition benefits luxury clothes firms. Several fashion companies use the internet to reach more people, yet their exorbitant costs make knockoffs and reproductions appealing. Copying branded products costs businesses, a lot of money, but NFTs can reduce or eliminate these losses. After nearly a year of store closings, the fashion industry is exploring fashion technology, including NFTs. Businesses are incorporating digital NFTs into actual objects to prove ownership and uniqueness. Luxury fashion faces new challenges from consumer culture transformations [8,4]. Luxury products are mostly bought by the wealthy [6]. Wealthy Millennials and Gen Z are driving luxury sales [8]. Younger, wealthier generations are changing the luxury market with their spending patterns, needs, and reliance on digital first [4].

The luxury sector, which has been slow to adopt e-commerce and digital commerce, has been accelerated by the COVID-19 pandemic [13,11]. Premium clothing sales have dropped due to COVID-19 store closures and work-from-home rules. In order to continue operating and placing orders, several fashion industry players moved to online marketplaces. They even used virtual shows to target consumers. They are currently investing in a variety of new technologies and relying increasingly on digitalization. They want cutting-edge technology because they know it will become more important. Progress is both necessary and well-reasoned. Morgan Stanley, a US-based investment bank and financial services provider, estimates that Metaverse may generate more than $50 billion in revenue for the luxury apparel industry, which includes a $22.6 billion NFT market. In the next years, this will increase, and fashion will become entrenched in the Metaverse. High-end fashion brands are joining the Metaverse to meet future demands.

Metaverse's DApp enables users create, view, and interact with NFTs. There are positive indicators as blockchain technology and NFT aim to recruit more frequent consumers. To understand the market's customer group, luxury companies like Kering have aggressively explored asset digitalization through NFTs. The Kering Group increased spending on communication, IT system upgrades, digital platforms, and e-commerce in its 2021 financial report [9]. Digitalization and NFT assist the house's COVID-19 two-year customer behaviour shift interpretation. Issue Magazine, a fashion e-magazine, was created by Bottega Veneta [9]. This displays Kering's social and environmental responsibility. NFT mode study discovered various difficulties. Cryptocurrencies' price swings make NFT's future unpredictable. The value chain of creative industries, especially art, includes innovation, production, distribution, display, and mediation [6]. Luxury brands sell their products online and in stores. Digital distribution may dilute NFT brand equity and reduce metaverse sites for luxury brands to showcase NFT merchandise. Fashion NFT designers, merchants, and platforms should note that many purchasers buy luxury goods as status symbols. NFTs are intangible, so platforms or companies that allow display and presentation are more likely to sell luxury fashion goods made of NFTs.

Customers may be interested in buying and displaying NFT if they can curate their own virtual gallery on NFT platforms. Virtual galleries may assist luxury fashion brands and NFT purchasers. As NFT fever has reached fashion, every major designer will have a tempting 2022 digital release timetable [7]. NFTs and the Metaverse's fast fashion may forecast our future wardrobes. NFT is popular among academics. NFT has expanded beyond digital assets.

1.4 The role of Gen Z in the metaverse

Every new technical advancement, the shift needs to be motivated by something. Gen Z just so happens to be the trend-setters and game-changers in the metaverse This generation is an excellent illustration of how users and operators inside the metaverse must collaborate to further technical advancement. Gen Z's impact on previous generations is advantageous for promoting participation and investment in the metaverse. You are essential to the success of the metaverse and the transactions that take place within it since you are essentially a tech enabler. Four times as many people attended Ariana Grande's 15-minute show than the world's largest stadium could ever hold during Fortnite's Rift Tour, a virtual reality event. This tested the metaverse's ability to grow globally, and its limitless capacity continues to be one of its key selling features

2. Objectives

i. Impact of NFT & Metaverse in Luxury Fashion industry.

3. Review of Literature

3.1 Sales of NFT

In May 2014, Kevin McCay became the first person to develop the first NFT. He created Quantum as his first NFT even though the cryptocurrency market was not yet buzzing. Between the start of the first NFT in 2014 to the middle of 2017, there was a lack of public awareness. However, in December 2017, the popularity of Crypto Kittes served as the catalyst for increased public knowledge of and demand for non-fungible tokens. Although interest in this new technology was beginning to grow, overall performance remained below standard. However, NFT began to expand quickly during the COVID phase, or in 2020.

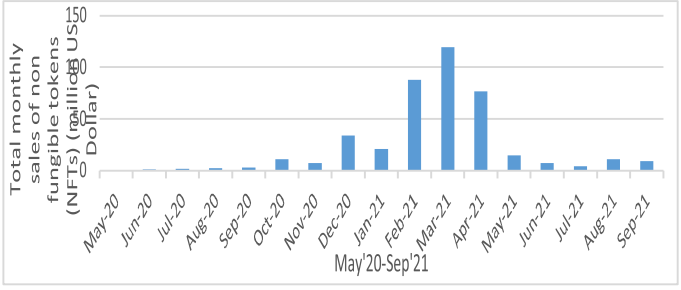

Figure 1: Total monthly sales of non-fungible tokens (NFTs), May' 20-Sept'21; Source: Nifty Gateway worldwide

As per Figure 1, The Nifty Gateway histogram showed the total monthly sales of NFTs, which started to climb in the fourth quarter of 2020 from almost nothing. After February 2021, volume exceeded $50 million and sales value rose to $76.79 million. The NFT industry and its supporting platforms, like the 2018-launched Nifty Gateway, were still young, but the sudden spike in sales value may imply that consumers liked NFTs. Figure 1 shows the international Nifty Gateway's monthly NFT sales histogram from May 2020 to September 2021. Between May 2020 and September 2021, Nifty Gateway sold 408.8 million US dollars in NFTs on the primary and secondary markets. NFT traders use Nifty Gateway. Nifty Gateway's online sales allow us to study how virtual gallery space affects NFT purchases. Time is on the X-axis and transaction volume on the Y. Fig. 2 illustrates NFT sales by category: PFP, Cultural Items, Game, and Art.

Figure 2: NFT Sales Volume- 2021 (Category-wise), Source: 1confirmation

In 2021, NFT activity skyrocketed, showing hints of widespread adoption. In contrast to 2020, which was the DeFi year, 2021 was the NFT year. Compared to merely $86 million in 2020, the total NFT trading volume increased to $19.6 billion in 2021. Table 1 depicts the approximate 2 million NFT traders that were active in 2021.

Table 1: 2021 was a banner year for NFT's; Source: 1confirmation

	2018	2019	2020	2021
Annual NFT Trading Volume ($ M)	1.3	8.6	86	19,600
Change(y/y)		7x	10x	229x

Figure 3: OpenSea Monthly NFT Sales Volume and Active Traders, Jan'21-Jan'22; Source: Dune Analytics

The market looked to be oversaturated with NFT collections after the summer of 2021, and activity quickly decreased from a peak of $325M in daily volume in September to barely $50M daily by November 2021. However, NFTs gained momentum by the end of 2021 and the beginning of 2022, when sales started to pick back up (Figure 3).

The number of active NFT buyers and sellers is increasing despite these changes in transaction volume (Figure 4). Up from 627,000 in Q4 2021, 950,000 distinct locations acquired or sold an NFT in Q1 2022. Since Q2 2020, there have generally been more active NFT buyers and sellers each quarter. As of May 1, 491,000 addresses had transacted with NFTs in Q2 2022, enabling the NFT industry to maintain its trend of quarterly participant growth.

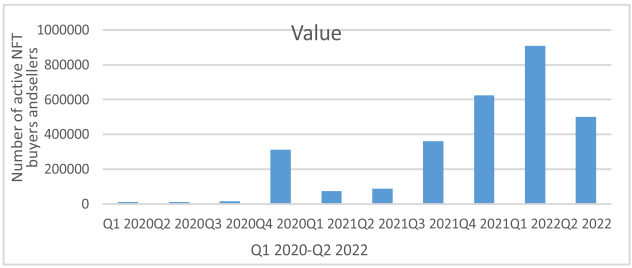

Figure 4: Number of active NFT buyers and sellers, Q1 2020- Q2 2022; Source: Chainalysis

3.2 Related Case Studies – NFT's x Luxury Fashion Brands

Table 2: Description of Case Studies as real time examples: NFT's X Luxury Fashion Brands

Sr. No	Case Study	Launch Date	Marketplace	Description	Reference link
1	Hermes: Baby Birkin	May-21	Basic. Space	A virtual animated bag from the Hermes line called Baby Birkin shows a 3D animation of a 40-week pregnant foetus against a background of space and theme music. As the baby grows, it travels about the bag, which does not physically exist.	https://www.highsnobiety.com/p/baby-birkin-nft-basic-space/
2	Gucci	Jun-21	Christie's Auction House	On the eve of the brand's 100th anniversary, Gucci released its first-ever NFT, an animated film that was inspired by the Aria collection.	https://hypebeast.com/2021/5/gucci-nft-debut-film-aria-collection-inspired-announcement
3	Burberry	Jun-21	Blankos	In their main game, Blankos Block Party, Burberry offered a few characters and other in-game objects that may be purchased as NFTs.	https://www.burberryplc.com/en/news/brand/2021/Blankos.html
4	Louis Vuitton	Aug-21	Android & Apple stores	A video game called Louis was released by Louis Vuitton: the game created to commemorate the brand's founder's 200th birthday. In the video, the players amass 200 candles, each of which contains a postcard detailing the brand's history and the trip of its creator. There are also 30 NFTs to collect.	https://wwd.com/fashion-news/designer-luxury/louis-vuitton-200-bicentennial-celebration-1234889762/
5	Dolce & Gabbana	Aug-21	UNXD platform	Collezione Genesi, the first NFT-based line from D&G, has nine NFT one-of-a-kind pieces created in collaboration with UNXD.	https://unxd.com/drops/dolce-gabbana-collezione-genesi?selected=all
6	Balenciaga x Fortnite	Sep-21	LendEDU	A really remarkable fashion and gaming partnership, where Fortnite gamers will be able to create their look by shopping the Balenciaga collection in the online boutique.	https://www.dezeen.com/2021/09/22/balenciaga-fortnite-video-game-fashion/
7	Jimmy Choo	Oct-21	Binance Platform	The 8888 mystery boxes and the virtual shoe were both introduced by Jimmy Choo. The hand painted limited edition shoe with the mystery box is sent to the virtual sneaker purchaser.	http://www.binance.com/
8	Bulgari			The first artificial intelligence-based NFT artwork from Bulgari will be unveiled. The logo's signature snake pattern was already included into the brand's digital artwork when it was first released. Along with the release of the renowned scent from the company, the 3D sculpture also includes 70 million images of plants and other natural scenery.	https://jingculturecommerce.com/bulgari-serpenti-metamorphosis-refik-anadol-ai-nft/

Sr. No	Case Study	Launch Date	Marketplace	Description	Reference link
9	Republique	Aug-20	Ethereum Platform	A digital start-up to improve virtual fashion without using actual clothing It was advised for social media fans to purchase digitally and personalise their digital attire using NFTs.	https://pressat.co.uk/releases/republiqe-clothing-drops-earth-day-inspired-crypto-fashion-looks-as-nfts-5d6134306820e8751164dced55db0dca/
10	Clothia	May-21	Rally.io	An eco-friendly method is offered by Clothia, an NFT platform for both customers and creators. Customers will be kept up to date on the latest trends if designers reach out to a global audience.	https://nft.rally.io/clothia?tab=1
11	Karl Lagerfeld	Oct-21		The team produced owner's avatars as collectibles to be owned and shared on social media as a way to show respect to the dead owner.	https://fashionunited.uk/news/fashion/sold-out-in-33-seconds-what-is-the-fashion-nft-phenomenon-all-about/2021092958034
12	Overpriced Hoodie	Apr-21	BlockParty	A brand-new company called Overpriced introduced a tangible hoodie that was connected to a scannable V code.	https://www.theguardian.com/fashion/2021/apr/15/virtual-hoodie-sells-non-fungible-token-nft-overpriced

4.0 Methodology

4.1 Research Model

Figure 5: Research Model

4.2 Research Analysis

This methodology section uses a relatively small collection of data because the NFT luxury fashion business is still in its early phases and there isn't much information available about what has been done there. Additionally, the NFT market and the high-end fashion industry are both undergoing rapid change, highlighting the idea that this article's focus on the chosen case studies will be on exploring the wider opportunities the NFT market has to offer the luxury fashion industry from the perspective of these cases rather than solely on their individual accomplishment. The analysis focused on the exploration of principles, ideologies, meanings, ideas, experiences, and emotions characteristic of the phenomenon through SWOT analysis because the primary goal of this paper is to understand how the luxury fashion sector can stand to benefit from incorporating NFTs into their existing business model.

Figure 6: SWOT Analysis

5.0 Results and Discussions

Luxury brands continue to struggle with digitalization: The virtual economy now has about 2.5 billion participants. This is the path that the world is following. Luxury brands must

have a virtual presence, just like in the real world. Luxury lagged behind the digital revolution. Luxury firms lag behind mass-market companies in e-commerce and social media for various reasons. Luxury clothes brands' biggest challenge is replicating the luxury experience online.

Legal Structure: Luxury fashion brands and NFT start-ups should be cognizant of legal issues. Buyers should be mindful of the "smart contract," a compilation of computer code and data that works as self-executing software and may supply the NFT conditions. The buyer should be informed of acquired rights and liabilities that could affect the NFT and underlying asset's value. Luxury fashion brands who want to enter the Metaverse must register their inventions and trademarks with the USPTO and other agencies. To secure exclusive rights and avoid brand damage like trademark dilution, a physical and metaverse plan may be needed.

Phygital Goods: The long-awaited meta-economy will revolutionise how people engage, purchase, and connect, creating new luxury business options. NFTs can give your goods a digital overlay. Therefore, real-world purchases that unlock virtual realms. Branded goods for customers and avatars will soon be available. Cult & Rain, a New York-based digital luxury fashion firm that makes high-end physical footwear, launched its first NFT shoe line to merge the virtual and real worlds.

