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Progress of Indian Textile Industry and Union Budget 2022-2023

A war disrupts the social and economic fabric of nations with its impact felt beyond the countries that are involved. The rising tension between Russia and Ukraine has impacted many industries around the world and Indian textile Industry is no exception. The ripples of war are being felt by India with the apparel exports from India to the European countries being delayed or put to hold. The economic and other sanctions on Russia has impacted the textiles and clothing exports from European countries that further export to Russia.

The heavy dependency of several of the world economies on coal and oil from Russia, and food supplies from Ukraine is likely to impact the manufacturing and textile sectors further. The increase in crude oil and food prices will lead to an increase in raw material and labor cost in the industry apart from increased freight charges. The micro, small and medium enterprises (MSMEs) exporters have started feeling the heat with the increasing duration of war. The influence of regional peace and security is being felt by the industry with the war extending beyond the expected duration and increasing uncertainty.

As quoted by former U.S. President Bill Clinton: “No generation has had the opportunity, as we now have, to build a global economy that leaves no-one behind. It is a wonderful opportunity, but also a profound responsibility.”

The nations need to shoulder this responsibility collectively to bring about an amicable solution.

Dr. D. V. Raisinghani
Hon. Editor, JTA
We are thankful that Omicron Variant was relatively mild and now slowly and slowly things are becoming normal. Now Indian economy is expected to expand by 9.2% in the current fiscal year and 8.0 to 8.5% in the next fiscal year.

Industry is expecting that this year's budget will increase to growth of Infrastructure, digitalization, manufacturing start ups, green energy among others. The emergency credit line guaranty scheme helped to MEMEs to offset the impact of the Pandemic.

Government should support local manufacturing for making India Atmanirbhar by reducing Custom Duties on raw material imports for domestic manufacturers, wherever it's short in supply in India. The synchronization among foreign trade policy, GST laws and custom is needed to make India more self-reliant.

Exporter Community is suffering due to delay in payments of refunds, so the industry urges the Government to have more clear, simple and smooth rules for avoiding export returns under IGST, so that exporters can get their refunds without delay. Foreign Trade policy must be signed based on trade and industry benefits.

For Indian manufacturers, there should be same GST rates on their input and their output, so that their working capital should not be blocked. Total cotton production is expected to 335 lakhs bales in the year 2021-2022. India accounts for one third of global cotton area. Gujarat Shankar 6 price is Rs. 92000/- per candy. To control the cotton prices Govt. has withdrawn custom duty on cotton till 30th September, 2022. Govt. should also think to bring cotton under essential item to avoid hoarding of cotton as was done in 2008.

High Cotton Prices are pashing consumption towards more blends and use of cotton waste. The MMF Industry is viewed as an avenue for the growth for the next decade due to the availability of fibre and capability to treat MMF. Unlike the Cotton Sector, the MMF Sector is a more organized truly Integrated Industry. India is the 2nd largest producer of Polyester and on longest producer of Viscose globally.

According to data from the Textile Commissioner Office, the production of Blended and non-cotton yarn has been growing at the annualized rate of four percent during the last five years.

Industry is considering diversification in MMF fibres for their long term fibre requirements. To promote MMF, to Apparel and Technical Textiles, Govt. of India announced the Production Link Scheme. The Textile Association (India) – Mumbai Unit organized a Seminar on Technical Textile at Vapi (Gujarat), where almost app. 400 delegates attended physically and virtually. More Seminars are expected in North, South & West in next three to four months.

Apt like the beautiful verse by Kantilya a Success needs Action and Action needs Initiative. We assure to bring together the Industry Stakeholders to invest in full Textile Value Chain for overall domestic and export growth with the maximum job creation.

JAI HIND!!!

R. K. VIJ
President
The Textile Association (India)
A Comparative Study on Physical Properties of Lotus & Bamboo Yarn

P. Ananthi* & P. C. Jemina Rani
Chikkana Government Arts College, Department of Costume Design & Fashion, Tirupur

Abstract:
Yarn is a long continuous length of interlocked Yarns, which is suitable for use in textile production, sewing, crocheting, knitting, weaving, embroidery, or rope making. Thread is a type of yarn used for sewing by hand or machine. Yarn can be made from a variety of natural or synthetic Yarns. Many types of yarn are made differently though. There are two main types of yarn spun and filament. Nelumbo nucifera or Nelumbo lutea is extracted from the stems of lotus which grow naturally on lakes. Almost all parts of lotus, i.e., leaves, flowers, seeds, and stems are used for edible and medical purposes as well as clothing purpose. Bamboo Yarn is naturally bacteria and odor resistant, and is the practical, yet eco-friendly choice. In the study Lotus Yarn and bamboo Yarns are compared for its physical properties. The two different cellulosic yarns such as Lotus and Bamboo and its physical properties such as single yarn strength, Yarn twist, Yarn Hairiness and imperfections are examined.

Keywords: Bamboo Yarn, Lotus Yarn, Physical Properties, Yarn

Citation: P. Ananthi & P. C. Jemina Rani, “A Comparative Study on Physical Properties of Lotus & Bamboo Yarn”, Journal of the Textile Association, 82/6 (335-337), (March-April’2022)

Article Received: 14-12-2021, Revised: 11-04-2022, Accepted: 20-04-2022

1. Introduction
Other natural Yarns that can be used for yarn production are linen and cotton. These seem to be much less elastic, and retain less warmth than the animal-hair yarns, though they can be stronger in some cases. The finished product also looks different from the woolen yarns. Other plants Yarns which can be spun include bamboo, hemp, maize, nettle, and soy Yarn. A new Yarn namely lotus has started marking its appearance in a significant and efficient way.

Nelumbo nucifera or Nelumbo lutea is extracted from the stems of lotus which grow naturally on lakes. Almost all parts of lotus, i.e., leaves, flowers, seeds, and stems are used for edible and medical purposes as well as clothing purpose. This Yarn has a unique quality in textiles being the only Yarn that is Nano-Yarn from natural Yarn which is the reason to be called eco friendly Yarn. It is antibacterial and self cleaning as well as super-hydrophobic quality containing plant. That lotus Yarn is consist of cellulose, hemicelluloses, fat waxy, lignin, ash, pectin, amino acids and so on, (cellulose is the main ingredient). Stems of the lotus plants are collected from the lake for the Yarn making process. After than take the stems bunches and mark a slight cut around them by the help of knife. After doing the slight cut around the stems they are pulled and broken in to the parts. It is twisted to expose Yarns and windup on a role in the form of yarn Sangita Toma1.

Bamboo Yarn is naturally bacteria and odor resistant, and is the practical, yet eco-friendly choice. True to a natural Yarn, bamboo knits are already absorbent and breathable. The strength of bamboo adds to the durability of the fabric and is found to work well for those who are allergic to other natural Yarns. Bamboo textiles are cloth, yarn, and clothing made out of bamboo Yarns. While historically used only for structural elements, such as bustles and the ribs of corsets, in recent years a range of technologies have been developed allowing bamboo Yarn to be used in a wide range of textile and fashion applications. Modern clothing labeled bamboo is usually rayon. The bamboo yarn can also be blended with other textile Yarns such as hemp or even spandex R Divya2.

2. Materials & Methods
The yarns 100% LOTUS spun yarn, 100% BAMBOO spun yarn of 40 (Ne) were selected to examine their physical properties. Two different 100% cellulosic yarns such as Lotus and Bamboo were selected and tested for its physical properties such as single yarn strength, Yarn twist, Yarn Hairiness and imperfections; the material made by this Yarn is light in weight and breathable. It can be dyed by both dyes (natural dyes and chemical dyes). The resulting fabric has the appearance of antique linen or raw silk; it is soft, exceptionally breathable and crease-resistant. Around 30 kg of stems is needed to produce 250 meters of thread. The development of this Yarn will give the people, to work in the original environments. It will become the means to support future generations, thus allowing this art to survive and increase their family income status. Bamboo Yarn is naturally bacteria and odor resistant, and is the practical, yet eco-friendly choice. True to a natural Yarn, bamboo knits are already absorbent and breathable. The strength of bamboo adds to the durability of the fabric and is found to work well for those who are allergic to other natural Yarns. Bamboo textiles are cloth, yarn, and clothing made out of bamboo Yarns. The samples were tested at a relative humidity of 65% ± 2% and at a relative temperature of 21c. The physical properties of both the fabrics are analyzed and discussed in result & discussion.

3. Result & Discussion
Lotus plant is believed to have healing abilities and wearing a fabric made from lotus fibers is also believed to have the
same effects. Lotus plants are pure by virtue, and they radiate this purity through their fibres. By wearing lotus fibre fabrics, one feels calm, peaceful and meditative. It also cures the wearer from headaches, heart ailments, asthma, and lung issues. The fabrics are 100 percent organic, and hence are environmentally friendly. The entire process of fibre extraction, spinning it into yarn and making the fabric is completely handmade making the process time consuming. This also limits the quantity of the fabric produced. Stems of the lotus plants are collected, cut, snapped, and twisted to expose its fibres. These are thin and white filaments around 20 to 30 in number.