Laying the groundwork for long-term environmental sustainability: Cryptocurrency and high-end fashion may not have the finest reputations when it comes to environmental effect. Bitcoin, for example, consumes half the energy consumed by the whole global banking industry. The good news is that not all cryptocurrencies are equally harmful to the environment. Others, such as Solana, have turned carbon neutral. In short, the environmental impact is totally dependent on you and how you construct your NFTs. If one is thinking about using NFTs in business, it can be given back to the environment simultaneously.

Establishing an online community: According to our 2022 Future of Commerce survey, 40% of luxury firms intend to offer more methods for customers to connect with them in 2022 and beyond. A thriving community is one of the most fundamental foundations of a successful ecommerce brand. Each successful NFT effort has a thriving community where consumers can interact with your business and volunteers may form lasting bonds. Premium brand digital artefact buyers are motivated to refer more individuals and become brand ambassadors.

Customized experiences: Exclusivity fuels desire. Customers want unique, customised experiences from their preferred luxury brands. Epsilon found that when premium businesses offer personalised experiences, 80% of customers are more likely to buy. An NFT collection with member-only advantages may strengthen client relationships. NFTs allow customers to show off their business ownership on social media. Ownership fosters emotional attachment, allowing clients to continue and increasing client lifetime value.

Create one-of-a-kind loyalty programmes: Tailored loyalty programmes with NFTs can provide a competitive advantage to premium businesses in the future of commerce. Luxury fashion companies may utilise NFTs to provide customers tokens in return for discounts, early access to new goods, membership in exclusive groups, access to special events, and much more.

6.0 Limitations

First, the luxury fashion industry has only lately started employing NFTs, thus there are few cases to investigate. Further literature and examples are needed to apply the findings to traditional luxury fashion firms. These luxury fashion NFT projects' financial and visual effects are being explored. Combining research findings with updated long-term effects of adopting NFTs into a brand's commercial plan may allow for more comprehensive conclusions.

- Second, the NFT market is growing technically and in popularity, influencing its digital asset status. NFTs, a new asset class, may cause clients and luxury fashion companies unexpected issues. Further research on legal developments is needed to update the findings.

- Third, the luxury fashion sector and NFTs are complex, making research difficult. Future research should additionally categorise luxury fashion buyers. This article discusses luxury fashion consumption by younger, richer consumers.

Then, each segment's fashion NFT purchase motivations and behaviours can be studied. Digital fashion may appeal to elderly consumers, but more research is needed to establish how fashion corporations can advertise it to them and reach new and existing consumer groups. Owing to the complexity and ongoing evolution of NFT and luxury fashion, nomenclature is still inconsistent, making literature and theoretical background interpretation challenging.

-Finally, the fashionable NFT road is long. Virtual fashion uses 3D NFTs, which are underdeveloped for mainstream fashion customers and have minimal virtual use. As virtual reality and the metaverse grow in popularity, NFTs will change. These cases use real, imaginary, and revolutionary luxury fashion NFT, which the findings section states is the best method for integrating and selling digital assets. Virtual components may take precedence over physical experiments and products.

7.0 Conclusion and Scope

Metaverse platforms are increasingly becoming a valuable potential for luxury brands. To please luxury shoppers, a brand must offer a superior online experience, such as personalised chat or technical support. Luxury shoppers have been used to purchasing the goods they desire. NFTs have shattered the single-ownership model of luxury products while securing simulated products' scarcity. NFTs certify asset ownership and record it on an open-source blockchain registry. Therefore, NFTs are a novel way to track ownership while protecting the luxury industry's exclusivity. As part of their digitalization plan, luxury brands have entered the NFT

market, and the debut of NFT works has boosted their virtual presence and stimulated digital innovation. Digital fashion, bitcoin, and NFTs have allowed fashion houses to expand outside their physical goods and brand culture. Due to new categories of offerings that merge the physical and digital worlds, conventional luxury fashion companies are now able to create and express their creative work across several channels, including digital ones. This aids in the battle against counterfeiting and maintains the brand's appeal to customers. NFTs may assist fashion enterprises in reaching out to new clientele and broadening their horizons beyond the physical, giving them countless creative choices. Instead of simply replacing a physical garment with a digital one, NFT fashion provides a chance for established luxury fashion houses to make a name for themselves online and gain access to a previously untapped commodities market and audience. The luxury fashion business was forced to join the crypto frenzy of non-fungible tokens. Gucci, D&G, LVMH, Burberry, etc., also joined this digital race. Gaming, art, and virtual fashion have seen collaborations amongst high-end fashion brands. In order to increase brand awareness among Gen Z, fashion companies have started to provide NFTs as customised video game avatars, 3D galleries, virtual clothing, in-game merchandise, and tribute videos as artwork. Users are able to interact, personalise, and play with like-minded people in the virtual world by using virtual collections offered by various businesses. Exclusiveness naive notion was also adopted to keep updated with technology and serve the community. In many cases, NFT sales revenues were donated to charities helping Covid-19 sufferers. Luxury companies embrace NFT's future in line with the current trend. For designers, artists, innovators, and computer professionals, NFTs will open up a variety of opportunities. Social media has made people more self-conscious about their online persona than their outward appearance. With the elimination of physical garment production thanks to this new technology, premium fashion companies may analyse digital clothes and guarantee sustainability.

Non-Fungible tokens entered the market sooner than predicted, hence their future is important. To comprehend futuristic possibilities, we must analyse luxury fashion's pointers. Some companies see it as a risky venture, while others see it as an opportunity to grow. Due to crypto's volatility, sceptics won't go with the flow without a trend or research. Luxury fashion is optimistic about the potential benefits that blockchain will offer for companies and end consumers, even if certain problems were covered in the Weakness & Threats part of the SWOT Analysis. The way we currently view life and how we experience the world will be completely altered by this technology. Gartner predicts that by 2026, one-fourth of people will use the metaverse for work, commerce, education, socialising, and leisure. Most luxury brands may not completely appreciate the power of wearable digital fashion and NFT features like unlock values. Therefore, further research and patience is needed before fashion NFTs can become the new normal for most premium fashion brands - we're just scratching the surface of what NFTs can unlock for luxury fashion.

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Journal of the TEXTILE Association

GARMENT

Seams - A Comparative Study of Hand Stitch And Machine Stitch

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Abstract:

Background

Indian Apparel industry is one of the largest and fastest growing industries in the world. It is one of the largest contributors to net foreign exchange earnings of the nation through export. Quality and Serviceability are the two components which can be defined by the workmanship, material, acceptable design, and comfort in the apparel. Serviceability depends on the structural construction of the garment of which seams play an important role. In India hand stitches has been used in traditional garments which have survived over a period of time. Also from review, it was found that hand stitches are stronger than machine at some places in apparel.

Method

Back stitch and chain stitch are two important hand stitches which are stronger than machine stitch. This research was carried out to compare the machine stitch with hand stitch for its strength and increasing durability at specific parts in the garment. Cotton and silk fabrics were used. Both samples were stitched by hand and machine using two types of thread i.e. cotton and nylon. The seam strength of all the samples was tested on seam tester using test method ASTM D-1683-04.

Result

It was observed that hand running stitch possessed better seam strength as compared to machine stitch. Thus hand stitch can be used in place of machine stitching for specific end uses at some places. Hand stitches done with nylon thread on cotton fabric gave the excellent result. Thus hand stitches can be used for structural as well as for decorative purpose.

Keywords: *Durability, Hand Stitch, Machine Stitch, Seam, Serviceability*

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1. Introduction :

India is rich in varied traditional hand crafted products. Numbers of people are skilled in hand stitching [7]. These skills are imbibed by succeeding generations through a cultural tradition and legacy but are not able to compete with the machines and so are losing on employment and recognition. Good design with proper use of hand stitching skill to produce quality product will help in generating employment to such a larger sector where people know and can afford hand stitch only.

Hand stitching is one of the oldest construction techniques and continues to be superior for finishing high-value and bespoke items even today. Stitching by hand is still prevalent in India, but only at household level. Fall on the sari and finishing on the edge of the dupatta and stoles are the common examples of hand stitching. There is a need to support and popularize this skill for sustainability. Good design incorporating hand stitches can be used for this purpose. The hand stitched techniques explored to construct garment will allow the designer and skilled people to experiment with a range of materials from conventional to cutting – edge where in hand seam can be used not only for decorative aspect but also for structural designs.

Apparel is the conversion of a two dimensional fabric into a three dimensional product. Seam is one of the important parameter and considered as basic requirements in the construction of apparel [5]. Its quality had great significance in the production of finished apparel products. Quality and Serviceability are the two principle components of apparel. Quality can be defined by the workmanship, material, acceptable design, and comfort in the apparel [3]. Serviceability depends on the structural construction of the garment of which seams play an important role.

A seam is a joint between two pieces of fabric and gives the shape of the apparel for wear [7]. Consumers evaluate seam quality mainly based on the seam appearance and its durability after wear and care procedures. Various types of seam, stitches can be applied on finished fabric (garment) with different stitch density (SPI) having diverse effects on the seam strength, quality in general and performance in particular. The Probability of the seam performance for different garment is also different depending upon the end use [2]. Machine stitching ensures a consistent and repeatable joint at higher speeds than sewing by hand. Since the invention of the sewing machine, hand techniques are reserved either for repairing or temporary or for the highest quality applications and for elements of construction that machine still are not capable for a finished apparel product.

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Durability of clothing is most important which is determined by the strength of seam [1]. Many studies have been carried out on the parameters which affect the seam efficiency, but there is still a gap of reported research work regarding the effect and comparison of hand stitching with machine stitching for better strength of the seam construction for apparels.

There are many factors which affects the seam strength. Seam appearance and performance depends on the type of fabrics, thread, and stitch type, type of seam and sewing parameters, which includes the needle size, stitch density, the appropriate operation [4]. The quality of seam can be examined from two main aspects: functional and aesthetic performance. The functional performance of the seam is mainly in terms of the strength and efficiency of the seam [6]. The visual and functional requirements of the apparel are mainly visualized through the performance features. Visual requirements are based on the patterns, design, colors, trends and accessories. The functional requirements are more associated to the durability of the apparel end use. The seam enhances serviceability and durability for functional performance of the fabric [9]. Both functional and aesthetic performance of an apparel product in terms of durability and stability are affected by seam strength.

Tensile strength and seam properties are the key performance indicators for final apparel to be fit for the end use [7]. Seam efficiency has been defined as the ratio of seam strength to the strength of the fabric in-sewn expressed as the percentage of the fabric strength [8]. In hand stitching, there are many types of stitches each one has evolved for a particular function and appearance. They may be visible and matched or contrasting depending on the desired effect, or concealed within the hem. In this study, seam strength of woven fabrics was studied for seam by machine and hand.

2. Material and Method

2.1 Materials

Woven fabric – cotton and silk of light weight with a 73 GSM and 43 GSM respectively were used to test the seam strength. The cotton and silk fabric were procured from Local market. The specifications of the fabric are given in Table1. For hand as well as machine stitch samples cotton and nylon thread with the specification given in Table 2 were used.

2.2 Method

The samples were cut in size of 14inches x 4 inches, by using ASTM D-1683-04 to test the strength of seams in woven cotton and silk fabrics. Plain seam was done by machine and running stitch by hand. Both for hand and machine sample, cotton and nylon thread were used. For each sample stitching was done leaving a seam allowance of 0.5 inches at the edge using a stitch type 301 and density of 12+- ½ stitches per inch. For testing strength of the seam tensile strength tester with test method D 5034 conforming to specification D 76, and a constant rate of extension capable of jaw separation rate of 12.0 +- 0.5 in./ min was used.

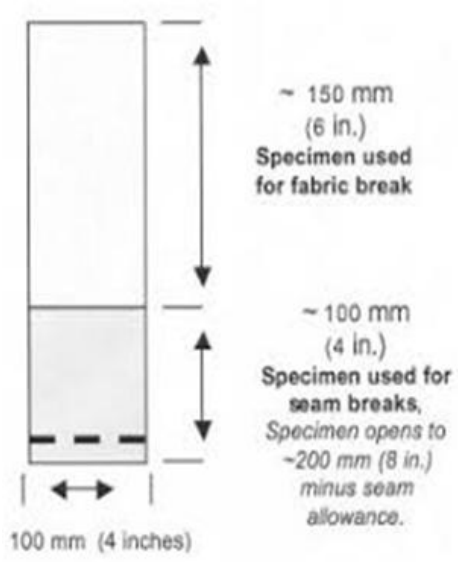


Figure 1- Seamed specimen size and placement in clamps

3. Result and Discussion

3.1 Preliminary data of the fabric

Fabrics used for the study were tested for its preliminary data.

Table 1: Preliminary data of the fabric

Fabric	Weave Type	Weight per unit areas	Fabric count (In Inches)		Yarn count	
			EPI	PPI	Warp	Weft
Mulmul	Plain	73	28.76	25.25	18	16
Tussar Silk	Plain	43	13.36	6.42	25.6	50.6

% of Drape Coefficient	Thick ness	Tearing strength	Tensile Strength	Cover Factor
0.15	0.80	63	17.32	28
0.28	0.12	42	10.26	16.64

3b. Preliminary data of the yarn used for hand and machine stitch:

Yarns were tested for the preliminary data using the formulas given below:

I. Ticket number = Resultant count(RC) x 3, where RC is yarn count and number of plies

II. %Shrinkage : $\frac{\text{Elongated length}}{\text{Original length}} \times 100$

III Diameter $= 1/28\sqrt{Ne}$

Thread used for experiment were with specification given as below.