Bamboo Yarn is naturally bacteria and odor resistant, and is the practical, yet eco-friendly choice. True to a natural Yarn, bamboo knits are already absorbent and breathable. The strength of bamboo adds to the durability of the fabric and is found to work well for those who are allergic to other natural fibers. Here the physical properties of both the Yarns are detailed and analyzed.

3.1 Physical Properties of Lotus and Bamboo Yarn – Yarn Count, Strength and Elongation

Fabrics with a low yarn count are generally weightier fabrics of greater durability. Fabrics with a higher yarn count are composed of finer threads which results in a softer, smoother, lighter fabric with greater drape. The general idea is that the higher the yarn count, the better quality which is tested with a standard testing method like ASTMD1907/D1907-2(2018).

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Lotus</th>
<th>Bamboo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. COUNT</td>
<td>38.38 (CV-1.29)</td>
<td>38.36 (CV-0.61)</td>
</tr>
<tr>
<td>2. STRENGTH</td>
<td>60.60 (CV-3.73)</td>
<td>50.67 (CV-2.83)</td>
</tr>
<tr>
<td>3. CSP</td>
<td>2325 (CV 3.19)</td>
<td>1944 (CV-2.72)</td>
</tr>
</tbody>
</table>

**Yarn Twist**

The number of twists per inch can, in plied yarns, be determined by counting the number of bumps in one inch, and dividing that number by the number of singles the strands plied together to make the yarn. The Yarn twist can be depicted in bamboo Yarn but not in lotus Yarn because of its finer and thinner spun yarn, but to mention the lotus yarn has a good strength & elongation seems to be at a higher level. The twist is tested with a twist tester microprocessor using a standard testing method like ASTM D1422/D1422-M13.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TWIST/INCH</td>
<td>21.26(CV-4.97)</td>
</tr>
<tr>
<td>2. TWIST/MINUTE</td>
<td>837.1(CV-4.97)</td>
</tr>
</tbody>
</table>

**Single Yarn Strength**

Single Yarn Strength Tester determines breaking strength and elongation of single cotton, wool and other yarns up to 50 N. Yarn Strength Tester complies with yarn strength testing methods like ASTM D2256, ISO2062, GB/T14344, etc.

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>Lotus</th>
<th>Bamboo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time to Break(s)</td>
<td>0.59(CV-13.64)</td>
<td>0.83(CV-7.33)</td>
</tr>
<tr>
<td>2. Elongation (%)</td>
<td>9.81(CV-13.64)</td>
<td>13.89(CV-7.34)</td>
</tr>
<tr>
<td>3. Tenacity (Rkm)</td>
<td>13.79(10.17)</td>
<td>16.4(CV-8.12)</td>
</tr>
</tbody>
</table>

**U%, Hairiness and Imperfections**

Hairiness is a property which indicates the amount and length of Yarn ends and loops protruding from the body of the yarn. The hairiness imparts a fuzzy appearance to the yarn product. It is desired in some situations such as for thermal insulation
and not desired in some other situations such as where clean operation is needed because the Yarn ends often break and drop from the hairy yarns by abrasion. The standard testing measures were followed & for hairiness ASTMYP/03-2015 and for imperfections ASTMD1425/D1425-2014 was maintained.

### Table 4

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Lotus</th>
<th>Bamboo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1 (U %)</td>
<td>11.45</td>
<td>11.13</td>
</tr>
<tr>
<td>½</td>
<td>11.43</td>
<td>10.86</td>
</tr>
<tr>
<td>1/3</td>
<td>11.41</td>
<td>10.83</td>
</tr>
<tr>
<td>¼</td>
<td>11.35</td>
<td>10.99</td>
</tr>
<tr>
<td>1/5</td>
<td>11.63</td>
<td>10.90</td>
</tr>
<tr>
<td>Mean</td>
<td>11.45</td>
<td>10.94</td>
</tr>
<tr>
<td>CV</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Thin 1/1(-50%/km)</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>½</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>1/3</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>¼</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>1/5</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Mean</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>CV</td>
<td>47.8</td>
<td>62.4</td>
</tr>
<tr>
<td>Thick 1/1(+50%/km)</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>½</td>
<td>70</td>
<td>38</td>
</tr>
<tr>
<td>1/3</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>¼</td>
<td>48</td>
<td>38</td>
</tr>
<tr>
<td>1/5</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Mean</td>
<td>49</td>
<td>32</td>
</tr>
<tr>
<td>CV</td>
<td>26.7</td>
<td>29.4</td>
</tr>
</tbody>
</table>

3. Conclusion

In the study above the results of the physical properties of lotus yarn & bamboo yarn discussed. From the above study it can be concluded that the yarn count, strength, elongation, yarn twist, single yarn strength, u%, hairiness and imperfections are significant in both the lotus & bamboo yarns. The lotus yarns have 60.60 value of strength, extraordinarily low hairiness was observed in lotus yarn comparatively to bamboo due to its oval shaped fibrous structure. The 50.67(CV-2.83 yarn exhibited higher strength with higher elongation at break. The lotus yarn have very good pilling grade due to less protruding fibers on their surface & good structural integrity. Lotus fiber has excellent properties of moisture absorbent, transmission, breathability Aishwarys Tahmima (2019). Apart from Bamboo, to know some uniqueness of lotus yarn the most essential physical properties were examined and evaluated. Both lotus & Bamboo yarn have similar characters. Both the yarns are suitable for fabrication process since both the yarns are cellulosic in nature their properties remain similar. Lotus Yarn has an extra added nature is that the fabrication made from these fabrics can have extra coolant property for the wearer.

References:

Digital Supply Chain Transformation and its Impacts in Apparel Industry

M. Krishnakumar1 & Minas Nisar2
1DC School of Management and Technology, Pullikkanam, Vagamon, Kerala, India
2Quality & Sourcing, Max Fashions, Dubai, UAE

Abstract:
Almost in every industry in the world, the transformation of conventional supply chains into a digital supply chain has been started since the past several years. Digital supply chain enables involvement of each and every stakeholder in the supply chain of a particular industry, in almost all the activities and processes through an integrated network which promises and involves transparent sharing of information which enables very significant improvements in the innovation, research & development, production, logistics, marketing, retailing and after sales service targeting the ultimate customer satisfaction. Apparel industry being one of the leading industries in the world, being considered as the one of the longest supply chain industries has also started implementing the process of transformation from conventional supply chain into a digital supply chain. This paper discusses the efforts, advantages, challenges and impact of digital supply chain in an apparel industry by taking a case example of a leading international apparel sourcing company in India.

Keywords: apparel industry, advantages, challenges, digitalisation, impact, supply chain transformation

Citation: M. Krishnakumar1 & Minas Nisar2, “Digital Supply Chain Transformation and its Impacts in Apparel Industry”, Journal of the Textile Association, 82/6 (338-344), (March-April'2022)

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1. Introduction
We are living in an era of exponential change. In the apparel industry, as in many other industries, the supply chain is currently undergoing a digital transformation. In every sector of the supply chain, digitalization is challenging old operating models and unleashing new potential. In recent years, it is focused on speed, innovation, and the digitalization of the entire supply chain on an end-to-end platform that will deliver data-driven insights and customized services. Since digital supply chain is the key for speed-to-market and installing innovation for the future, it is the most interesting topic to study.

The convergence of technologies has led to changes the way consumers and businesses interact. Businesses can now use data-driven insights to better predict and interact with customers in such a way that it is faster and innovative than ever before. The new consumer is connected, time starved, driven by experiences and seeking the best, for relevant products. They are demanding more transparency and exerting more pressure on companies to be sustainable [1]. These rapid changes are redefining the supply chain. Transforming from a conventional supply chain into a digital supply chain, it requires a lot of effort, commitment and resources at all levels of the organization. This paper discusses the efforts, advantages, challenges and impact of digital supply chain in an apparel industry by taking a case example of a leading international apparel sourcing company in India.

1.1 Transformation in supply chain
Almost in every industry in the world, the transformation of conventional supply chain into a digital supply chain has been started since the past several years. Digital supply chain enables involvement of each and every stakeholder in the supply chain of a particular industry, in almost all the activities and processes through an integrated network which promises and involves transparent sharing of information which enables very significant improvements in the innovation, research & development, production, logistics, marketing, retailing and after sales service targeting the ultimate customer satisfaction [2, 3]. Supply chain is defined as “The processes from the initial raw materials to the ultimate consumption of the finished products linking across supplier-user companies” (APICS dictionary).

Mobile phones, internet and social media are the best examples of digital technology the world has witnessed. These have changed the shopping and buying behaviour of customers in different ways and dimensions.

1.2. Digitalization
Digitalization is not about whether the goods or service are digital or physical. It is all about a new way of managing and doing things. Like in any other industry, digital technologies are disturbing the traditional way of the fashion industry to achieve things. IoT, social media, data tools, cloud facility, artificial intelligence and 3D are the major among them which is creating a better way of working. Customer's choice is changing day by day as they have access to the world trends in a touch. Different social media is now a platform for trend setting. Big Data is going to be the guide to predict the customer demand. The data directly from the consumer behaviour will now set the production. The facility of clouding will enable the companies to communicate and take a better decision-making process with the existing data. Analytical way to interpret the data is going to be the advanced skills required in the near future. [5].
Artificial intelligence and robotics have already been tried by many companies for the advancement in reduction of time, increase accuracy and to turn impossible to possible. Robotics and AI has been used in warehouses and in production replacing labour and energy [6]. The result was as good as expected. As any new concept digitalization, also has pros and cons. However, the change it brings is going to be big.