Table 2: specification of thread used for the construction of plain seam

Yarn	Ticket No.	Twist/ inch	Ply	Diameter	Tensile strength	Tex
Cotton	30	Z(103)	2	0.26mm	0.46 kg	51.6
Nylon	26	S(65)	2	0.28mm	1.74 kg	57.2

The strength of stitches on cotton and silk fabric was tested for both hand and machine

3c. Results of the test on cotton fabric are given in table below

Table 3: Strength of seam on cotton fabric

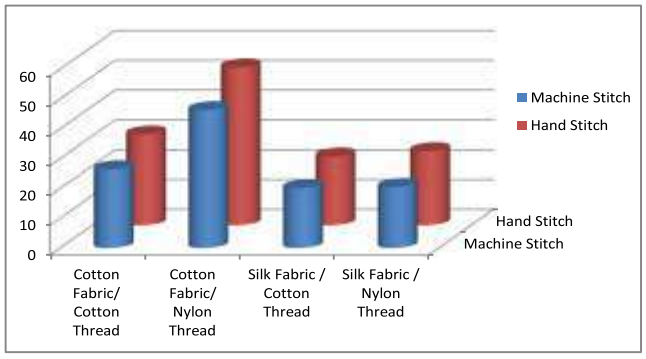
Fabric	Cotton thread (kg)		Nylon thread(kg)	
Cotton fabric	Hand Seam	Machine Seam	Hand Seam	Machine Seam
	30.44	26.45	52.96	46.28

From table 3, it was observed that hand stitched samples showed better results in both cases as compared to machine stitch sample. Thread used for stitching also plays an important role. Strength of samples stitched with nylon thread showed better results for both hand stitch and machine stitched samples. For samples stitched with cotton thread on cotton fabric hand seam showed strength of 30.44 as compared to machine stitched sample which showed strength of 26.45. Hand seam is stronger than machine seam here. With the nylon thread on cotton fabric hand seam exhibited strength of 52.96 whereas machine seam exhibited strength of 46.28 which is less than hand stitch sample. Seam of the sample with nylon thread was stronger than the samples with cotton thread. Difference between the cotton thread and nylon thread samples in hand seam showed much difference which was also observed in machine samples.

Table 4: Strength of seam on silk fabric

Fabric	Cotton thread (kg)		Nylon thread(kg)	
Silk Fabric	Hand Seam	Machine Seam	Hand Seam	Machine Seam
	23.07	20.05	24.85	20.44

From table 4, it was concluded that hand stitched samples showed better results in both cases as compared to machine stitch sample. Strength of samples stitched with nylon thread showed better results for both hand stitch and machine stitched samples. For samples stitched with cotton thread on silk fabric hand seam showed strength of 23.07 as compared to machine stitched sample which showed strength of 22.05. Hand seam was stronger than machine seam here. The pattern was same as observed in case of cotton fabric. With the nylon thread on silk fabric hand seam exhibited strength of 24.85 whereas machine seam exhibited strength of 20.44 which is less than hand stitch sample. Samples with nylon thread were stronger than samples with cotton thread. Cotton thread hand and machine seam showed better strength than nylon thread samples for both hand and machine seam .



Graph 1: Breaking strength of the seam

In graph 1, X-axis shows the samples and Y-axis shows the strength of each sample. From the graph it was concluded that hand stitch is stronger than machine stitch in all the four cases.

The maximum strength of the machine seam sample was in the case of cotton fabric with nylon thread whereas minimum was in case of silk fabric with cotton thread. For hand stitch samples also the maximum strength observed was in the case of cotton fabric with nylon thread whereas minimum was in case of silk fabric with cotton thread. Out of the samples tested, the seam done by hand using nylon thread on cotton fabric showed the best result.

4. Conclusion

From the above it was concluded that for plain seam hand stitch sample showed better strength than machine stitched samples for both cotton and silk fabric. There was difference in the seam strength on cotton and silk fabric. Cotton showed better results than silk fabric. Difference in strength with cotton and nylon thread was observed on same type of fabric. Samples with nylon thread showed better results. For better seam strength the combination was use of nylon thread on cotton fabric with hand stitching. It is not only the type of base material and type of stitch but also the type of thread influence the strength of the seam. Wherever machine seam generally fails hand stitching can be used. Garments can be made by hand stitching if speed of machine is incomparable. Designs made with hand stitch in combination with machine stitch can be explored.

5. Recommendation

In this sustainable movement scenario, people are experimenting with new methods which are environmentally safe, sustainable and innovative as well. The shift from machine to hand stitching for innovative designs can be one of the methods towards sustainability giving opportunity to people who do not have investment capacity for machine but possess skill. There can be further study which can be carried out on the different types of seams used to strengthen the seam using hand stitching. It can be explored to be used for construction, surface ornamentation and both for innovative designs. People who are not working as professional in the field of design but are skilled with hand stitching will be benefitted with this kind of projects.

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REVIEW

The Potential of Abelmoschus Esculentus Fiber

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Abstract:

Now-a-days, natural fibers becoming out of competition for commercial applications because of the versatility of synthetic fibers and the drawbacks of natural fibers. Synthetic fibers may not be available in the future and may harm nature as they are petrochemical based and non-eco-friendly. The natural fiber availability is also limited and therefore consistancy needed to discover new natural fibers and check their potential for commercial applications. The Abelmoschus Esculentus (Okra) plant became agricultural waste after harvesting okra fruit. This okra plant waste can utilize for the extraction of Abelmoschus Esculentus (okra) fibers like other bast fibers. The efforts given for the extraction of okra fiber can produce good quality of fibers and also reduce greenhouse gaseous generated due to the burning of agricultural waste. This review article focused on the characteristics of the okra technical fiber which can be utilized for various applications. Also, create awareness about the extraction of okra fiber from the agricultural okra plant waste which can increase the per capita income of the Indian farmer. Also, invoke the researcher to develop various applications of okra fiber like that of other bast fiber.

Keywords: *Abelmoschus Esculentus fiber, Agricultural waste, Applications, Characteristics*

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1. Introduction :

Abelmoschus Esculentus (Okra fiber) is the bast fiber extracted from the green stem of the okra plant. Okra plant is a monocotyledonous plant belongs to Abelmoschus esculentus family. Okra plant cultivated for the okra fruit commonly called "bhindi". Other names of the okra are mentioned in Table 1[1, 2]. Okra plant is cultivated in two seasons in a year and grows an average height of 4-7 feet. After collecting okra fruit, a huge amount of okra plants are discarded as agricultural waste. The discarded stem of the green okra plant can be utilized for the extraction of technical okra fiber.

Table 1 - Other names of okra

Scientific Name	Abelmoschus Esculentus (Hibiscus Esculentus)
Common Name	Lady Finger. Okra
Vernacular Name	Okra, Gumbo
Sanskrit Name	Tindisha, Pitali, Gandhamula
Hindi Name	Bhindi
English Name	Okra, Lady Finger, Edible Hibiscus, Ockro
Middle East	Arabic Farsi: Hebrew
	Turkish: Bamia and Bamveh
	Italian: Gombo
	French: Gombo
	Swedish: Okra

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The okra fiber extracted from agricultural waste shows similar advantages like conventional plant fibers compared to their petro-based counterparts, renewable resource, low cost, low density, biodegradability, good energy recovery, low embodied energy, and CO2 neutrality. Other than this, the production of okra fiber does not require extra use of fertilizers, pesticides, and like as these are already used for the cultivation of the main crop [3, 4]. The growth of the okra plant depends on geographical conditions, soil conditions, age of the plants, climate, variety, etc. Depending on the growth of the okra plant, the stem of the okra plant can yield about 10-25% okra fibers of the weight of the plant (dry basis) [5].

In India, okra is the main vegetable in the diet because of its good nutritional value, and a good amount of vitamin A and folic acid, besides carbohydrates, phosphorus, magnesium, and potassium [6]. India is the largest producer of okra about 73% of the total annual production of okra in the world. Therefore, it is necessary to advocate the Indian researchers and farmers about the utility of okra fiber for different textile applications like banana fiber, so that Indian farmers can gain additional income (about 10-11% of the profit gained by okra cultivation) with okra cultivation.

The technical fiber made from the okra plant can be used for a variety of applications was the main focus of this review article. Also, this review generates awareness about the ability of agricultural okra plant waste to be converted into okra fiber, which can boost the per-capita income of Indian farmers. Additionally, appeal to the researcher to discover various commercial uses for okra fiber, similar to those for other bast fibers.

2. Extraction of okra fiber

The extraction of the bast fiber can be done by various

methods like dew retting, cold water retting, hot water retting, mechanical separation, chemical extraction, enzymatic extraction, and ultrasonic separation steam explosion [4, 7]. The most versatile, efficient, economical, and easy process is the cold-water retting process [8]. In this process, after the cultivation of okra fruit, the green okra plant has been collected. After collecting the fresh plant, about three months old and around 6.5 feet high, the central part of the stems was removed and kept underwater to allow microbial degradation. Within 12-15 days the stems degraded appreciably to allow fiber extraction. The fibers were isolated from the degraded stems by being washed three times, using deionized water, then tied with ropes, and dried by sunlight in the open air. The dried okra fibers (as shown in figure 1) are kept in a moisture-proof container afterward for storage.

Figure 1- The dried okra fibers

3. Chemical composition of okra fiber

The okra fiber is categorized as a lignocellulosic bast fiber that contains high cellulose content like that of other bast fibers viz. banana, jute, hemp, and ramie [9]. Physically, the okra fiber is bright, shiny, strong, and naturally golden in colour. The okra bast fiber chemical composition is very similar to other common plant fibers such as jute, flax, hemp, etc. [10, 13]. The main chemical constituents of the okra fibers (as shown in Table 2) are cellulose, hemicellulose, and lignin along with pectins, fatty and wax matters, and protein [10, 11]. The chemical composition of the fibers varies on the species and geographic location, age, climate, soil condition, and fiber extraction method [11, 12]. Since the major components of plant fiber are cellulose, hemicellulose, and lignin, the fiber structure and properties are depended on those components [12].

Table 2 - The okra fiber chemical composition

Sr. No.	Composition	Weight%
1	α-Cellulose	60-70
2	Hemicellulose	15-20
3	Lignin	5-10
4	Pectins	3.4
5	Fats and waxes	3.9
6	Water-soluble compounds	2.7

4. Physical structure of okra fiber

The okra fiber is polygonal in shape that varies from irregular to circular shape. The range of diameter of the okra fiber varies from about 60-100 µm. The average diameter and standard deviation of all the fibers were 80 ± 20 µm. The cell wall thickness and lumen diameter vary typically between 1 to 10 µm and 0.1 to 20 µm, respectively. As a consequence of it, the considerable difference in the diameter values of the single fiber and lumen, and their rough shape strongly affect the mechanical and dimensional properties of okra fibers. The fineness of the okra fiber is not uniform throughout the length and it is about 4-10 tex. The length of the okra fibers is about 10-50 cm depending on the physical behavior of the okra plant. The density of the okra fiber is about 1.15-1.40 gm/cc which is lower as compared to other bast fibers. Therefore, it is lighter in weight. The length-to-breadth ratio of the okra fiber is 153-280 [8, 13-15].

5. Thermal properties of okra fiber

The thermal properties of okra fiber have great importance to decide the suitability of the fiber for various applications. The weight loss of okra fiber is done in three stages and thermal decomposition is done in two stages. In the first stage of weight loss, about 8-9% weight loss of the okra fiber was observed due to water vaporization in the temperature range of 30-100 °C. In the second stage of weight loss and the first stage of thermal decomposition, about 16% weight loss of the okra fiber was observed in the temperature range of 220-310 oC due to thermal depolymerization of hemicellulose, pectin, and the cleavage of glycosidic linkages of cellulose. In the third stage of weight loss and the second stage of thermal decomposition, about 67% weight loss of the okra fiber was observed in the temperature range of 310-390 oC due to the degradation of the α-cellulose present in the fiber [14]. The decomposition of lignin, owing to its complex structure, occurs slowly within the whole temperature range. Furthermore, the residual weight percentage was observed at about 7.5%. In an inert atmosphere, the final products of the degradation of cellulose consist of carbonaceous residues and possible undegraded fillers [16]. It is important to know the thermal degradation of the okra fiber because processing at high temperatures and longer times can be caused fiber degradation [13].

6. Mechanical properties of okra fiber

Okra fiber is not uniform in diameter; therefore, it is very difficult to analyze the mechanical behavior of the okra fiber. The okra fiber possesses brittle behavior like that of jute. Okra fiber is lighter fiber as the its density is 1.15-1.4 gm/cc. Therefore, mechanical performance of okra fiber is also nearly like that of jute fiber [11]. The tensile strength of the okra fiber varies from 230-550 MPa. The bundle strength of the okra fiber is about 6.5 to 10.9 Kgf. The tenacity of the okra fiber is 25-45 gpd, whereas the elongation is 1.6-3.2%. Young's modulus is 12.8-16.9 GPa [8]. The tensile strength and Young's modulus are varies with respect to the diameter of okra fiber. Both properties reduce as an increase in diameter in all natural fibers. The same behavior is followed by the okra fiber according to the diameter of the okra fiber. The okra fiber possesses a relatively high modulus and significantly lower elongation compared to coir and husk fiber. The overall mechanical behavior of the okra fiber is similar to jute and sisal fiber [14, 17].

7. Moisture absorbency of okra fiber

All the plant fiber has good moisture absorbency, which was one of the drawbacks for certain types of plant fiber applications like fiber-reinforced composites [17]. The okra fiber possesses about 15-20% amorphous structure which is responsible for 7-8% moisture content of the okra fiber. The tendency of moisture absorbency can be increased or decreased by various treatments on the okra fiber. These treatments on the okra fiber were implemented according to end use of the okra fiber. The moisture absorbency behavior of the okra fiber is also similar to jute and sisal fiber [13, 14].

8. Applications of okra fiber

The okra bast fiber properties are similar to other bast fibers like jute and sisal. Therefore, the potential area for the okra fibers are [8, 13, 14, 17]:

1] Home Textiles: Multi-coloured /bleached, dyed, printed, and processed okra or okra/cotton upholstery and upholstery fabrics, tapestry, wall coverings, floor coverings, floor mats, soft suitcases, aprons, hats, gloves, folder covers, shoes, tablecloths, fashion accessories Lace, patchwork and weaving, gift boxes, and other handicrafts made from okra fibers, yarns, and fabrics. Environmentally friendly okra upholstery fabrics and tarpaulins made from okra or okra mixtures.