Digitization of supply chain is the solution for it, as supply chain is the track for a product to finally reach the customer. Improvement in the supply chain is vital to meet the changing demand.

Today Customers are 10 % faster than the service providers are. Therefore, it is now more vital for the companies to adapt to new way of reaching the customers. Outdated technology system, inefficient manual processes and lack of transparency are just a few example of what isn't working in today's traditional, analogue supply chain. From consumer behaviour and engagement to Omni-channel and new retail formats; digitalization is occurring at every level of apparel industry from product creation to delivery. Some of the technologies that are driving this transformation are 3D printing. 3D samples/ virtual sampling techniques, cloud computing, social media, mobile devices and data analytics, coupled by changing consumer behaviour and expectations led by millennial and generation Z customers. In this present and future scenario, the supply chain becomes the data chain. Analytics serve to support decisions, which will happen faster and help reduce lead times, which, in turn, reduce the working capital [7].

1.3. Digital Supply Chain

“Digital Supply Chain (DSC) is defined as a customer-centric platform model that captures and maximizes the utilization of real-time data coming from a variety of sources. It enables demand stimulation, matching, sensing and management to optimize performance and minimize risk.” [8].

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Traditional Supply Chain</th>
<th>Digital Supply Chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transparency</td>
<td>Limited view of supply chain</td>
<td>Complete view of supply chain</td>
</tr>
<tr>
<td>Flexibility</td>
<td>End customer demand is adulterated as information flows along the material path</td>
<td>End customer demand changes are rapidly assessed and analysed</td>
</tr>
<tr>
<td>Communication flow</td>
<td>Information delayed because it moves through each organization</td>
<td>Information is available for all the supply chain stakeholders simultaneously</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Limited accessibility to the entire chain, restricting meaningful collaboration</td>
<td>In-depth collaboration to capture intrinsic supply chain value</td>
</tr>
<tr>
<td>Important KPI</td>
<td>Reducing cost</td>
<td>Reducing time</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Different planning cycles results in delays and unsynchronized responses across multiple tiers</td>
<td>Real-time response on planning and execution level (across all tiers to demand changes)</td>
</tr>
</tbody>
</table>

Source: [4]

“IT's all about Data”

Behind the great potential of the digital supply chain (DSC) is the Industry 4.0, the fourth-industrial revolution. This is based on implementation of a wide range of digital technologies — the cloud, big data, the Internet of Things, 3D printing, augmented reality, and others. The two examples will explain how it differentiates from the traditional or the existing linear supply chain. Firstly, it is the data visibility and transparency. Secondly is sensing new opportunities by integrating the information and data from all the stakeholders of the supply chain. In the apparel industry, it is all about identifying the changing scenario of the customer demand and behaviour and then altering the supply chain and process as a whole, instead of just experimenting new products. In the coming 5 years the industry is going to change, the successful companies have to now slowly take advantage of new management practices, a continuously expanding data reservoir and new technology relevant to the digital supply chain if they have to achieve future competitive advantage and delight their customer. [3, 9].

The main advantage of DSC is the fastness of response to consumer demand. The quick system provides the essential information that allows goods to be shipped with the speed and quality needed to satisfy the customer. In the traditional supply chain, the main aim is to reduce the cost of manufacturing. However, in today's scenario customers are demanding for more options, fast fashion is the answer to it. The aim KPI of DSC is reducing the lead-time. This is the fundamental difference between traditional and DSC.

1.4 Advantages of Digital Supply Chain

The DSC can bring significant advantages, including:

- Speed: digitalization can cut down product development time significantly. For example, buyers and suppliers can send the digital samples back and forth rather than shipping physical prototypes each time, thereby saving time and expenses.
• Flexibility: Digitalization improves the communication among stakeholders of each stage of the supply chain which will speed up the process of decision making. The changes can be altered in each stage easily according to the changing customer demand.

• Improved efficiency: digitalization increases the interaction between the different stages of the supply chain, making the process more time and resource efficient, which in turn results in reduced operating costs.

• Risk minimization: since needed changes can be done virtually, no physical adjustment of the blueprint is needed. The risk of prediction is minimal as the products are developed according to demand. Also the manufactures can use digital technologies to respond to any manufacturing issues more rapidly.

• Trust: Integrated automated interaction with suppliers builds trust. The payment process can be easier to trace and on time, helps in building up trust.

• Environmental sustainability: Digital sampling and 3D sampling can negate the need to ship physical items up and down the supply chain, which helps designers and manufactures reduce their use of resources. The wastage of resources can be reduced to a good extent.

• Reduce in lead time: the lead time in the design stage can be reduced majorly with 3D sampling technologies. Decision making process can be cut short to days from weeks.

However, because of the interconnected nature of supply chain, in order to reap the maximum benefits of digitalization, companies must ensure that the various phases of supply chain work in synergy. There must be a well coordinated and connected effort from everyone to utilize the new concept. Each stage of the supply chain is highly reliant on each other, that one problem at one stage will inevitably have negative consequences on the other. So the efficiency brought by digitalization at one stage of the supply chain will not improve the overall operation until there is sufficient coordination with the other stage. That begins from the organization[10].

1.5 Challenges in DSC
The main challenges of organization that is planning the transformation are

i) Transformation between the organization and their customer.

ii) Transformation between the organization and all of their partners cross the value chain. But the third category of digital transformation that plays a very important role so as to accelerate the transformation is

iii) Transformation within the organization – the transformation of internal human resource, organizational culture and cultivating a system of data-driven insight with digital literacy.

2. Materials and Methods
2.1 Digitalization in apparel industry: A case of Li & Fung
The apparel industry as the most globalized industries in the world is a supply driven commodity chain led by a combination of retailers, factories, contractors, merchandiser's, buyers, and suppliers. Each of the stakeholders of apparel supply chain is very much important in the network of supply chain that spans from fibres to yarn, to fabrics, to accessories, to garments, to trading and to marketing. Fast fashion is another trend which is forcing the fashion industry to be digitalized to serve the demand with the right product, in the right time, and in the right quantity.

Development of 3D printing and virtual sampling technology are the other two important inventions to cut down the lead-time. With 3D samplings, technology companies can make a faster decision on the styles for the season and therefore reduce the cost of making samples and enable speed-to-market. Fast fashion is the best way to keep up the changing customer demand and preference. To make it possible for a global brand they should adapt to the newest technology for reducing the lead-time, and the cost[11].

The major KPI's of the supply chain is reduction in cost. The apparel industry did a major struggle in meeting customer demands as well as maintaining the cost reduction of the organization. However, in today's modern competitive environment where markets are becoming more global and dynamic, the customer is the actual player. Customers are demanding more variety, better quality and services including reliability and faster delivery. Therefore, to ensure the competitive edge of the firms, it has become mandatory for the apparel industry to be more participative and adaptive. Traditional supply chain is viewed as a linear flow, where input enters at one end and transforms to output at each stage of its supply chain. But with the changing scenario of customer demand, preference and the concept of fast fashion, the apparel supply chain is facing a major disturbance. This disturbance has to be identified and then strategic changes and modification of supply chain is very vital in apparel supply chain. This supply chain is now practical for the industries where change in product and customer behaviour is very rare. [1].

According to recent studies the biggest challenge fashion companies will face in coming years are- Improvement and digitalization of supply chain, Speed-to-market, High flexibility throughout the supply chain, Transparency and quality of information, Artificial intelligence and robotics, 3D printing and 3D / virtual sampling technology, New consumer buying cycle, IoT- Internet of things, Social media, Big data and cloud service.

Across the sectors digitalization is challenging old operating models and unleashing new potential. There is new technology for all the major departments of the supply chain of the apparel industry that is going to make a huge change. In traditional supply chain which consists of major four stages
like Design, Manufacturing, Distribution and sales, technologies has implemented new ways for operations in following ways:

- The design process can be completely moved from a paper-based process to a completely digital process with the use of 3D software. This shift will reduce the lead time very drastically as this will cut down the proto samples before production. Also, the need for making physical samples will be minimal which reduces the expense, time and increases the adoption. The changes can be done in the designing stage itself where earlier it was decided after receiving samples.

- In the manufacturing stage, technologically advanced machinery will improve the quality, efficiency and quantity.

- In the distribution stage artificial intelligence and robotics will make a new mark in delivery time.

- In the sales stage, customer buying behaviour and inventory tracking can be done by in store-technologies which will help in meeting the correct demand on right time.

A number of digital technologies can be applied to various stages of the apparel supply chain as mentioned below.