2] Geotextiles: Okra Geotextile is used to control surface soil erosion on slopes and plains, as well as embankment stability, road subsoil reinforcement, river and waterway embankment protection, underground drainage, soft ground reinforcement, and other applications. As a result, the okra geotextiles bear the burden. During the construction phase, it serves as a separator, acts as a filter, and controls cross-scattering, subsidence, and landslides.

3] AgroTextiles: Okra fabrics are now used as sunscreens, plant nets, windscreens, harvest nets, field nets for crop protection from birds, weed control, seed mulch, soil conservation, semi-arid forest development, nursery pots, and so on.

4] Fiber-reinforced composite material: Okra fibers are lighter, have less elongation%, have good stiffness, are durable, have good thermal stability, and have good tensile behavior therefore it has the potential to use for fiber-reinforced polymer composites for commercial applications. Okra fiber can be used in paper-fiber composites and paper-fiber laminates.

9. Future scope of okra fiber in India

- The research on okra fibers will prove its potential for various commercial applications.
- The research of various after treatments on okra fibers will improve the properties of okra fibers for the specified application.
- The research on standard okra fiber extraction process will help agriculturist to increase per capita income with okra farming like banana farming.

10. Conclusion

The research so far on okra fiber proves its potential for commercial textile application. The characteristics of the okra fiber are analogous to the jute and sisal bast fiber which concluded that okra fibers can be utilized for applications where jute and sisal fibers are generally used. The under-utilization of the okra plant for fiber extraction is mainly due to appropriate awareness, knowledge, facility, and technology availability. The augmentation in a commercial application will solve this problem. The chemical composition, physical properties, thermal properties, mechanical properties and moisture absorbency of okra fiber reviewed in this paper prove the suitability of okra fiber like jute, sisal, and banana fibers for commercial applications. The improvement in the commercial application of okra fibers creates scope to improve the per capita income of the farmer and also reduce the emission of greenhouse gaseous generated due to burning of the agricultural okra plant waste.

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FIBRE

To Study the PET/Bamboo & PET/Cotton Blend Yarn to Made for the Knitted Fabric on Comfort Properties Behavior: Part-I

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Abstract:

Comfort is one of the most essential aspects of clothing, so properties such as air permeability, water vapour permeability, and liquid water permeability are critical for a clothed body's comfort. In this research work the effect of yarn count, types of fibre and blend composition on fabrics properties made from Polyester/bamboo and Polyester/cotton blended yarn has been studied. Three types of blend of polyester/bamboo and polyester/cotton (80/20, 65/35, 50/50) are used for 20s and 30s Ne yarn preparation. However, as cotton content percentage increases in the blend, imperfections, hairiness, unevenness & increases. Hairiness value decreases with increase in bamboo content % in blend. Water vapour permeability is higher in polyester/bamboo fabric as compared to polyester/cotton blended fabrics.

Keywords: *Knit Fabric; Water Vapour Permeability; Imperfections & Mass Irregularity; Hairiness*

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1. Introduction :

In last ten years the technology is changed a lot of, the demand of fabric is also changed and the changes in the cloth comforts in which sensorial, psychological and thermo physiological comfort. It is now not only about style and durability. The factors on which comfort is based are types of fibre, fabric structure, yarn properties, finishing treatments and clothing conditions [1]. Fabric's thermal comfort is controlled by the heat movement, flow of moisture and air through the fabric. To increase the properties of resultant yarn type and to reduce the cost of the raw material blending of different fibres is done which is a common practice in the spinning industries. The percentage of fibres in the blend have effect on various properties and besides it, the properties of blended yarns are affected by the properties of the constituent fibres and their compatibility. Further, it is observed that the stronger fibres have to be blended at least by a certain percentage in order to increase the tensile properties [2, 3]. Bamboo has a number of particular properties like anti-static property , inherent antibacterial property (a single antiseptic and bacteriostatic bio-agent known as "Bamboo Kun" is strongly combined with bamboo cellulose molecules and remains during the process of being produced into bamboo fibre) and good UV defense [4, 5]. Bamboo cellulose fibres that have been regenerated provide excellent comfort in a variety of applications. Innerwear, hygienic goods, home furnishings, sanitary fabrics, and nonwovens all use regenerated bamboo fibre these days [6, 7]. Eco friendly processes have been developed for the bleaching of fabric with a viewto reduce the water consumption and processing time. There is no significant difference in thewhiteness values. Further, by employing eco-friendly processes, there is significant decrease involume of effluent generated [8, 9, 10].Although considerable research work carried out on study of cotton and bamboo fibres for apparel applications but limited work available on blended fabrics with finishing treatment like enzymatic finishing. Hence, in this research work, yarns and fabrics made from different blends of polyester/ bamboo and polyester/ cotton have been studied and analysed in grey and Bio- Finished stage. Due to the increasing demand for knitted garment these days, knitted fabrics have been produced and studied.

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2 Materials and Methods

2.1 Raw Material

In the present study the various elements of textile material have been taken into account. For the blended fabric sample preparation three fibers used are Bamboo, Polyester and Cotton. Polyester fibers in various proportions are blended with two different fibres.

2.1.2. Fibres Parameters

Table 1 Specification of fibres

Fibre	Length (in mm)	Fineness	Tenacity (gpd)	Short fibre %	Elongation %
Bamboo	38	1.54 D	2.5	-	20.8
Cotton	30	3.5mic/1.23D	3.5	7.5	5.3
Polyester	38	1.38 D	5.8	-	24

2.1.3. Preparation of yarn samples

20s Ne and 30s Ne yarns were prepared in the ratio of (50:50, 65:35, 80:20) using blend of Bamboo and cotton fibre with Polyester. A uniform blend of polyester/bamboo and polyester/ cotton is produced by manual opening and mixing. The ratio taken blending of Bamboo and Cotton fibres with polyester is (50:50, 65:35, 80:20) for Polyester : Bamboo and (50:50, 65:35, 80:20) for Polyester : Cotton. By blending, the functional properties, process performance properties get improved and also it helped in the reduction of cost of mixing. In a Lakshmi Rieters blow room line a predetermined quantity of fibres were mixed and processed.

2.1.4. Fabric samples preparation

The above P/B and P/C yarns were used to make fabric, the no. of different samples were twelve, by using 20s Ne & 30s Ne using circular knitting machine of single jersey. These samples were prepared from polyester/Bamboo and Polyester/Cotton in two set.

2.1 Methods

Before testing, the conditioning was done for 48 hours of all samples in standard atmospheric condition where temperature was 27 ± 2°C and relative humidity 65 ± 5% as per standards.

2.1.1 Water vapour permeability

This test was carried out by cup method of water vapour permeability. As per the standards of British version the fabric sample for testing is fit over the open mouth of a pot like cup which is was filled with water and this was kept under standard atmospheric condition for testing [BS7209]. This water pot is then weighted after a time period when it will achieve equilibrium and after that the calculation was done of water vapour transfer rate from the specimen.

The index of water vapour permeability is determined as a percentage of the WVP of a standards fabric sample which is taken as a reference fabric along with the test specimen.

Table 2 Specification for the Polyester/Cotton and Polyester/Bamboo fabrics

S.No.	Blend ratio & samples	Count (Ne)	GSM (g/m^2)	Stitch length (mm)	WPI	CPI	Stitch density	Thickness (mm)
1.	80/20, PET/Cotton	20s	275	3.5	42	35	1470	0.672
2.	65/35 PET/Cotton	20s	270	3.5	42	37	1554	0.652
3.	50/50 PET/Cotton	20s	270	3.5	42	37	1554	0.652
4.	80/20, PET/Bamboo	20s	265	3.5	41	36	1476	0.641
5.	65/35 PET/Bamboo	20s	268	3.5	41	37	1517	0.651
6.	50/50 PET/Bamboo	20s	272	3.5	42	35	1470	0.662
7.	80/20, PET/Cotton	30s	228	3.5	47	42	1974	0.621
8.	65/35 PET/Cotton	30s	220	3.5	47	43	2021	0.601
9.	50/50 PET/Cotton	30s	218	3.5	46	44	2024	0.602
10.	80/20, PET/Bamboo	30s	221	3.5	47	73	2021	0.599
11.	65/35 PET/Bamboo	30s	224	3.5	47	42	1974	0.611
12.	50/50 PET/Bamboo	30s	226	3.5	47	41	1927	0.612

2.1.5. Bio-finishing treatment

In bio-finishing, 1% concentrated cellulose enzyme was used and 2g/l acetic acid was added in the bath to make a 5.5 pH buffer solution. The fabrics were treated at a liquor ratio of 1:20 for 60 min at 55˚C.Then Na2Co3 was being added to the solution for deactivation by raising the temp up to 70°C for 15 min. After finishing, hot wash was done for 15 min followed by cold wash with addition of acetic acid for neutralization and then washed thoroughly with cold water and samples were air dried and conditioned.

The level of water in each pot is kept 10mm empty, which is kept for the air gaps between the fabric and water surface. For maintaining the fabric level a sample of wire is placed on each pot which gives the support to the fabric. Glue is applied to the specimen and mouth of pot, the diameter of sample is 96mm and it is kept on the top at its outside surface. This fabric is covered with ring and over the pot, the space between ring and pot surface is sealed by the PVC tape. The pot which is covered by another reference fabric is too prepared as like the sample fabric. All these pot are than kept in the standard atmospheric condition for testing and kept

here for about 1 hour to achieve the equilibrium. Weight of every pot is then taken nearest to 0.001g by noting the time. After keeping the pot for approximately 12 hours the weights of pots are again measured by noting the time also.

Calculations

$WVP = 24x\ W/At\ (g/m^2/day)$ …….(1)

Where, W = loss in mass (g), A = internal area of disk (m2), t = time between weighing (h),

$$A = \frac{\pi d2.10^{\tau}}{4} \quad \text{…….(2)}$$

Where, d =diameter of disk from internal side (mm)

The ASTM E 96-80 [47] an another method B is same as like the above method in which the gap for air in between the fabric and water surface 19mm (0.75 in) and a velocity of air of 2.8 m/s (550ft/min) is used on the fabric surface. The gap between the sample and water surface is important in these tests because air is also a higher WVP resistance [ASTM E96-80]. There are three factors on which set-up of experiment of total resistance to WVP depend.

Sometimes the experiment is carried out with the help of inverted cup in which the fabric inner surface is in contact with water [P.W.Gibson, 1993]. More favourable results can be found in favour with the hydrophilic fabrics by this method.

2.2.2 Imperfections and mass irregularity

In both types of yarns for the measurements of imperfections and mass irregularities the yarn at a constant speed was passed in between two capacitance plates. The principle of UT5 is measurement of capacitive. The change in mass of yarn is modified into an electrical signal. Now this electrical signal modified into another signal which is known as digital signals. UT5 computer then directly store and process these digital signals. The measurement of hairiness is then measured by UT-5 throughout the length of yarn.

2.2.3 Tenacity

Testing of yarns for tenacity was done using Uster Tenso Rapid-4 as per the standard (ASTM D-1578, JIS). TENSO RAPID-4 automatically gives some specific information about the yarn tenacity. During Testing the yarn sample is hold by two jaws, out of which 1st top jaw is attached with load cell and bottom jaw is moving down with a standard speed. The machine automatically calculates the breaking load for each sample.

2.2.4 Hairiness

The hairiness measuring system according to UT-5 measures the entire length of yarn. The hairiness value of UT-5 is called H (Hairs/cm).Mass irregularity and imperfections of both types of yarns were determined according to ASTM standards (D 1425/1425M-14) by Uster Evenness Tester-5 (UT-5). It is based on photo cell principle and is used to detect the fibres protruding from the surface as hairs of the yarns. The yarn to be tested it passed through the tensioners and between the photocell. As the yarn is drawn over the thread guide the projecting fibres interrupt the light beam. The resulting signal from the photocell is amplified, counted and displayed on the counter (ASTM D1425).

3 Results and discussion

3.1 Yarn properties

3.1.1 Unevenness % & Imperfections

It has been observed from Table 3 that the change in blend percentage in yarn influences unevenness & imperfections for both yarn counts. Further as the blend percentage of cotton increases in both (20s & 30s) yarn unevenness % increases, it is due to the higher percentage of short fibres content present in the cotton leading to floating fibres generation in the drafting zone. However as the proportion of bamboo fibre in blend increases no significant change has been observed in both the count as per unevenness is concerned.

It can be observed from Table 3 the imperfections values of Polyester/Cotton yarn found to increase with increase in the proportion of cotton fibre in both count due to the short fibre percentage. As far as Polyester/Bamboo yarn is concerned, total imperfections are lower as compared to Polyester/Cotton yarn as reported earlier.

Table 3 Unevenness (U %), imperfections of polyester-bamboo and polyester- cotton blended ring spun yarn

Yarn count (Ne)	Blend	U%		Imperfections per kilometre							
		Polyester/ Cotton	Polyester/ Bamboo	Polyester/Cotton				Polyester/Bamboo			
				-50%	+50%	+200%	Total	-50%	+50%	+200%	Total
20s	80/20	11.33	10.02	10.0	27.0	17.0	54	2.50	17.5	5.00	25
	65/35	11.25	11.27	2.50	47.5	15.0	65	3.50	22.5	25.0	51
	50/50	12.30	11.79	5.00	27.0	25.0	57	0.0	25.0	20.0	45
30s	80/20	12.24	11.42	30.5	25.0	41.5	96.5	15.0	27.5	22.5	65
	65/35	15.07	11.26	2.90	75.5	25.0	78.4	2.50	67.5	7.50	77.5
	50/50	14.23	10.45	8.50	37.0	77.5	123	0.0	45.0	42.5	87.5

3.1.2 Tenacity

It has been observed from Table 4 that the influence of change of fibre proportion of cotton and bamboo in the blended yarn affect tenacity. Further as bamboo and cotton fibre percentage in the blend increases, tenacity of yarn decreases. It may be due to the low tenacity of cotton and bamboo fibres and subsequently weak inter fibre cohesion of cotton and bamboo fibre in the resultant yarn because the fibre strength plays a key role in the yarn strength. Polyester/bamboo blended yarns have 18% (approx.) higher tenacity than polyester/cotton blended yarns.