Table 2 Digitalization of apparel supply chain: stages and Digital solution

<table>
<thead>
<tr>
<th>Stages</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design analytics and 3D sampling</td>
<td>Digital design software, cloud computing, virtual sampling, predictive</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Digital printing, sensors, IoT technology</td>
</tr>
<tr>
<td>Distribution identification (RFID)</td>
<td>Robots, autonomous vehicles, Radio-frequency</td>
</tr>
<tr>
<td>Sales technology and social media</td>
<td>Multichannel technology, in-store technology, cloud computing, IoT</td>
</tr>
</tbody>
</table>

In the traditional supply chain which is largely discrete and the stages have a flow without interconnection of information. But in integrated DSC it's all about Data. According to sourcing experts DSC can cut short the lead time by at least 48%. Data driven insight is the concept of Digital supply chain. The data from the whole process can be analysed and used for better decision making [5]. For example, the stakeholders can over think through the process in both the direction:

- Forward from design to sales: The use of virtual samples allows designers and producers to interact and decide more quickly and efficiently during the adoption stage. Number of development samples can be cut short. It improves the efficiency of design, production and distribution by allowing the stakeholders to respond quickly when appropriate a change is required.

- Backward from sales to design: It enables consumers and retailers to trace back and get real time updates in the supply chain to see where actually their product comes from. It gives clarity on whether the product is sustainable and ethically sourced avoiding counterfeit products.

2.2 Li& Fung

Li & Fung is one of the leading international apparel sourcing firms in the world connecting the numerous apparel manufacturers all over the world with several leading apparel buying and retailing companies in the world. With its head office located in Hongkong, the company has branch offices and liaison offices in many countries in the world and few offices in India also. Established in 1906, this company has grown into a big multinational corporation from a small start-up focused on trading handicraft from China to the western countries. This company has gone through major changes, innovations, disruptions, experimenting new ways of working, creating value to its customers [12].

The company has also started implementing the transformation of its supply chain to a digital supply chain under a plan of Three-years. This new Three-Year Plan represents the company's continuing business transformation with the goal of creating the Supply Chain of the Future and helping brands and retailers to better respond to consumer trends and navigate the digital economy. At its core is a focus on three key themes of speed, innovation and digitalization [12].

Speed

The Company has considered speed is crucial in meeting the needs of its brand and retail customers who are operating on shorter lead times, placing smaller orders and requiring greater flexibility in inventory replenishment. The Company has therefore focused on being more agile and producing results more quickly by simplifying processes, using technology and embracing new ways of working with its customers and other industry partners.

To do this the Company would focus on simplifying its business and using productivity initiatives to drive internal agility. This has been expected to result in shorter lead times for customers competing in the digital economy and productivity gain reducing operating costs for the Company.

Innovation

The Company has focused on creating innovative solutions for customers to address the ever-changing needs of their consumers with solutions to maximize the value from their supply chain and differentiated products that delight the consumers. The Company has planned to embed innovation not only into its product and service offerings but also in its business models and ways of working with its customers and other ecosystem partners, enabling a culture of open innovation and collaboration.

To do this the company would focus on new ways of working, partnering for new products, and new business models which feature supply chain solutions for customers
and vendors. This is expected to result in long-term growth over the course of the Three-Year Plan.

**Digitalization**

In order to achieve speed and innovation the Company's goal is the digitalization of the entire supply chain. The Company has aimed to digitize all key aspects of the supply chain from product development, material costing, and sampling, to the final creation and delivery of products. This end-to-end platform will make customers' processes more seamless, efficient and cost effective and enable the Company to deliver data driven insights as well as customized services to brands and retailers [13].

The supply chain of the Future is a multidimensional world where brands and retailers, and vendors and suppliers can seamlessly connect into an ecosystem of their digital services and data insights that was never possible until now. Their ambition is to reach a state when they can deliver predictive analytics to enhance the business performance of the customers and partners, by capturing and sharing the information across the supply chain partners. This is the future of supply chains. The first step is a steady process to truly digitize the supply chain [13].

### 2.3 Digital Platform

The aim of the digital platform is digitizing every stage of the supply chain in order to have a seamless flow of information and data among the supply chain stakeholders which helps in getting competitive advantage over others because of quicker and efficient decisions could be taken through this integrated digital supply chain network.

![Figure 1 Digital Supply Chain Platform (Li & Fung)](https://www.lifung.com/supply-chain-innovation/lf-digital-platform/)

The LF Digital Platform connects brand and retail customers with their supplier base. This digital platform helps in transforming the manual work into digital data right from the initial stage of design development till to the fit review. It will allow the myriad of systems used by their customers and vendors to connect and use data analytics for better decision making. Their size and scale mean they are uniquely positioned to adapt platforms to accommodate these system differences and transform the supply chain with integrated end-to-end data flow.

**Customer portal**

This customer portal enables the customers to come together to get into a single global source for data which will be available at any point of time, accessed through any digital device from anywhere. The entire supply chain stakeholders could get access to the dashboards, reports and insights over end-end visibility.

**Vendor portal**

This portal enables the vendors or suppliers to connect digitally through this platform. About 15000 vendors and suppliers can be connected through this portal to get details related to bankers, carriers, cargos, secondary vendors and also make the follow up of orders, payments, shipments etc.

**Supply chain solutions**

Li & Fung supply chain solutions provide a range of tools for retailers and suppliers across four platforms: Materials Platform, 3D Design Platform, Production Platform and the Vendor Platform.

The material platform acts as a kind of marketplace where the supplies of yarn, fabric, trims linked together to enable easy access and sourcing of materials at a competitive cost and also fast approvals and decision making.

The 3D design platform enables the fast and speed sampling process from design concept to testing to final design. This also helps in reduction in lead time of sampling process, reusability of the digital sample without any incremental cost of product development, reduced wastages and also minimal shipping.

The production platform helps in connecting the production suppliers in more than 40 production markets all over the world enables easy order tracking system and also optimized usage of resources among the production suppliers.

The vendor platform connects more than 15000 suppliers as partners where they will be actively participating in dynamic costing process, scenario-based analysis, forecasting and pre-costing with real-time changes is helping bring about speed, allowing for faster decisions and matching orders with the right factory. The suppliers and vendors can avail the trade credit services, vendor compliance and sustainability, vendor supply chain services, manufacturing excellence, and smart factory solutions. All the tools on four platforms are collaborative and can be customized for each customer.

### 3. Results and Discussion

#### 3.1 Impact of Digitalization in Apparel Industry

**3.1.1 Enabling higher speed, performance and profitability**

With digitalization on board the major impact will be by implementing virtual sampling which will reduce the lead time enabling speed-to-market and improve the
performance. The lead time reduction is the major one. The digital platform will improve the relation between the supplier, vendor, and customer by proper utilization of data resources for decision making.

Speed is a critical part of the strategy. It will increase speed like never before, helping the customers reduce production lead times and increase speed-to-market. This means making decisions closer to time to market, giving them quick response to trends, improved inventory control and decreased mark down – all with the aim of improving profitability.

In an average industrial planning process and current LF pre-order takes up to 17 weeks. This stage includes development of design, vendor sourcing, and adoption of final design after proto samples and costing. The design confirmation takes time as the confirmation is done after receiving a sample from the vendor. Then comes the order confirmation where the buyer conforms the quantity of design after costing and then pre-production happens. In this stage the sourcing of fabric, trim and also fit approval takes place. This stage on an average takes 13 weeks as the delay in approval is major drawback. Then comes the production and shipping stage which usually takes 10 weeks of time. Li & Fung has their own logistic support, which will be undergoing the transportation.

Table 3 Impact of DSC in lead time

<table>
<thead>
<tr>
<th>Process</th>
<th>Conventional (days)</th>
<th>Digital (days)</th>
<th>Reduction in time (days)</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-order</td>
<td>17</td>
<td>8</td>
<td>9</td>
<td>53%</td>
</tr>
<tr>
<td>Pre-production</td>
<td>13</td>
<td>4</td>
<td>9</td>
<td>69%</td>
</tr>
<tr>
<td>Production &amp; Shipping</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>60%</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>16</td>
<td>24</td>
<td>60%</td>
</tr>
</tbody>
</table>

With digitalization on board this process can be cut short from 40 weeks to 16 weeks. This will increase the speed, efficiency and profitability for every stakeholder of the supply chain. Li & Fung as a third-party agency can make their position strong in the competitive market where everything is getting advanced. The big customers like Tommy Hilfiger, CK will then only choose LF because they can provide the data insight outcome which no other third party has. By this Li & Fung can reduce their threat of being overtaken by factories. Factories are also becoming competitive and advanced with best human resources and technology. If a new process is implemented then the pre-order stage will only take 8 weeks where LF plans, designs, source and does the costing in an advanced way. In the pre-production stage LF has their own fit process where approval and decision making from buyers is done fast. The sampling approval takes place fast like never before. Then the production stage is cut short to 4 weeks including shipping.

3.2 Virtual Sampling in product development

The next major impact will be by implementing virtual /3D sampling. With the focus on Speed, Innovation and Digitalization, Virtual Sampling is gaining momentum within LF. Increasing number of customers are also getting on board to get their hands on technology to reduce lead time, save costs and make better decisions in product development. The current process does not allow this as it has many stages of approvals and physical samples [14].

The key challenges in the traditional product development process are:

- Time and cost wasted with rejected styles.
- Longer time to market.
- Lack of early customer feedback resulting in higher mark down.
- Lack of more options at product development stage.