3.1.3 Hairiness

It has been observed from Table 4 that yarn hairiness decreases as the % age of bamboo fibre increases when compared with cotton blended yarns. It may be explained in the light of fibre flexural and torsional rigidity. Cotton fibres have higher flexural and torsional rigidity as compared to bamboo fibre. Hence, wrapping of bamboo fibre is easier in the yarn body leads to lower yarn hairiness in P/B. There is a reduction in yarn hairiness when the %age of bamboo in increased. Polyester/bamboo blended yarns have 6% lesser hairiness than polyester/cotton blended yarns. A marked reduction is observed in hairiness with increase in linear density from 20s to 30s. The number of fibres reduces in the same blend proportion as the yarn becomes finer.

Table 4: Tenacity & hairiness of polyester-cotton polyester-bamboo blended ring spun yarn

Yarn Count (Ne)	Blend	Tenacity GPT		Hairiness(UT-5)	
		Polyester/ Cotton	Polyester/ Bamboo	Polyester/ Cotton	Polyester/ Bamboo
20^s	80/20	25.75	33.75	7.12	5.55
	65/35	23.75	28.17	8.15	6.23
	50/50	22.48	25.83	9.45	6.45
30^s	80/20	32.35	31.25	6.23	6.15
	65/35	23.24	29.89	6.95	5.96
	50/50	20.25	28.36	7.45	6.85

The effect of all experimental factors, viz. Fibre type, Blend, Yarn count & finishing treatment on fabric properties viz. abrasion resistance, bursting strength, pilling resistance, have been analysed.

3.2. Water vapour permeability

The effect of blend, count, fibre type & finish on water vapour permeability of the fabrics is represented in Table 5 and Figure 1. It has been observed that as the percentage of bamboo and cotton fibres increases in the blend, water vapour permeability of fabrics also increases. WVP is higher in polyester/bamboo blends as compared to polyester/cotton blends. It may be due to the higher moisture regain and micro porous structure of bamboo fibre. The WVP of the fabrics decreases as the count of the yarn increases. It may be due to the higher TPI of the yarn in these fabrics; which results more compactly packed fibres in the yarn. The WVP of the bio-finished fabrics is different for both polyester/cotton and polyester/bamboo blends. In case of polyester/bamboo blended fabrics water vapour permeability increases, it is explained in the light that these yarns produce a less hairy and compact structure which provides great inter-yarn space. On the other hand water vapour permeability reduces after bio-finishing for polyester-cotton blend, this may be due to the reduction of yarn inter-yarn space and pore size after finishing, because cotton component shrinks after finishing treatment.

Table 5 Effect of count, blend, fibre type & finishing on water vapour permeability of polyester-cotton and polyester-bamboo blended fabrics

Yarn Count (Ne)	Blend	Water Vapour permeability before Bio-Finishing (gm/m²/day)		Water Vapour permeability after Bio-Finishing (gm/m²/day)	
		Polyester/ Cotton	Polyester/ Bamboo	Polyester/ Cotton	Polyester/ Bamboo
20^s	80/20	1145.27	1195.30	1175.46	1405.29
	65/35	1427.18	1475.40	1255.32	1625.67
	50/50	1717.74	1805.25	1493.87	1945.55
30^s	80/20	1050.90	1215.55	1050.90	1254.78
	65/35	1465.60	1350.45	1186.75	1385.71
	50/50	1687.58	1445.54	1365.92	1652.29

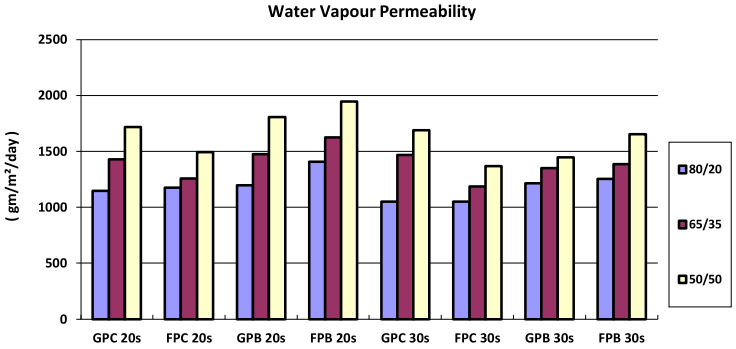

Figure 1 Effect of count, blend, fibre type & finish on water vapour permeability of fabrics

4 Conclusions

- Effects of Fibre: The polyester/bamboo blended yarns are not similar to polyester/cotton blended yarn in terms of their mechanical and physical properties. Bamboo blended fabrics have higher values of water vapour permeability rather than cotton blended fabrics.
- Effect of Blend: Water vapour permeability increase as bamboo and cotton % age increases.
- Effect of Count: As linear density increases water vapour permeability reduced.
- Effect of Bio-finishing: Grey Polyester/bamboo blended fabrics have higher values of water vapour permeability rather than polyester/cotton blended fabrics
- Bio- finished polyester/bamboo fabrics lower reduction in water vapour permeability is observed. For the apparel purpose 20s Polyester/bamboo is better compare to other fabric, this is due to its better moisture related properties.

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INDUSTRY 6.0

FROM INDUSTRY 5.0 TO INDUSTRY 6.0

Anti-fragile Manufacturing for People and Planet

Vilas Gharat, M.D., Gharat & Associates;
Mentor of Change, AIM-NITI Aayog, Govt. of India;
Board Member of Trustees (TAI – Mumbai Unit)

Industry refers to economic activities, which relate to conversion of resources into useful goods. Industry is concerned with the production or processing of goods and materials.

The causes of Industrial Revolution

The Major Causes of the Industrial Revolution Include.
1) Capitalism
2) European Imperialism.
3) Mining of Resources.
4) Impact of the Steam Power on the Revolution.
5) Agricultural Revolution.
6) Scientific Revolution.
7) Governmental Policies

Industrial Revolution 6.0

The Industrial Revolution brought rapid urbanization or the movement of people to cities. Changes in farming, soaring population growth, and an ever-increasing demand for workers led masses of people to migrate from farms to cities. Almost overnight, small towns around coal or iron mines mushroomed into cities.

It is a futuristic idea, where various manufacturing operations and services will be provided to customers using Artificial Intelligence, Cloud Computing energy, Human–Robot working, Big data, where satellite and industrial AI (Artificial intelligence) will enabled robots to assist the supply chain

Will there be a sixth Industrial Revolution?

As we enter the 6th industrial revolution, also known as Industry 6.0, one technology stands out as a game changer: Artificial intelligence (AI). The integration of AI technology into various industries is bringing about a new wave of Automation, Efficiency, and Innovation.

Goals of Industry 6.0

Some features may be termed as a) Information flow beyond, b) Planetary Boundaries, c) Antifragile Manufacturing, and d) satellite communication.

- Information streams in hyper connected ventures are diverse, complex, and dynamic modern stock chains across a few administrative areas.

Vilas Gharat

Mr. Vilas Gharat is working as a Managing Director, for Gharat & Associates, having over 50 years' experience in manufacturing function in all composite sectors of Textile Industry. Out of which more than a decade in Operations and HR with emphasis in Business Process Consulting,

Mr. Gharat is having Specialization in various field of textile value chain like;

- Change Management, Business Development and Project Management
- Project Management, Business Development
- Supply Chain Management
- Resource Allocation
- Process Reengineering
- Change Management, Production and Business
- Planning Function
- Training and Mentoring CEO's

He has wide experience in:
Business Consultant for Oswal Hammerle, for their upcoming state of art technology plant for manufacture of sophisticated Yarn Dyed Shirting Project, primarily catering to the needs of international garment manufacturers. This is a Joint Venture project of Oswal group and F.M. Hammerle (Austria)

His previous assignment involves restructuring and transformation of a large Textile units

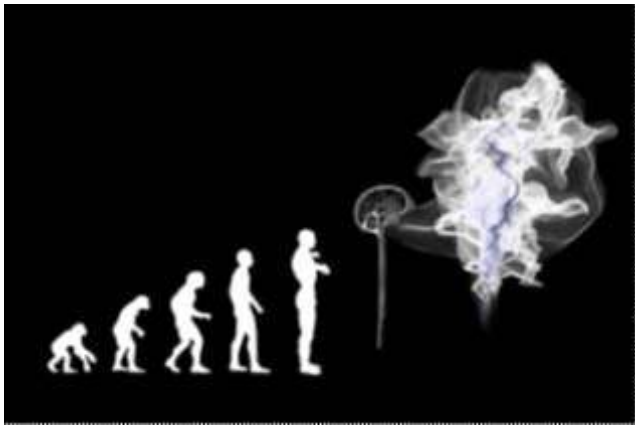
He worked with various executive capacities as Executive Director -Suvin Advisors Pvt Ltd.; Senior President in S Kumar's., Technical & Commercial Advisor in J. K. Cotton Mills, Senior President in Morarjee Brembana Ltd., Birla's in Indonesia, Oswal Hammerle, Bhojsons, Nigeria etc.

Awards:
Mr. Gharat was awarded with Best General Manager Award in MSTC - National Award for energy conservation for Simplex Mills & MSTC and Best Vendor Award from Johnson & Johnson.

Mr. Gharat was awarded with FTA by The Textile Association (India) in 1999,

Mr. Vilas Gharat was a President of The Textile Association (India) - Mumbai Unit during 2017-2019 and 2019-2021. Now he is on the Board of Trustees of TAI – Mumbai Unit.

E-mail: vilasgharat@gmail.com, gharatandassociates@gmail.com



- Independent reconfiguration and transformation.Quantum processing upgrades the viability and efficiency of current AI models while empowering the formation of totally different ones.
- The development of the manufacturing plant is checked and put away in cloud server-based, which can be dealt with directly.
- Hundred percent of straight forwardness can be accomplished by any stretch of the imagination level of creation and cycle.

Need of Industry 6.0

In the era of COVID-19, the entire World was facing difficulties in meeting customers' demand regarding supplying goods services, manufacturing, and other daily need items.

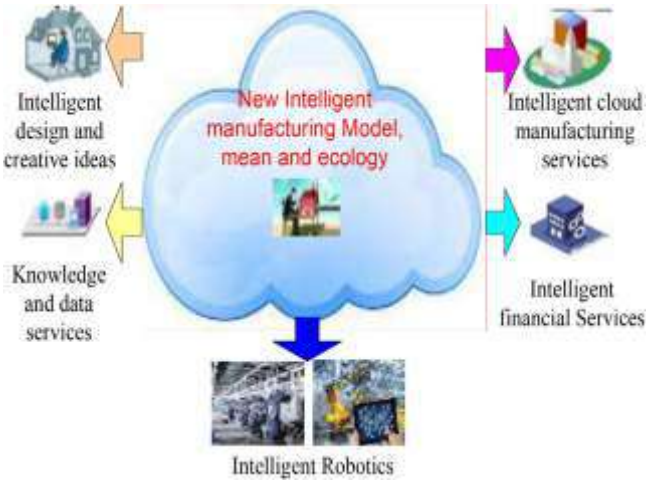
This Global crisis has forced Manufacturers, Organizations, and Service providers to rethink the current production Strategy, delivering services to customers, Customer interaction, Supply chain network, Circular economy, Integration of products, Green transition, and Digitalization etc.

Throughout the industrial revolution history, it has been seen, that industries have the caliber and prove their capability to the prime transformation. In addition, enterprises will always be ready to accept such, transformation toward the weather change impartiality and change in digital governance in a flexible and foreseeable World.

3D printing technology is spreading its wings toward a new degree of freedom in the new revolution by adding a more comprehensive range of materials, biomaterials, chemicals for lithography control release medicine.

The 3D printing, AI, Machine learning-enabled technology used in medicine could reduce the chances of infections during the human touch in OPD services. In the time of Pandemic where daily new viruses are ready to attack humanity, these robotics-based medical systems could ensure the safety of humans with less risk,

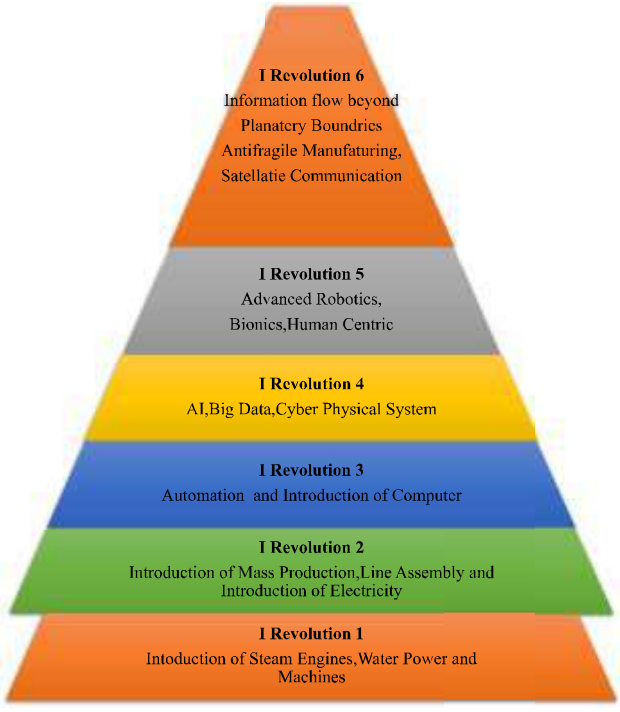
This would provide a significant advancement to humans where it would have the potential to add simulated pain



receptors, which would tend to fix natural skin on body parts by using Synthetic or Artificial materials.

Quantum computing can transform the shape of Business, Industries, healthcare systems, Finance, and Material science by solving complex problems that traditional computers could not resolve. Quantum computing has great potential to change the supply chain, value chain and expand.