The impacts of 3D sampling are shortened product development cycles, enabling brands to review entire collections, in all colour ways, within weeks of design sketches, instead of months, faster feedback and approvals from buyers [14][15].

The process which usually takes weeks' time to decide on design can be converted to days. This is the biggest advantage of 3D sampling. The number of samples can be cut short to few which will give the buyers a big advantage of being partners with Li & Fung. The product development stage will be very short because this LF can attract more customers also.

Table 3.1 Benefits of implementing 3D sampling

<table>
<thead>
<tr>
<th>Business benefit</th>
<th>Business use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed up decision making on line assortment</td>
<td>Replace protos and other fit samples with 3D (keeping final sample physical)</td>
</tr>
<tr>
<td>Replace physical samples with 3D</td>
<td>Speed up process of approving proto samples</td>
</tr>
<tr>
<td>Replace physical samples with 3D</td>
<td>Replace physical samples with 3D</td>
</tr>
<tr>
<td>Make better design &amp; merchandising decisions</td>
<td>Finalize location &amp; size of graphics, trims (e.g. pockets)</td>
</tr>
<tr>
<td>Improve fit</td>
<td>Test fit across multiple sizes not only base size</td>
</tr>
</tbody>
</table>

advantage Li & Fung gives by choosing them will be unique one in the market.
4. Conclusion

Digital supply chain transforms the dynamics of the supply chain of any industry including the apparel industry. It is not an optional choice but emerging as a necessary one in all types of organisations. Transformation to the digital supply chain is becoming a major paradigm shift in the various industries which are curiously looking for the cost and operational optimisation to perform better than before to survive the competitive business environment. The apparel industry in India which has a vast number of small and medium enterprises which are yet to understand the basic concept of supply chain management, for them the adaptation of digital supply chain would be a major task to transform. At present, the transformation to digital supply chain can be seen only from the large integrated apparel manufacturing companies and this trend will transform to the next level of manufactures in the next several years and so on to the bottom level of the manufacturing pyramid in one or two decades.

References

Eco-friendly Multifunctional Finishing on Textiles – A Review

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Abstract:
The current trends in the use of essential oils and herbal extracts to be incorporated into the textile materials have been evaluated in detail in this review. The review outlines the use of various eco-friendly essential oils and herbal extracts for multifunctional finishing over hazardous chemical agents used for textile finishing. The lack of durability of the finish is one major limitation with the use of natural products on textiles for multifunctional finishing. As natural essential oils are volatile in nature, its fixation on fabric is difficult as compared to the chemicals commonly employed for multifunctional products. Most of the herbal extract or essential oil finishing on textile substrate gets reduced during wash cycles since they do not have any affinity to textiles or they are not fixed on the surface of textiles. The various limitations in the use of natural products and the various oil finishing application methods used to increase the longevity of the protection have been discussed in this review. The improvement in the washing fastness of the eco-friendly finishing is the need of the hour which has been focused in this paper.

Keywords: Antibacterial, Durability, Eco-friendly, Finishing, Mosquito Protection, Multifunctional, Nanotechnology, UV protection


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1. Introduction
Tradtitionally, textiles are thought about as low technology domain as their primary functions are protection of modesty, providing microclimate and good aesthetics. The intensification of world competition has led the textile manufacturing companies from developed countries to compete for a significant share of the global market by developing new technologies or new products. With the increase in demand of the consumers for textile products with higher performances, industries are trying to differentiate their products with specific and special functions. The creation of new material properties and the improvement in existing properties are the most important factors for the functionalization of textiles. Hence researchers are in constant attempts to impart more functional characteristics to fabrics (in addition to the above mentioned primary functions) so as to produce, what are known as multifunctional textiles [1]. Textile industry is one of the major contributors in polluting the environment. Besides generating harmful toxins during textile production, the sector emits toxic gases like alkane series into the air. The global population demands loads of textile production which continue to grow to compete for improvement in living standards. Consequently loads of textile waste is generated every year which pollutes water, air and the waste dumped sites in landfills.

The growth in environment consciousness amongst people has made them desirous of shifting towards eco-friendly products. Researchers and scientists are in search of novel ways to find solutions to this problem by proposing the use of natural fiber sources, natural essential oils and herbal extracts for finishing of fabrics. Use of harmful chemicals need to be replaced by these natural products in a sustainable way for health and environment benefits. Keeping this emerging problem in view, the present review work has been undertaken to explore various traditional materials, methods and the latest application techniques being used for multifunctional finishing. This paper also highlights the scope of research in eco-friendly multifunctional finishing.

2. Finishing using various essential oils
The demand for textile finishing is making it more marketable is increasing due to the global competition. The increasing globalization has created many ways and challenges to the textile researchers and industrialists to create new materials and methods. The rapid growth in technical textiles and their end uses has generated many opportunities for the application of innovative and durable finishes. The next phase of growth and development of the textile industry will be focused on value-added sustainable textiles. Various natural essential oils have been identified to possess functional properties, for e.g. Neem oil can be used for insecticidal, antibacterial and antimicrobial properties [2], Jojoba oil and Vitamin E oil for UV protection and antibacterial properties [3]. Another research summarizes the diverse features of nano TiO2 on wool, its multifunctional properties on wool and the novel properties besides the known properties of nano TiO2 on wool [4]. A detailed review of how ecofriendly finishes can be contributed to the development of multifunctional finishing on textiles is discussed herewith.

2.1. Antibacterial Finishing
In a study, Neem oil nanoemulsion has been prepared using Tween 20 surfactant. The emulsion prepared with the aid of a magnetic stirrer at room temperature for about 4 hour at 1250 rpm has been kept under probe sonication at 10,000 frequencies for varying time interval (30, 45, 60 min). To get a high add-on on the 100% cotton substrate, the optimized finishing formulation has been obtained amongst 18 trial
formulations. The treated substrate with optimized formulation has been found to possess 99.99% antibacterial property which retained its efficiency till 5 washes and tends to reduce till 15 washes [2].

In another work, cotton samples have been treated with varying percentage of Neem oil and aloevera through pad-dry-cure method. The antimicrobial activity of these samples against Gram positive and Gram negative bacteria, S. aureus (108cfu/ml) and E. coli (108cfu/ml) have been tested. It has been found that the herbal finishes with 10% Neem oil showed 56% reduction against S. aureus and 95% reduction against E. coli whereas the fabric finishes with 10% aloevera gel reported antibacterial property of 86% against S. aureus and 95% against E. coli respectively [5].

In another study, 52 plant oils and herb extracts have been investigated for activity against Acinetobacter baumanii, Aeromonas veronii biogroup sobria, Candida Albicans, Enterococcus faecalis, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Salmonella enterica subsp, enterica serotype typhimurium, Serratiamarcescens and Staphylococcus aureus, using an agar dilution method. The 52 oils were rosewood, Celery seed, Frankincense, ylangylang, cedarwood, Lime, Orange, Petitgrain, Bergamot, Lemon, Grapefruit, Mandarin, Myrrh, Coriander, Pumpkin, Cypress, Lemongrass, Palmarose, Citronella, French lavender, Tasmanian Lavender, Macademia, Carrot seed, Eucalyptus, Fennel, Wintergreen, Juniper, Tea Tree, Cajuput, Niaouli, Peppermint, Spearmint, Basil, Evening primrose, Marjoram, Oregano, Geranium, Aniseed, Bay, Pine, Black pepper, Patchouli, Apricot kernel, Sweet almond, Rosemary, Sage, Clary sage, Sandalwood, Clove, Thyme, Vetiver, Ginger. Lemongrass, oregano and bay inhibited all organisms at 2-0% (v/v). Rosewood, coriander, palmarosa, tea tree, niaouli, peppermint, spearmint, sage and marjoram inhibited all organisms except Ps. aeruginosa at 2-0% (v/v) [6]. These oils have been used for pharmaceutical applications and not for textile applications. However the 52 oils tested for pharmaceutical applications having excellent antibacterial results can be reduced to oil in water nanoemulsion and applied on textiles through various application techniques to develop antibacterial textile end products.

In alternative studies, excellent antimicrobial property of eco-friendly essential oils and plant extracts like rosemary, peppermint, bay, basil, tea tree, celery seed and fennel have been reported [6 - 11].

Another study aims at developing sustainable nanostructured textile material treated with tetrahydroxy curcumin and assesses its application within the areas of wound management. Stable oil in water nanoemulsion of tetrahydroxy curcumin derivative has been developed by high pressure homogenization technique. Textile material has been immersed in optimized nanoemulsion having particle size distribution 100–300 nm, zeta potential −30.1 to −31.1 mV and drug content 80–83.3% by exhaust methodology using cyclodextrin and polycarboxylic acid as a cross-linking agent. Treated sample has been found to be more effective against B. Subtilis and E.coli when evaluated for its antimicrobial activity. The results optimized using response surface methodology odetermined that, 0.5% nanoemulsion at 100 °C for 15-min period of time shows maximum inhibition [12].

Herbal extracts of celery seed applied on cotton fabric by microencapsulation, cross linking and a combination of both have been found to possess excellent antimicrobial properties of 99% against S. aureus and K.pneumoniae respectively. It has been observed that the acacia gum microencapsulated herbal extract is durable upto 15 wash cycles whereas the cross linked herbal extract with a resin has been found to be durable upto 10 washes. Fabric lost one of the physical parameters, loss of tensile strength or crease recovery angle in both these cases. However, a combined technique ensured the treated fabric to be durable upto 15 washes without compromising on any of its physical properties [13].

2.2. UV Finishing
In a study, permanent fixation of Monochloro- triazine-betacyclodextrin (MCT-bCD) onto cellulose component of P/C blend fabric has been done to impart antibacterial efficiency and UV-protection (UPF) functionality to cellulose component contained in cotton/polyester fabric. This has been followed by application of natural antibacterial (Jojoba oil) and UV-protection (vitamin E) agents separately. Both the oils have been found to give very good UV and antibacterial results, Jojoba oil being better than Vitamin E [3].

In another research study, certain oils have been reported to impart very good UV protection properties such as almond oil (SPF5), Jojoba oil- (Simmondsiachinensis SPF4). Natural Shea Butter (Vitellariaparadoxa SPF 6-10), Macadamia nut oil (SPF 6), Olive oil (SPF9), Avocado oil (SPF15), Wheat Germ oil (SPF22), Raspberry seed oil (SPF 40), Carrot seed oil- (SPF 40), Soybean oil (SPF10) and Evening primrose (Oenothera spp.Oil) [14, 15].

However the stated oils, which have been reported to have very good UV protection factor, have been tested for cosmetics and pharma applications. The optimized formulation of these oils can be applied on textiles and tested for their UV protection factor.

2.3. Mosquito Repellent Finishing
The use of essential oils on different textile materials for protection against the mosquito menace and the effective method of microencapsulation for increasing the longevity of the protection have been done by various researchers and can be briefed as follows:

In a research, Cypress oil, Thyme oil and Grapefruit oils together in combination of 2:1:1 have been microencapsulated using different wall material such as...
acacia arabica, sodium alginate and moringa oleifera gum. The finishing has been applied on bamboo/ tencel 50:50 blend substrate using exhaustion method. The finished substrate with Moringa oleifera gum as wall material has been found to possess mosquito repellent effectiveness sturdy up to 30 washes with no sensitivity to the user [16].

In another work, microencapsulated Citronella oil using different wall materials like gum arabic, chitosan etc. has been applied onto the textile fabric. This finished fabric has been found to possess long lasting insect protection compared to fabrics sprayed with an essential oil ethanolic solution, assuring a mosquito repellent effect higher than 90% for three weeks [17]. In another study, preparation of microcapsules of biostereicides, named Citronella essential oil and Citriodiol have been prepared and applied to the cotton substrate by conventional padding technique. Citriodiol treated cotton presented 100% repellency and long lasting durability for more than 30 days after padding onto the cotton fabric samples [18].

A research states that a chemical compound, betacyclodextrin (βCD), having hydrophobic cavities can act as a host for a hydrophobic guest molecule. It acts as an inclusive compound for various guest molecules. This enables the development of fabrics that release chemical compounds such as fragrances, mosquito repellent and antimicrobial agents [19]. A study reports synthesis, characterization and optimization of β-Cyclodextrin citrate (β-CD CA) followed by fixation with essential oils of clove, cedarwood, lavender, peppermint, eucalyptus and jasmine for the assessment of repellent efficacy against Anopheles Stepheensi by means of mosquito repellent arm in cage test on cotton [20].

In a research work, the aqueous and methanolic extracts of Lemon grass plant has been microencapsulated and applied on the polyester fabric. The microcapsules of aqueous extract showed 92% mosquito repellency, on the contrary the methanolic microcapsules exhibited 80% repellency [21]. It has also been reported that the textile substrate individually treated with leaf herbal extract of Vitex negundo plant loaded with alginate nanoparticle [22], Andrographispaniculata plant extract [23] and the three herbal extracts of Ricinuscommunis, Euphorbia herita and Senna auriculata, applied on denim fabrics directly by using pad dry cure method, showed mosquito repellent properties durable up to 10-15 wash cycles [24].

Apart from repellence, essential oils like Cryptomeria japonica, eucalyptus, Nerium oleander L flower extract [25], Lawsonia inermis leaf extract [26], Chromolaenaodororata L [27], Dalbergiasssiosoo demonstrated remarkable larvicidal activity against larvae of mosquito [28]. The active ingredient found in neem plant, azadiractin extract has long been recognized for its mosquito larvicidal capability [29]. In another work carried out by Gupta and Singh (2017), the herbal extract of mint leaves has been finished through pad-dry-cure method on cotton sample. The evaluation has been done through excito mosquito repellent behavioral test. The wash durability of the finished fabrics has been evaluated at 5, 7 and 9 wash cycles. The finished fabric has been observed with 100% mosquito repellent activity for direct application method. The durability of the finishing has been found to reduce with subsequent washing [30].

In another work, nylon net has been treated with nanoemulsion of chrysanthemum oil. The emulsion having mean droplet diameter of 53 nm, has been applied on nylon net through layer by layer technique. The fabric possesses 95% mosquito repellency rate at finish application and 80 % mosquito repellency rate after imparting 25 wash cycles. The repellency rate increased with the increase in oil nanoemulsion concentration and number of layers in the LbL technique.

The increase in the concentration of emulsion and number of layers in the LbL technique, leads to increase in the oil attachment to the textile substrate through electrostatic bond formation resulting in the higher mosquito repellent activity [31].

2.4. Multifunctional Finishing
Few single sources in research studies have been reported to provide multifunctional properties to textile substrates: A research focuses on economical and environmental friendly surface modification of wool fibers with good wash durability and comfort properties. Chitosan in acetic acid solution has been applied by padding, and grated by ultraviolet radiation, through radical reactions promoted by a photo initiator. Chitosan grafting of 2% has been found to be sufficient to give satisfactory antimicrobial activity (67% reduction of Escherichia coli) after oxidative wool pre-treatment and 1 h impregnation at 50 °C. It has been found that the chitosan UV-grafting can be indicated as a valid eco-friendly method to apply multifunctional finishing to wool fabrics without affecting their comfort properties [32].

In another work, eco-friendly multi-functionalization of cotton/wool (C/W) and viscose/wool (V/W) blended fabrics, Ag-nanoparticle (Ag-NP) and/or ZnO-nanoparticle (ZnO-NP) functional agents has been utilized into the finishing bath along with succinic acid (SA) or citric acid (CA) as ester-crosslinking agent, and sodium hypophosphite catalyst. The padding technique has been used to treat the fabric blends in the finishing formulation. The blended fabrics finished with Ag-NP/ZnO-NP/CA/SHP nano-finishing formulation has been reported to exhibit outstanding durable antibacterial activity, wrinkle recovery properties and UV-blocking functionality even after 10 wash cycles [33].

In another eco-friendly antibacterial and mosquito repellent finishing study, nylon net textile substrate has been finished with Cymbopogon flexuosus (lemongrass) oil nanoemulsion by the layer by layer (LbL) technique. The nanoemulsion has been characterized for particle size, zeta potential, viscosity, pH and Poly Dispersity Index. Mosquito antennal response to pure CF oil and its nanoemulsion has been noted. The
application technique has been optimized for the concentration of nanoemulsion used and the number of polymeric layers applied. The fabrics have been found to retain its antibacterial, mosquito repellent and fragrance retention efficacy even after 25 washes [34].

Another work reports the synthesis and application of Peppermint oil in water nanoemulsion for eco-friendly multifunctional finishing on cotton substrates. The oil in water nanoemulsion prepared using high speed homogenization technique has been applied onto the cotton fabric by layer by layer Technique. The particle size of the nanoemulsion has been found to be stable and in the nanometer range when tested with the help of Mastersizer 2000 analyzer. The use of Nano emulsion through LbL technique has led to 98.02% and 97.72% antibacterial property against S. Aureous and K. pneumonia respectively, 100 % mosquito repellence property and 7.21 UPF property of the finished fabric [35].