Industry 6.0 is the Amalgamation of industry 4.0 and Industry 5.0 with Innovative convergence ideas.



Benefits of Industry 6.0 – Key Enabling Technologies

It is a futuristic idea that is a product of disruptive technologies such as Artificial Intelligence (AI), Big Data, Augmented & Virtual Reality, Cloud Computing, IoT, and Autonomous Robots. As the world is bouncing back from the pandemic, these disruptive technologies have a unique opportunity to be key enabling technologies. It will affect small to large conglomerate industries but with a different perspective.

It will enable digital transformation from customer interaction to supply networks.

It will revolutionize mass customization, lot-size-one production, zero defect production, and re- and de-manufacturing. It will help design antifragile systems to utilize new business logic and models. As the world is growing towards Green industrialization and Re-industrialization, Industry 6.0 underpins this ambition. It will create a huge market for Rebranding professionals, who can work along with this disruptive or, may I say, Key Enabling Technologies.

Management Life

Industry 6.0 would support hyper-connected Industries, provide dynamic value networks, dynamic supply chain, transparency in information flow all over the administrations either internally or externally throughout the World.

It would be the way of life with keeping the proper balance or mastering the economics of learning. It will promote the human virtual digital twin where all can simultaneously see physical goods and virtual product information, connect the manufacturing industries globally, and provide superior technical help, better understanding, and decision-making.

Anti-fragile manufacturing will be the predicted concept for this revolution, where anti-fragility can be obtained through systems flexible design. It depends on non-functional requirements where software systems are judged based on openness, usability, safety, immovability, and other functions.

In the coming years, this revolution would provide Creative thinking, Unique and Innovative ideas in manufacturing and other fields and enhance the protagonist characteristics of humans and machines.

Limitations of Industry 5.0 and assisting Technologies of Industry 6.0

Industry 4.0 was based on Mass production and Smart production, whereas achieving sustainability resilience and collaborations of Man, and Machine.

It was the concept of industry 5.0 and the futuristic concept of industry 6.0 advocates Anti-fragile manufacturing, Ubiquitous, human digital twin and customer that connects manufacturing, hyper-connected industries and customer needs are on high priority with use of sustainable resources.

For a few years only, Researchers, Industrialists, Policymakers, and Future visionaries started to think beyond industry 4.0 and industry 5.0. Additionally, some futuristic have also pointed out the inadequacy of both industries.

According to the view of experts that industry 4.0 may have a low tendency to integrate digital connectivity and man–machine alliance, It had already well known that Artificial Intelligence and Robotics engineering is one of the essential supporting columns in the fourth industrial revolution, only the primer of the machine and human collaboration is not enough to start the new revolution.

The cost for implementing digital technologies such as IoT, AI, Big data, and Robotics in the industrial revolution 4.0 and Industrial revolution 5.0 has required a large amount of cost and extraordinary skill, which could be the reason of un-satisfaction amongst the industries and social perspective.

Industry 5.0 represents some exclusive limitations and responses such as high price responsibilities in manufacturing policies, standardization, and legalization in all policies to preclude any thoughtful problem among the digital technology, society perspective, and business.

The probabilities of social heterogeneity among the society in relations of values and adapting the new technologies of a new revolution, measurement of ecological balance and social values, significant investment and integration of all the customers from high business to SMEs, and environment based new policies with agility, outcome-based and greater dependency on technologies as a noble initiative by business, Finland in "From industry X to industry 6.0" was sketched a series of predictive implementation strategies, policies, investment, business landscape, Research and development, and manufacturing ecosystem and future path dimensions to promote industry 6.0.

Additionally, Government, agencies, and industries responses are being limited for some time. Still, academia is peerlessly embracing the critical discussion on industry 6.0, as MDPI journals, World Conference on Technology, Innovation and Entrepreneurship, and IET (The institution of engineering and technology).

The dream of Industrial revolution 6.0 can only be attained by doing systematic work and collaborative effort of Government and Manufacturers toward the welfare of society. This revolution wants the long-term commitment from the manufacturers, policymakers, stakeholders, and government to implement sustainable industry 6.0 in the organization. The implementation of this holistic approach can be geared with proper research and development to positioning in the revitalization of Industrial Production.

During the execution of industry 6.0 could face many challenges such as digital transformation, difficulty in adopting new and advanced technologies, allocation of resources, industry-relevant technology, internationalization, industry collaboration, freedom to research in development, capital cost involved in developing and implementation of new technologies, re-skilling costs, and adoption of 5G /6G technologies. Industry 6.0 has been the Theoretical concept; it will change the manufacturing world's entire scenario if it applies to industries.

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RESULTS FOR ATA PART I - PASSED/ATAHE CANDIDATES DECEMBER, 2022

Centre / Result	PASS	ATAHE
Ahmadabad	2022/01, 2022/03, 2022/04, 2022/05	2022/02
Bhilwara	2022/10, 2022/11, 2022/233, 2022/13, 2022/14, 2022/15	
Delhi	2022/20, 2022/21, 2022/22,	
Ichalkaranji	20221/30, 2022/31	

Total	Registered	Appeared	Passed	ATAHE	PASS %
	17	17	15	02	88.00

RESULTS FOR ATA PART II- DECEMBER, 2022

Centre / Result	PASS	ATAHE
Ahmadabad		
Bhilwara		
Delhi		
Ichalkaranji	2022/532, 2022/533	

Total	Registered	Appeared	Results	ATAHE	Passed %
	10	10	2 Passe / 8 Withheld	01	-

Result withheld of Roll Nos. 2022/501, 2022/502, 2022/503, 2022/504, 2022/510, 2022/520, 2022/530, & 20221/531 for non submission of Industrial Report of Ahmedabad, Bhilwara, Delhi & Ichalkaranji Centre.

RESULTS OF ATA PART III - PASSED CANDIDATES DECEMBER, 2022

Centre	Yarn Manufacture	Fabric Manufacture	Textile Wet Processing	Knitting & Garment Manufacture
Ahmedabad	2022/601, 2022/602, 20221/603, 2022/604	Nil	2021/801	NIL
Bhilwara	NIL	NIL	NIL	NIL
Delhi	NIL	NIL	NIL	NIL
Ichalkaranji	NIL	2022/720, 2022/721	NIL	NIL

Result withheld of Roll Nos. 2022/610, 2022/611, 2022/701, 2022/702, 2022/711, 2022/801 for non submission of Industrial report of Ahmedabad & Bhilwara Centre.

Candidate	Yarn Manufacture	Fabric Manufacture	Textile Wet Processing	Knitting & Garment Mfg.	Total
Registered	07	05	01	NIL	13
Appeared	07	05	01	NIL	13
Results	4 Passed, 3 withheld	2 Passed, 3 withheld	1 withheld	-	13

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RESULTS FOR GMTA SECTION A/B/C PASSED CANDIDATES DECEMBER, 2022

Centre	Section A	Section B	Section C
Ahmadabad	2022/AHA/01	2022/AHB/01	-
Delhi	NIL	NIL	2022/DEC/10, 2022/DEC/10,
Ichalkaranji	2022/ICA/10, 2022/ICA/11, 2022/ICA/12, 2022/ICA/13, 2022/ICA/14, 2022/ICA/15, 2022/ICA/17, 2022/ICA/18	2022/ICB/10, 2022/ICB/11, 2022/ICB/12, 2022/ICB/17, 2022/ICB/18	2022/ICC/21, 2022/ICC/22, 2022/ICC/23, 2022/ICC/24, 2022/ICC/25, 2022/ICC/26, 2022/ICC/27, 2022/ICC/28, 2022/ICC/29, 2022/ICC/30, 2022/ICC/32, 2022/ICC/33
Mumbai	NIL	NIL	-
TOTAL	**09**	**06**	**14**

Section A does not require grace marks. The remaining Sections B & C require grace marks subject to minimum of 15 marks in two subjects. Hence it applied.

Candidates	Section - A	Section -B	Section -C	TOTAL
Registered	13	13	18	44
Appeared	09	11	18	38
Result	09	06+02=08	14+1=15	29+3=32

Pass 76.00%

Grace marks not required.

RESULTS FOR GMTA SECTION D & E PASSED CANDIDATES DECEMBER, 2022

Centre	Section D			
	Yarn Manufacture	Fabric Manufacture	Textile Wet Processing	Apparel Manufacture
Ahmadabad	NIL	NIL	2022/AHD/01	2022/AHD/10
Delhi	NIL	NIL	NIL	2022/DED/20, 2022/DED/21
Ichalkaranji	NIL	NIL	NIL	NIL

Candidates	Section - D				
	Yarn Manufacture	Fabric Manufacture	Text. Wet Processing	Apparel Manufacture	Total
Registered	NIL	NIL	03	03	06
Appeared	NIL	NIL	03	03	06
Passed	NIL	NIL	01	03	04

Pass 67.00%

Candidates	Section - E				
Ahmadabad	2022/AHE/01				
Delhi	-				
Ichalkaranji	2022/ICE/10				

Candidates	Section - E				
Registered	02				
Appeared	02				
Results					

Results are withheld for want of submission of the project report.

Sd/-
Dr. G. S. Nadiger
Chairman, P. A. C.

Sd/-
Mahendrabhai G. Patel
Hon. Gen. Secretary

The Textile Association (India) Central Office

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Schedule of A.T.A. Part - I, II & III December, 2023

ATA Part-I	Time 10.00 a.m. to 1.00 p.m.	ATA Part-II	Time: 2.00 p.m. to 5.00 p.m.
Date	Subjects	Date	Subjects
22.12.2023	Basic Engineering Sciences	22.12.2023	Principles of Yarn Manufacture
23.12.2023	General Engineering	23.12.2023	Principles of Fabric Manufacture
24.12.2023	Textile Fibres	24.12.2023	Principles of Textile Wet Processing
25.12.2023	Elements of Textile Technology	25.12.2023	Principles of Textile Testing and Statistics
26.12.2023	Elements of Comp. and its Applications	26.12.2023	Industrial Organization and Management

ATA Part - III - Time: 10.00 a.m. to 1.00 p.m.

Compulsory Subjects

22.12.2023	Elements of Technical Textiles
23.12.2023	Man-Made Fibre Technology

Optional Subjects

Date	Yarn Manufacture Group	Fabric Manufacture Group	Textile Wet Processing Group	Knitting & Garment Manufacture Group
24.12.2023	Process Control in Yarn Mfg.	Process Control in Fabric Mfg.	Wet Processing-I	Knitting Technology
25.12.2023	Modern Yarn Manufacture	Modern Fabric Manufacture	Wet Processing-II	Garment Technology

1. Last Date for receiving applications at unit 25th July 2023.
2. Last Date for receiving all the applications with late fee at unit 25th August 2023.
3. Last Date for receiving applications at the central office 25th September 2023.

Sd/-
Dr. G. S. Nadiger
Chairman, P. A. C.

Sd/-
Mahendrabhai G. Patel
Hon. Gen. Secretary

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Schedule of G.M.T.A. Examination December 2023

Section - A Date	Time 10.00 a.m. to 1.00 p.m. Subject No. & Title	Section - B Date	Time: 2.00 p.m. to 5.00 p.m. Subject No. & Title
22.12.2023	A-1 Engineering Physics	22.12.2023	B-1 Yarn Manufacture
23.12.2023	A-2 Engineering Chemistry	23.12.2023	B-2 Fabric Manufacture
24.12.2023	A-3 Engineering Mathematics	24.12.2023	B-3 Textile Wet Processing
25.12 2023	A-4 General Engineering	25.12.2023	B-4 Apparel manufacture
26.12.2023	A-5 Professional Orientation	26.12.2023	B-5 Textile Testing

Section - C Date	Time 10.00 a.m. to 1.00 p.m. Subject No. & Title
22.12.2023	C-1 Textile Fibre Science
23.12.2023	C-2 Polymer Technology
24.12.2023	C-3 Textile Engineering Mechanics
25.12.2023	C-4 Applied Statistics
26.12.2023	C-5 Data Management and Information System

	Section - D Time: 2.00 p.m. to 5.00 p.m.			
Date	Yarn Manufacture	Fabric Manufacture	Text. Wet Processing	Apparel Manufacture
22.12.2023	Short Staple Yarn Mfg.	Advanced Fab. Manufacture	Wet Proc-Pre Treat. & Bleaching	Apparel Technology
23.12.2023	Long Stap & other Yarn Mfg.	Knitting Technology	Wet Proc.-Dyeing	Supply Chain Mange in Apparel Mfg.
24.12.2023	Engg Design & Yarn Structure	Engg Design of Fab. Structure	Wet Proc-Printing & Finishing	Apparel Merchandising
25.12.2023	Process & Qual Management & Yarn Mfg.	Process Control & Qual. Mrkt in Fab. Mfg.	Analytical Chem. In Textiles	Garment Proce. Tech.
26.12.2023	Man-made Fibre Technology	Fabric Structure & Design	Proce & Qual Manage In Wet Proce.	Process Control & Quality Manage in Apparel Mfg.

Optional Papers

27.12.2023	Specialty & High Performance Yarns(s)	Non-Woven Technology	Colour Tehory & Col. Matching	Social & Trade Compliances
28.12.2023	Silk Reeling & Throwing Technology	Technical Textiles	Effluent Treat & Eco Friendly Proce.	Garment Acces. & Fashion Forecasting
29.12.2023	Quality & Envir. System in Yarn Mfg.	Quality & Environment Systems In Fab. Mfg.	Quality & Environ System in Wet Proc.	Visual Merchandising

Section - E Date	Time 10.00 a.m. to 1.00 p.m. Subject No & Title
25.12.2023	E-1 Industrial Engg & Mill Management
26.12.2023	E-2 Energy Environment & Efficiency in Textiles

Optional Papers

27.12.2023	EOD-1 International Trade Management
28.12.2023	EOD-2 Control Systems in Textile Machines
29.12.2023	EOD-3 Entrepreneurship Development

1. Last Date for receiving applications at unit 25th July 2023.
2. Last Date for receiving all the applications with late fee at unit 25th August 2023.
3. Last Date for receiving applications at the central office 25th September 2023.

Sd/-
Dr. G.S. Nadiger
Co-Chairman, P. A. C.

Sd/-
Haresh B. Parekh
Hon. Gen. Secretary

Azadi Ka Amrit Mahotsav

वस्त्र मंत्रालय
MINISTRY OF TEXTILES

G20 भारत 2023 INDIA

National Technical Textiles Mission (NTTM)
Ministry of Textiles, Government of India

Presents

NATIONAL CONCLAVE ON SPORTECH -
The Future of Sport Textiles and Accessories Industry in India

2nd June, 2023

Venue: Hotel Shangri-La Eros, New Delhi

Jointly Organised By

ITTA

INDIAN TECHNICAL TEXTILE ASSOCIATION

WRA's COE Sportech

WOOL RESEARCH ASSOCIATION WRA THANE

TAI - CENTRAL UNIT

TAI President Participated in the important meetings

PHDCCI EXPERT COMMITTEE ON TEXTILE

PHDCCI Expert Committee on Textiles delegation led by Mr. Madhu Sudhan Bhageria, Chairman of the PHDCCI Expert Committee on Textiles and CMD, Filatex India Ltd. apprised him about the activities of the Textile Committee and the PHD Chamber of Commerce & Industry as a whole.

Mr. R K Vij, Co-Chairman, PHDCCI Expert Committee on Textiles and President, The Textile Association (India) along with other members, Mr. O. P. Lohia, CMD, Indorama Synthetics Ltd.; Mr. D. D. Sharma, CEO, Bhilosa Industries, Mumbai; Mr. Rajnesh Datt, Chief Operating Officer-PSF, Bombay Dyeing, Mumbai; Mr. Rakesh Kumar Sangrai; Sr. Secretary, PHDCCI & Ms. Tanisha Panwar, Assistant Secretary, PHDCCI called upon Mr. Sanjay Malhotra, Secretary, Department of Revenue, Ministry of Finance at his office on 17th March 2023.

The objective of the meeting was to discuss & request to correct the anomaly of "Inverted GST Duty Structure" & to rationalize the Customs duty on PTA, MEG & Polyester yarn.

Mr. Malhotra gave considerable time and was also invited to the upcoming Ambassador's Meet. He assured full co-operation and support in the coming time.

BHOOMI PUJAN OF BLOOMTEX INDUSTRY

Bloomtex Industries Pvt. Limited did it's Bhoomi Poojan on 26th March, 2023 at Bhagthali SIDCO Kathua, J & K. Company is doing a total around 400 crores investment to produce Polyester and Polyester Viscose yarn in 2-3 phases in next 3 years time under Central Govt. policy of 2021 package and provide employment to 750 -1000 persons.

Bloomtex is promoted by Mr. Mukesh Tyagi a textile Technocrat from renowned TIT College at Bhiwani. Bloomtex is a sister company of BST Textile Mills Rudrapur, where Cotton Yarn is being produced. Shri R. K. Vij, President Textile Association (India) was present on the occasion. All the Senior Govt. Officials attended the function. Shri Shiv Anant Tayal, MD of JK PDD was present at the above function of Bhoomi Poojan at Bhagthali Site. He assured for all cooperation to achieve the targets. The function was attended by large number of Textile Professionals from Punjab and from North India. Shri Ajay Gupta of Reliance Indistries, A. K. Dadoo from Welknown Polyester were also present. The Machinery suppliers LMW and Voltas Ltd., Rieter and Zinser were present. Bloomtex will be the first project to commence production at Bhagthali in next 8-10 months. Bloomtex industries thanked the Chief Secretary Shri Ajay Mehta, Principal, Secretary Industry Shri Prashant Goyal, Director General Industry Jammu Ms Anoo Malhotra ji and Shri Shiv Anant Tayal ji, MD JK PDD, MD Sidco Dr. Rakesh Minhas ji, was helping this project to reach at this stage in such a short Time.

Mr. R. K. Vij, President, The Textile Association (India) attended to Gujarat Chamber of Commerce and Industry (GCCI) meeting with Textile Minister in Ahmedabad along with Shri Hasmukhbhai Patel, a Member of Parliament and President, TAI Ahmedabad Unit for the growth of Textile industry in India.

Representative from all other association were also present. Textile Minister patiently listened to the representatives and the solutions were discussed for the benefit of whole Textile Industry.

TAI - AHMEDABAD UNIT

Visit INDIA ITME 2022 Exhibition

Total 10 Managing Committee Members of TAI-Ahmedabad Unit visited INDIA ITME 2022 Exhibition held during 8th – 12th Dec 2022 at Greater Noida, Delhi.

Group photo at the pavilion of India ITME 2022 exhibition Centre

Health Checkup Camp (Blood & Urine test)

TAI-Ahmedabad Unit arranged Health Checkup Camp (Blood & Urine test) on 17th December 2022 at Dinesh hall for its members & their family members. Near about 335 members and family members took benefits of this program.

Photo at the time of registration for blood & urine test camp

View of Blood Collections by the team of Scientific Diagnostic Centre

Ground nut oil tins distribution

Under the member's welfare activities, The Textile Association (India) Ahmedabad unit distributed 4 nos. ground nut oil tins to each of the registered members with 35% subsidized rates on actual market price. Total 765 members were registered to avail this benefit. Association distributed total 3002 nos ground nut oil tins among the registered members. The oil tin distribution process was carried out between 5th & 20th January, 2023.

Outstation Managing Committee meeting

The Textile Association (India) Ahmedabad Unit arranged its 12th Meeting of the Managing Committee Members for the year 2019-2023 on 16th January 2023 at Hotel Kostamar Beach Resort, Diu. In this meeting members accompanied their spouse also and enjoyed the moments of Diu beach.

Group Photo of members with family in Hotel Kostamar Beach Resort

World Textile Conference-3

TAI-Ahmedabad Unit supported to the World Textile Conference-3 being organized by TAI-Central Office, Mumbai held on 25th & 26th February 2023 at Dinesh hall, Ashram Road, Ahmedabad, Gujarat. The theme of the conference was "World Textiles: Redefining Strategy". The conference was inaugurated by the Chief Guest Shri Bhupendrabhai Patel, Hon'ble Chief Minister, Govt. of Gujarat where Smt. Darshana V. Jardosh, Hon'ble Union Minister of State-Ministry of Textiles & Railways, New Delhi graced the occasion as Guest of Honour. In the inaugural function, keynote address delivered by Shri Punit Lalbhai, Executive Director, Arvind Ltd and Lead Sponsor speech delivered by Shri Uday Gill, Executive Director –Indorama Venture Limited, Thailand. Near about 800 participants participated in the said conference from India as well overseas.

Manak Manthan meeting

Bureau of Indian Standards, Vadodara organized Manak Manthan meeting to discuss on Indian Standard with Manufacturers and Stakeholders in associate with TAI-Ahmedabad Unit. The meeting held on 17th March 2023 at meeting room of Association and Most of the office bearers took part during an interaction session after presentation. The outcomes of the meeting were very much informative and positive. Almost 27 participants were participated from different manufacturing units.

Manak Manthan meeting

Stakeholder Meeting on Chemicals

Office bearers of TAI-Ahmedabad Unit attended a Stakeholder Meeting on Chemicals in Textiles organized by Toxics Link, New Delhi is an environmental NGO in India working on cross cutting issues of chemical safety and waste. The meeting held on 28th March 2023 at Hotel Courtyard by Marriott, Satellite, Ahmedabad.

Group photo of Stakeholders

COLORJET Awarded by Shri Yogi Adityanath, Chief Minister of Uttar Pradesh

ColorJet Group Manufacturer of Digital Textile Printers has been honoured with the prestigious State Export Award for outstanding performance in international trade at the ceremony held on 31st March, 2023 at Lok Bhawan in Lucknow organised by Export Promotion Bureau of Uttar Pradesh.

Shri Yogi Adityanath Hon'ble Chief Minister of Uttar Pradesh handed over the Award to Mr. M. S. Dadu, Chairman of ColorJet Group. Shri. Nand Gopal Gupta, Cabinet Minister of Industry Development along with other dignitaries from UP Government also present at the occasion.

The Export Award is the highest recognition granted by the State Government to a Company that has demonstrated exceptional performance in international trade.
The Award is presented to companies that have successfully expanded their business footprint overseas and have significantly contributed to the country's export earnings.

ColorJet has been recognized for its outstanding performance in expanding its operation globally, thereby contributing to the growth of the country's economy. ColorJet Group has consistently demonstrated a commitment to quality and innovation in its product and services, which has helped ColorJet, establish a strong reputation in the international market.

While addressing an Award ceremony, the chief minister said, "Uttar Pradesh will emerge as the torchbearer of the fourth industrial revolution (industrial revolution 4.0), adding that this was evident from investment proposals worth ₹35 lakh crores received at the Global Investors Summit held in Lucknow in February. "MSME itself is going to become the foundation of industrial development of U.P.

The Global Investors Summit has decided that U.P. will lead the fourth industrial revolution", he said.

While Award receiving, Mr. M. S. Dadu Chairman, ColorJet Group said that "The Award is a testament to the hard work and dedication of the entire team at ColorJet. The company has invested heavily in developing indigenous technology for the world market to ensure that it meets international standards and regulations. This has enabled it to expand ColorJet business in over 30+ countries now.

All ColorJet printers are designed and robustly built across all components to print excellent results and offer great enduring value to the print solution provider across the globe. All ColorJet Printers are not just a sum total of their parts. They are ergonomically designed & engineered through 3D simulation processes at ColorJet's Innovation Laboratories and built optimally, to deliver phenomenal business value to its customers. Group Innovation Laboratories is having an R&D facility recognized by the Ministry of Science & Technology, Govt. of India which innovates & Integrates Digital Print technology that wins world markets.

COLORJET Awarded by Shri Yogi Adityanath, Chief Minister of Uttar Pradesh

ColorJet India has been awarded as India SME 100 Awards in a ceremony organized by India SME Forum, supported by Ministry of Micro Small & Medium Enterprise, Government of India.

To recognize the efforts and contributions of SMEs India, SME Forum successfully concluded the 9th edition of INDIA SME 100 Awards considered as one of the most prestigious award in the SME fraternity.

On the occasion, the Union Minister for MSME, Shri Narayan Rane highlighted various initiatives undertaken by the Government under the leadership of PM Shri Narendra Modi ji which have strengthened MSME entrepreneurial capacities for resilience and competitiveness for the inclusive as well as sustainable recovery.
He further reiterated PM Shri Narendra Modi ji's clarion of the Atmanirbhar Bharat and guided the requirements of the mantra of 'Make in India' and 'Made for the World'.

M. S. Dadu (Chairman), ColorJet Group said that ColorJet India is feeling honoured and delighted to have this recognisation for its deep commitment to the technological innovation, strong outreach & service infrastructure and

complete customer focus. Being the largest manufacturer of India, our textile printing technology are being exported worldwide and preferred by all the leading apparel brands globally.

The Hon'ble Minister of State for MSME, Shri Bhanu Pratap Singh Verma and Shri B. B. Swain, IAS, Secretary, Ministry of MSME handed over the award to Mr. M.S. Dadu, Chairman , ColorJet India Ltd.
"The Executive Board of India SME forum has Mr. Prahlad Kakkar, renowned Brand Marketing Guru, Mr. T. R. Bajalia, Ex- Dy. M.D. of SIDBI and ED-IDBI, Dr. J. S. Juneja, Ex-Chairman & CEO of NSIC, Mr. Vinod Kumar, Managing Partner, SDRC India Advisors, all stalwarts and luminaries of India's Small and Medium Entrepreneurship movement. The India SME Forum was presented by Axis Bank along with Airtel Business, MakemyTrip, Acer, BSE & SME.

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USTER®
Think quality

Recycled Yarn – The Future Reality Now and fall season

Uster outlines the challenges, and solutions

Spinning yarn blends of virgin and recycled fibers is a much bigger challenge than any other commonly used blend. But the results can still be acceptable with comprehensive quality testing, know-how and experience – as well as the new Uster Statistics 2023 edition as a vital benchmarking tool.

View of the gathering in the event

The European Union has defined a strategy for sustainable and circular textile production, to make the sector greener and more competitive. Part of this 2030 Vision for Textiles calls for all textile products on the EU market to be durable, repairable and recyclable – and largely made of recycled fibers. Many leading retailers are also championing the use of recycled materials from 2030 onwards.

The use of mechanically recycled fibers in spinning has specific quality considerations: such fibers have a higher short fiber and nep content and may often be colored, particularly if post-consumer material is used. It's also true that recycled yarns have limitations in terms of fineness. Officially, a yarn can only be branded `recycled´ when spun with more than 20% recycled fibers. This is set by the Global Recycled Standard (GRS), a voluntary product specification for tracking and verifying the recycled content of materials in a final product.

Spinning recycled yarns
Blending virgin and recycled cotton together is well known as a challenge for spinners. The smartest spinners and world-class processes simply can't overcome the fact that some important quality parameters will be adversely affected. It's clear that the use of recycled cotton in a blend with new fiber wil

Recycling Logo

l impact on both the overall yarn strength and its CV%. Even the most sophisticated spinning machinery won't fix the problem.

Awareness of the risk of yarn quality deterioration with recycled fiber blends means that quality control is the only way to assure customer satisfaction. Even then, the task is far from simple. When spinning new materials, Uster strongly recommends taking both numeric test results and graphic evaluations into account, to eliminate the risk of problems in further processing.

Avoiding fabric defects
Spinners face major difficulties because of the high proportion of short fibers in recycled cotton (CO-R) and the fact that, when mixing with virgin cotton (CO), the fiber length distribution is sometimes suboptimal. This results, for example, in incorrect guidance of short fibers in the drafting

system and potential draft errors.
In tests, a Ne 20 rotor yarn of 75% CO and 25% CO-R was compared with a 100% cotton yarn. The values for evenness, imperfections and hairiness were measured and produced a CVm% of 22% in Uster Statistics, which might appear to indicate excellent quality for the recycled yarn if relying on numeric values alone. In fact, closer analysis with Uster Tester spectrograms showed a draft error at the draw frame. In this case, the problem was detected before causing an uneven structure in the subsequent fabric made from the yarn.