Table 1: Natural oils used for multifunctional finishing

<table>
<thead>
<tr>
<th>Common name</th>
<th>Botanical name</th>
<th>Nature</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosewood [6]</td>
<td><em>Anibarosaedora</em></td>
<td>Oil</td>
<td>Antibacterial, Aroma rich</td>
</tr>
<tr>
<td>Peppermint [7, 35, 47]</td>
<td><em>Menthapiperita</em></td>
<td>Oil, Leaf extract</td>
<td>Antibacterial, Mosquito repellent, Aroma rich</td>
</tr>
<tr>
<td>Bay [8]</td>
<td><em>Laurusnobilis</em></td>
<td>Oil</td>
<td>Antibacterial</td>
</tr>
<tr>
<td>Celery seed [48]</td>
<td><em>Foeniculum vulgar</em></td>
<td>Oil, Leaf extract</td>
<td>Antibacterial, mosquito repellent</td>
</tr>
<tr>
<td>Fennel [48]</td>
<td><em>Cymbopogoncitrus</em></td>
<td>Oil</td>
<td>Antibacterial</td>
</tr>
<tr>
<td>Lemongrass [6, 34]</td>
<td><em>Ocimumspp</em></td>
<td>Oil</td>
<td>Antibacterial, Mosquito repellent, Aroma rich</td>
</tr>
<tr>
<td>Oregano [6]</td>
<td><em>Origanum vulgar</em></td>
<td>Oil</td>
<td>Antibacterial</td>
</tr>
<tr>
<td>Holy Basil [47]</td>
<td><em>Azadirachta indica</em></td>
<td>Oil, Leaf extract</td>
<td>Antibacterial, Mosquito repellent</td>
</tr>
<tr>
<td>Neem [2, 9, 46]</td>
<td><em>Daucus carota</em></td>
<td>Oil</td>
<td>UV protection</td>
</tr>
<tr>
<td>Carrot seed oil [2, 8]</td>
<td><em>Rubusidaeus</em></td>
<td>Oil</td>
<td>UV protection</td>
</tr>
</tbody>
</table>

Amongst the above suggested essential oils, Peppermint, Lemongrass, celery seed, Holy basil and Neem are found to possess excellent functional properties such as antibacterial and mosquito repellent properties.

Peppermint oil have been found to possess excellent antibacterial, mosquito repellent and moderate UV protection properties on cotton fabric [35]. Its antimicrobial properties are mainly due to the combined effects of major compounds such as l-menthol, menthone, methyl acetate, and limonene. Herbal extracts of celery seed applied on cotton fabric by microencapsulation, cross linking and a combination of both have been found to possess good antimicrobial properties till 15 wash cycles against S. aureous and K. pneumonia respectively [13]. Celery seed is known to possess antiancer, anti-obesity, anti-hepatotoxic, larvicidal and antimicrobial properties and thus is an excellent choice for functional finishing. Lemongrass oil nanoemulsion has been found to exhibit excellent antibacterial, mosquito repellent and fragrance retention efficacy on nylon net fabric even after 25 washes [34]. This is due to its major component citral which can inhibit the growth of a broad spectrum of pathogens. Holy basil and neem have been reported to possess good antibacterial properties on cotton fabric [5]. This is due to the medicinal properties of these herbs.

3. Issues and challenges for ecofriendly multifunctional finishing

One of the major limitations with the use of natural products like essential oils or extracts for multifunctional finish is lack of durability of the applied finish. The natural essential oils are volatile in nature; its fixation on fabric is difficult as compared to the chemical finishing. Most of the herbal extract or oil finishing can be removed during wash cycles since they do not have any affinity to textiles or they are not fixed on the surface of textiles. Consumers are in need of effective functional textiles with advanced easy handle, comfort, improved health and hygiene. However certain techniques and technologies can be developed, improved or validated to enhance the wash durability of eco-friendly oil or herbal finishing such as:

a. Development of micro-capsules having combination of compatible essential oils having multifunctional properties using natural wall materials such as Moringa Oleifera, Gum Arabic etc. This can be followed by Padding for application on textiles

b. Preparation of oil in water Nano emulsion of essential oils having multifunctional properties using natural wall materials w.r.t. the use of appropriate emulsifiers followed by its application on fabric through LbL or padding technique

4. Application Techniques to improve the durability of the Finish

4.1. Microencapsulation Technique

Microencapsulation is one method used to trap the active agents using different wall materials like modified starch, sodium alginate, gum acacia etc. and then applied on the textiles. Coacervation (phase separation) is utilized in the preparation of volatile essential oil microcapsules. This technique gives best results according to research survey and comprises of three steps. The first is the formation of immiscible phases, second is deposition of the coating and
the third is rigidization of coating. This microencapsulation technique indulges in obtaining two unmixable liquid phases from a solution containing dispersed macromolecule. The liquid or solid to be encapsulated is diffused in the macromolecule (wall material) solution. The encapsulating polymer is induced to separate as a viscous liquid (coacervate) by different methods. This separation process is called as coacervation. The macromolecule is present at high and low concentrations within the coacervate part and within the supernatant part, respectively. The coacervate phase forms a continuous layer which coats the material to be encapsulated, under certain conditions. The formed micro particles may be collected by filtration or centrifugation, and thereafter washed with the acceptable solvent, dried and hardened by cross-linking, thermal or desolvation techniques [36]. The coacervation technique of microencapsulation is depicted in Fig. 1.

In a study essential oil from mustard seed has been extracted by simultaneous steam distillation and extraction which has been analyzed by Gas chromatography mass spectrometry (GCMS). The essential oil encapsulated by complex coacervation in microcapsules with genipin, a natural water soluble cross linker, has been found to possess good antimicrobial activity with inhibition zones and MIC values in the range of 9.68- 15.57 mm and 128- 512 µg/ml respectively [37].

The release mechanisms of encapsulated materials rely on the aim of microencapsulation. The external pressure mechanism is the most generally used, that breaks the microcapsule wall and releases the liquid from the core. The abrasion caused in the utilization of end product, releases the core material of the microcapsule wall, for e.g. due to the abrasion caused in washing machines or driers. Heat, conjointly plays a vital factor to release core material in many end applications.

4.2. Layer by Layer Assembly Technique

Layer by layer assembly (LbL) method could be a unique thin film fabrication technique developed for fabrication of thin composite films on solid surfaces. It involves a sequential adsorption of oppositely charged polycations and polyanions so as to build a series of polyelectrolyte multilayer films on the substrate as depicted in Fig. 2. In a study, ZnO nanoparticle-based multilayer nanocomposite films have been fabricated by LbL technique on cotton woven fabrics priorly cationized with 2, 3-epoxypropyltrimethylammonium chloride (EP3MAC) by pad-batch method. To evaluate the deposited nano-ZnO multilayer films on the cotton fabrics, XPS and SEM have been used. Excellent antimicrobial activity against S.aureus bacteria and protection of cotton fabrics from UV radiation have been assessed on cotton fabrics deposited with the nano ZnO films [38].

The process of LbL begins by imparting charge on the substrate appropriately, followed by immersion in an oppositely charged polyelectrolyte solution with washing steps in between. The charged surface attracts the oppositely charged polyelectrolyte through strong electrostatic bond. The substrate coated with a monolayer is treated with the solution of oppositely charged electrolyte solution with a washing step in between to remove the loosely adhered polyelectrolytes. The LbL cycle of immersing the substrate into the alternate solutions of polyelectrolyte with rinse steps in between, can be repeated to deposit up to 20 ultrathin layers [39 - 41]. The process of LbL is demonstrated in Fig. 2. This application technique of electrostatic bond formation on substrates has been studied extensively for applications in plastics, sensors, LEDs and fuel cells. Research studies done on the fabric substrates have reported that the LbL technique can be used to form functional nanocomposite textile fibres especially suitable for protective textiles. A wide range of other functional molecules like charged Nano particles, enzymes and dyes may also be incorporated in a controlled manner into the layers [42]. A finishing formulation of natural agents by using appropriate emulsifiers can be applied on textile substrate through LbL technique to improve the durability of the finish.

4.3. Pad dry cure Technique

Padding is a conventional method of finishing where the fabric is impregnated in the solution of finishing formulations with natural active agents and passed through a pair of rollers with expression nearly 70-90%. Along with
natural agents certain crosslink, binders etc. can also be used. Padding needs to be followed by air drying or curing in stenter machine [43]. However this conventional method is often accompanied with excessive weight add on, less durability to washing and loss of mechanical strength. Scientists and researchers are looking for substitutes which are sustainable, durable and ecofriendly.

For comparison, few studies are stated below to show the mosquito repellency rates of textile substrates finished with different application methods:

In a research study, nylon net fabric treated with chrysanthamum oil nanoemulsion by lbl technique for 20 numbers of layers shows 95 % mosquito repellency rate and 90% mosquito mortality rate at finish application whereas 80% mosquito repellency rate and 60% mortality rate after 25 wash cycles.

In another work where microencapsulation method is incorporated, the aqueous and methanolic extracts of Lemon grass plant has been microencapsulated and applied on the polyester fabric. The microcapsules of aqueous extract showed 92% mosquito repellency and the methanolic microcapsules showed 80% repellency [21]. In a research, Cypress oil, Thyme oil and Grapefruit oils together in combination of 2:1:1 have been microencapsulated using different wall material such as acacia arabica, sodium alginate and moringaoleifera gum. The finished bamboo/tencel 50:50 blend substrate using exhaustion method with Moringa oleifera gum as wall material has been found to possess mosquito repellent effectiveness sturdy up to 30 washes [16].

In another work, the herbal extract of mint leaves has been finished through pad-dry-cure method on cotton sample which has shown 100% mosquito repellent activity for direct application method. The durability of the finishing on substrate has been found to reduce with 5, 7 and 9 subsequent wash cycles [30].

The results show that the Layer by Layer thin film fabrication Technique and Microencapsulation Technique provide enhanced results than padding technique for natural finishing formulations on textiles for better sustainability.