Common language for better communication
It is an unavoidable fact that blending virgin and recycled cotton will make some quality parameters worse. Using recycled fiber is often desirable, but it creates a new reality for the industry. To cope with the risks, better communication and a common understanding are needed throughout the textile value chain.

Uster's common language of quality will be – once more – vital in improving communication throughout the textile industry. For 66 years, Uster Statistics have been the only globally-accepted quality benchmark and the foundation for industry-wide quality improvement. The new edition, to be launched at ITMA 2023, includes for the first time a section for recycled yarn.
The Uster Statistics 2023 edition features an extended range of fiber data, supporting sustainability goals. An ideal fiber mix – with or without recycled content – also ensures meeting quality requirements for least waste. Fiber graphs will be newly available for every process step.

The new reality
Spinners need to find a way to transform their mills to a more sustainable future. The challenge of spinning recycled yarns must be acknowledged, and the big goal here is to succeed with it. Spinners already have the tools they need, allowing them to benefit from both laboratory instruments and quality monitoring systems to optimize quality and productivity. Their experience, combined with Uster knowledge and latest technology in quality control and analysis systems, are a promising basis for a sustainable future for the textile industry.

The new reality of the need for closer communication and cooperation will include all players from fiber to fabric. It's an essential debate for everyone – and Uster is ready to take the lead.

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Restoring Original Rotor Performance with Yarn Clearer Refurbishment and fall season

Optical yarn clearers detect yarn inconsistencies. Their performance is critical for the quality of rotor yarn. Customers, who refurbish their yarn clearer regularly, benefit from improved yarn quality and consistent machine performance. Rieter recommends refurbishing the yarn clearer after five to ten years of operation to restore its original performance.

Rieter's semi-automated rotor spinning machine BT 923 is widely used among customers and is one of the company's most popular models.

Based on Rieter's experience, the yarn inspection and clearing function of the yarn clearer IQ+, may deteriorate after five to ten years of continuous operation, primarily due to ageing of the equipment. This deterioration in performance can lead to issues such as yarn non-cutting, which can cause quality inconsistencies.

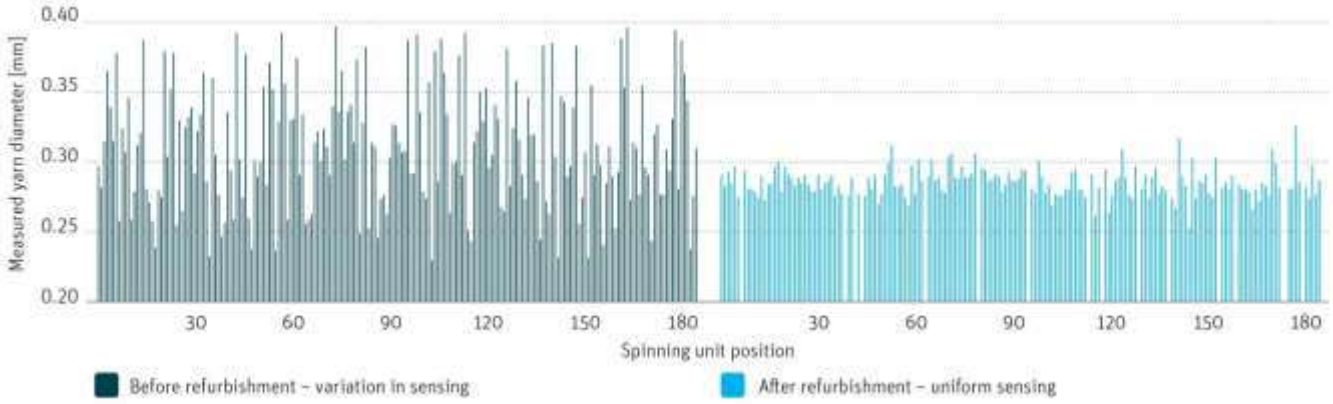
It can also lead to increased yarn cutting and nuisance stoppage of the rotor spinning position which will significantly increase the workload for machine operators due to piecing and restart. Hence, the overall production efficiency drops.

Uniform and consistent yarn clearing is the key
Rieter provides a fast and cost-effective solution with its IQ+ yarn clearer refurbishment which can be carried out at Rieter's repair service centers around the globe. The special refurbishment kit comprises a new housing and the replacement of broken housings and aged components. After the refurbishment, the yarn clearer is calibrated using specialized test equipment to ensure the best quality. The yarn clearer reference value is recalibrated based on the original equipment specification (Fig.2).

Rieter yarn clearers use advanced optical sensor technology with an integrated microcontroller for an online evaluation. This sensor precisely detects yarn faults and communicates these to the machine software. Refurbishing damaged or non-functioning yarn clearers not only helps reduce maintenance costs but also helps extend the lifetime of the spare parts. The uniform and consistent quality of yarn delivered from each rotor spinning position eliminates the need for operator intervention.

Refurbished yarn clearer in semi-automated rotor spinning machine BT 923

Customers benefitting from refurbishment
"Rieter's refurbishment of



Yarn clearer refurbishment graphic before and after 3458-v1_97916_Presentation Website _English

yarn clearer IQ+ helped us regain the original performance of the rotor spinning position. The yarn faults in the packages and false cuts are eliminated. This provides us with assured yarn quality and an improvement in productivity," says Sriram, Factory Manager, The Kadri Mills Pvt. Ltd. (Unit of KG Mills), a vertically integrated textile company located in Coimbatore, India, founded in 1946. The Rieter customer produces cotton rotor yarn counts ranging from Ne 10 to Ne 20 with BT 923 semi-rotor machine.

Chen Shun Ming, Chief Engineer at Zhejiang Huzhou Weida Group Co., Ltd., China, also benefitted from the yarn clearer refurbishment:"Through a complete refurbishment of the yarn clearer, its functionality was restored to its like-new function. The overall operation of the rotor spinning machine and yarn clearer is stable, the miscutting is improved, the work of blocking is reduced, the effect is very good, we are very satisfied." Zhejiang Huzhou Weida Group Co., Ltd. was established in 1985. The company is specialized in producing eco-friendly rotor mélange yarns such as viscose, cotton, polyester blends, acrylic, Tencel, bamboo, and modal blends.

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Rimi Nayak collaborates with Liva

Rimi Nayak collaborates with Liva to create an exclusive collection 'BOTANICS'.

This capsule range of resort celebration wear is set to seamlessly integrate fashion and sustainability.

Rimi Nayak India has collaborated with Liva from the house of Birla Cellulose to create an exclusive capsule range of resort celebration wear; 'BOTANICS.' The collection is heavily inspired by Mother Nature and its various flora and fauna. The bold floral prints in myriad bright hues are a tribute to the evergreen and effervescent nature. The riot of colours is balanced with contrasting neutral shades to signify the opposites that occur in nature including the change of seasons.

Created with Liva's natural and sustainable fabrics, the silhouettes range from free-flowing drapes and saris to structured outfits reflecting the same dichotomy that exists in nature. The collection has a lot of bright vibrant colours, big floral prints and a range of separates which can be mixed and matched together, to create looks suiting one's own personal style.

Speaking about the collaboration, Mr. Sree Charan, Global Head- Brand & Communications, Liva, said, "The core essence of Liva is creating natural fluid fabric which is fashionable and sustainable at the same time. This collaboration is a result of the alignment between Rimi Nayak's design philosophy and Liva's commitment to go heavy on style and light on the planet. With our fluid fabrics and her exquisite designs, the collection is not only aesthetically appealing but also environmentally responsible."

The exclusive collection by Rimi Nayak India and Liva Fabrics will feature classic cuts, signature prints, and unconventional surface techniques that the brand is known for. The collection will be available at Rimi Nayak India stores across the country.

Rimi Nayak, the designer behind the label, expressed her excitement for the collaboration, "Liva's fluid fabrics are a designer's dream, and I am thrilled to work with them on this collection. I have always been a fan of sustainable and eco-friendly fabrics, and Liva's commitment to sustainability aligns with our brand values. Together, we have created a collection that is both stylish and conscious."

To check out the collection, click on the link

Liva Fabrics | Natural & Viscose Fabrics | Birla Cellulose Fibre - LIVA Fluid Fashion

KARL MAYER Sustainable lightweight construction

KARL MAYER Technical Textiles and STOLL present themselves as innovative partners for sustainable composite solutions at the JEC World from 25 to 27 April 2023 in Paris.

The KARL MAYER GROUP will again be focusing on sustainable textile solutions for reinforcing composites at the upcoming JEC. On Stand L 24 in Hall 25 of the Parc des Expositions de Paris Nord Villepinte, visitors can expect to see a diverse range of semi-finished products and components that score points for their ecological footprint thanks to their production from renewable raw materials and/or minimised waste.

Processing of flax on the COMP MAX 4

Among the highlights are multiaxial non-crimp fabrics made of flax. The reinforcing structures are produced on KARL MAYER Technische Textilien's COP MAX 4 multiaxial knitting machines and are used, for example, by the boat-building specialist GREENBOATS. The two companies are working together on various projects and, by pooling their know-how, are developing products that will open up new doors, and not just in the boat-building industry. A sandwich composite with a honeycomb structure in the middle will demonstrate the performance of the innovative reinforcement textile in Paris.

The flat knitting industry also contributes to more sustainability in composites, as STOLL will show at JEC World. The exhibition will focus on the topics of shaped knitted fabrics and thermoplastic forming. Knit to shape branched tubes, partly with reinforced weft, will be on show, which save waste and process steps thanks to their ready-to-use production. In addition, incorporated thermoplastic yarns make the impregnation process superfluous. Furthermore, STOLL has knit to shape parts with thermoplastic forming on a carbon basis and technical knitted fabrics made from renewable raw materials in its trade fair luggage. "With our flat knitting machines, we are completely free in the use of yarns," says Martin Legner, Head of Technical Textiles Applications at Business Unit STOLL of the KARL MAYER GROUP. He and the entire team at the KARL MAYER GROUP are looking forward to showing visitors to JEC World the possibilities offered by their knitting technology and to discussing new ideas.

For more details, please contact;

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JOURNAL OF THE TEXTILE ASSOCIATION

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SUBJECT INDEX

•

Subject	Authors	Issue	Page
• **FINISHING:**			
➢ Mosquito Repellent Textiles and their Evaluation: A Review	Rupali Kakaria, Neha Singh & M. S. Parmar	4	237
➢ Influence of Silane Based Quat on Different Properties of Cellulosic and Blended Fabrics	Kushal Desai & Bharat Patel	5	332
• **GARMENT:**			
➢ 5 Key Measurements for Development of Size Chart	Shubhangi Yadav (Shinde) & Bhawana Chanana	1	3
➢ Study on Tactile Comfort Characteristics of School Uniforms	P. Amarjeet Singh, M. Manshahia & A. Das	1	26
➢ Sustainable Technologies for Cellulosic and Protein-Based Textiles	Harshal Patil & Ashok Athalye	2	100
➢ Revival of the Looped Fabric: Crocheting Flat to 3D Structures	Priya Mittal & Bhawana Chanana	2	119
➢ A Study on Fitting Problems Faced by Men in Traditional Ready-to-Wear (Lower Wear) Garments	Sulekha Ojha & Charul Sharma	3	151
➢ Robotic Applications in Garment Manufacturing: Revival of Garment Industry	Shelly Khanna, Amandeep Kaur, Nagender Singh & Ajit Singh	3	194
➢ A Review of Development of Waterproof Breathable Garments	Abhishek Kumar, Manpreet Manshahia & Jyoti Aggarwal	5	348
➢ Seams - A Comparative Study of Hand Stitch And Machine Stitc	Madhu Sharan & Rinku Agarwal	6	416
• **KNITTING:**			
➢ Thermal Comfort Properties of Elastic Knitted Fabrics	Manjunath Burji, P. V. Kadole, A. J. Dhavale & Dhananjay Chavan	1	22
➢ Comparative Study of Moisture Characteristics of Knitted Structures	S. Suganthi, K. M. Pachiayappan, S. Ariharasudhan & S. Sundaresan	3	166
➢ To Study the PET/Bamboo & PET/Cotton Blend Yarn to Made for the Knitted Fabric on Comfort Properties Behavior: Part-I	Anupam Kumar , Ramratan & Jitender Kumar	6	424
• **MANAGEMENT:**			
➢ Development of Stab and Impact Resistance Tester for Body Protector	M S Parmar, Neha Kapil & Sangita Saini	2	88
➢ Cost Reduction Techniques for Growing Businesses: A Case Study with Polyester DTY Machine	Bibekananda Basu	5	316
• **MARKETING:**			
➢ Impact of Social Media Marketing on Customer Trust in Indian Textile Industry	P. Prasanthi & B. Senthil Kumar	2	93
• **NANO TEXTILES:**			
➢ Nanomaterials for Textile Applications - A Critical Review	Y. Jhanji	1	9
• **NON WOVEN:**			
➢ Air-Permeability and Water Absorption of Typha Wet Laid Nonwovens for Technical Applicationand Tencel Socks	Govardhana Rao Chilukoti & Ramesh Naidu Mandapati	3	161
➢ To Study Contribution of Surface Finishes to Needle Punched Non-Woven Properties	Atul Dhavale, M. C. Burji & Rohit Shinde	5	339
• **PRINTING:**			
➢ A Study on Progression of Sanganeri Block Print	Madhu Sharan, Mitali Shah & Ayesha Chauhan	5	320
➢ Lean Manufacturing and Sustainable Production for Hand Block Printing – A Case Study	Anurodh Sharad Agnihotri , Bhawana Chanana & Sitthichai Smanchat	6	401

FORM IV (See Rule 8)

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I, J. B. Soma, hereby declare that the particulars given are true to the best of my knowledge and belief.

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