5. Precedence of Natural active agents over synthetic agents for textile finishing

Natural active agents are non-sticky, nontoxic and environmentally friendly. Natural agents are safe on sensitive skin but cannot be applied directly as they are concentrated and may cause rashes. Natural agents tend to impart reduced irritation to skin and are harmless to most fabric substrates [44]. On the contrary, synthetic agents has been reported to causes rashes, swelling, eye irritation, brain swelling in children, anaphylactic shock, low blood pressure, and one report of death. DEET (N, N-diethyl-3-methylbenzamide), a mosquito repellent commonly found in mosquito repellent creams and textiles must be used with caution, especially with children. It has been known to cause dizziness and can severely irritate the skin [44, 45]. Oils such as Citronella, Lemon eucalyptus and Neem have proved to be excellent alternatives to chemical mosquito repellent DEET [46]. For these reasons, industrialists are trying to bring out improvement in existing properties and the creation of new functional materials by using natural essential oils and herbal extracts. However natural essential oils can be short-lived in their effectiveness as they are volatile in nature and can evaporate completely. Thus they may need more frequent re-application to maintain full protection or the durability of these agents can be enhanced through a proper finishing formulation and application technique.

6. Conclusion

Multifunctional textiles are the future of the global textile industry offering new challenges as well as opportunities to create value added textiles. In today’s modern era, the consumer is demanding enhanced comfort, ecofriendly nature, easy care, health and hygiene while at the same time expecting protection against mechanical, thermal, chemical and biological attacks in an effective way. These high expectations can be met by the development of finishing formulations comprising of ecofriendly herbal extracts or essential oils and its application on the fabric by breakthrough techniques like microencapsulation and LBL thin film fabrication technique for effective finishing as discussed in the review. For enhanced durability, the incorporation of the substance should be done deep inside the fabric ensuring its effective release and durability.

Fabric structure and properties also play a very essential role in the development of ecofriendly multifunctional finishing, as they are very versatile and offer a large number of effects; therefore significance should also be given to the same. Research on ecofriendly multifunctional finishing can bring one step forward in conserving green equilibrium. This probe if employed by industry will surely reduce the carbon and water footprints induced by the Textile Industry.

References
Use of Face Masks - Regulatory, Performance and Ecological Considerations

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²Department of Chemistry, HNB Garhwal University, Campus Pauri, Pauri Garhwal, Uttarakhand, India

Abstract
Face mask is one of the key personal protective equipment (PPEs)/medical devices to protect from external biological, chemical and other hazardous sources. It acts as a physical barrier to pollutants and microorganisms such as virus and/or bacteria. Use of masks has been well understood by everyone due to Covid-19 pandemic. The masks are manufactured using different types of raw material and having made of different geometric designs. In addition, the chemicals used in the manufacturing chain may add hazardous substances such as aniline, formaldehyde, fluorocarbons etc. in masks. It is therefore, necessary that the mask meets the performance requirement along with regulatory and ecofriendly considerations as per the legislative measures. Specifications of the masks across the globe and objective assessment of characteristics by national and international standards is of paramount importance due to sensitivity of the performance and sustainability. In the present article, an overview of raw material, design and performance are discussed. Further, the standard specification & international/national test method to ascertain the compliance are discussed along with the ecological parameters. An attempt made, to overcome the hazardous substances by a startup enterprise, M/s Thermaissance are illustrated as potential solution for sustainable manufacture and use of these devices.

Keywords: Ecological Considerations, Face Masks, N95 mask

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1. Introduction
Personal protective equipment (PPE) is part of technical textiles under medical textiles and protective textiles. Medical textiles such as Masks, Coveralls, Gown, Hand Glows and protective clothing such as water repellent or oil repellent, flame retardant and antimicrobial are being used either for protection of healthy persons (worn to protect oneself when in contact with an infected individual) or for source control (worn by an infected individual to prevent onward transmission). However, the use of single protective/medical device such as N95 mask alone is insufficient to provide required level of protection or source control, and hence, other personal and community level measures are needed to suppress transmission of respiratory viruses. The World Health Organization (WHO) has developed specific guide lines on IPC strategies for health care settings, long-term care facilities (LTCF), and home care. In the present paper, an attempt is made to discuss the regulatory, performance and ecological considerations in regard to PPE- face mask with the concurrent review of literature [1].

2. Characteristics of Face mask with reference to the extent of protection -EU Market
There are three categories of PPE recognized by the EU Directives and these are based on the risk, consequences (type of hazard) and severity of injury likely to occur to someone not wearing adequate PPE. These are simple, complex and intermediary Design. ‘Simple’ design PPE covers products that claim to provide protection against only minimal risks with effects that are gradual and can be safely identified by the user in good time. ‘Complex’ design PPE covers products that claim to provide protection against risks of mortal danger or dangers that may seriously and irreversibly harm the health of the user. All other products fall into a third unnamed category often called “Intermediate Design” or “Category 2”. These are products that claim to provide protection against risks of severe injury. Each category requires a different level of involvement by a Notified Body [1].

2.1 Types of Envisaged Protection and PPEs as per US market
There are many types of protective equipment, each with specific applications in regard to respiratory, eye and face, skin and nose. Information on common elements of the PPE as per US market are discussed elsewhere [1]. Personal protective equipment as per US market is divided into four categories based on the degree of protection afforded namely Level A, Level B, level C and level D. The detailed specifications of each level of protection are described elsewhere [1].

3. Basic Requirements of Face masks
Surgical face masks are made with non-woven fabric, which has better bacteria filtration efficiency and air permeability while remaining less slippery than woven cloth. The material most commonly used to make them is polypropylene, either 20 or 25 grams per square meter (GSM) in density. Medical
masks should be certified according to international or national standards to ensure that they offer predictable product performance when used by health workers, according to the risk and type of procedure performed in a health care setting. Designed for single use, a medical mask’s initial filtration (at least 95% droplet filtration), and breathability, if required, fluid resistance is attributed to the type (e.g., spun bond or melt blown) and multiple layers of manufactured non-woven materials (e.g., polypropylene, polyethylene or cellulose). Medical masks are rectangular in shape and comprise three or four layers. Each layer consists of fine to very fine fibers. These masks are tested for their ability to block droplets (3 micrometres in size; EN 14683 and ASTM F2100 standards) and particles (0.1 micrometre in size; ASTM F2100 standard only). The masks must block droplets and particles while at the same time they must also be breathable by allowing air to pass. The use of medical masks in the community may divert this critical resource from the health workers and others who need them the most [1].

In addition to filtering capacity, factors such as user comfort and breathability also vary across different models. For instance, although the tight-fitting N95 respirator has filtering capacity superior to surgical masks, they have lower breathability and may cause discomfort after hours of wearing. Keeping these factors in the background, the generic requirement of mask as PPE or as medical device, the present paper provides information and guidance on the use of masks in health care settings, for the general public and during home care keeping the World Health Organization (WHO) specific guidelines on IPC strategies for health care settings, long-term care facilities (LTCF).

4. Essential Requirements of PPEs and Medical Devices-Face Masks [1, 2, 3]
It is pertinent to note that the face mask used by the health workers and medical personnel is termed as medical device while the general public using face mask for protection against the microbial or pollutant hazard is called personal protective equipment (PPE). The requirements of face mask as medical device or as PPE are described in Table 1 including relevant international standards. Likewise, Table 2 gives the specification of Mask - KN95 as per Chinese Standards. Table 3 gives the specifications for filtering face pieces (e.g., Surgical, Procedural, and Medical Mask) [1].

### Table 1: Essential Requirements of face mask (as per European market) [1]

<table>
<thead>
<tr>
<th>Medical Device/PPE</th>
<th>Device Type</th>
<th>Medical Device Essential Technical Requirements for derogation applications to the MHRA</th>
<th>Relevant standards for design and performance</th>
</tr>
</thead>
</table>
| Surgical face masks | Type I - Single use/disposable (Not generally intended for use by NHS workers) | Design and Performance: Must provide bacterial filtration efficiency (BFE) of 95% or above to be labelled Type I if tested to BS EN 14683.  
- Must have differential pressure of less than 40Pa/cm² to be labelled Type I if tested to BS EN 14683.  
- Must fit closely over the nose, mouth and chin of the wearer. The use of deformable nose bands or nose bridges is recommended which can enhance fit by conforming to the nose contours.  
- Manufacturer must have quality management system in place with evidence of compliance to ISO 9001 or BS EN 13485 or equivalent  
Label: Information to be supplied with the device and use of symbols in accordance internationally recognised symbols Must indicate masks type of mask. ‘Type I’ (if it complies with BS EN 14683) or should state ‘not fluid resistant’ as appropriate, should have a n expiry date | BS EN 14683:2019 Medical face masks. Requirements and test methods or ASTM F2100 minimum Level 1 or equivalent technical solution |
<table>
<thead>
<tr>
<th>Medical Device/PPE</th>
<th>Device Type</th>
<th>Medical Device Essential Technical Requirements for derogation applications to the MHRA</th>
<th>Relevant standards for design and performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II</td>
<td>- Single- use /Disposable</td>
<td>Design and Performance:&lt;br&gt;.must provide a bacterial filtration efficiency (BFE) of 98% or above to be labelled Type II if tested to BS EN 14683.&lt;br&gt;must have a differential pressure of less than 40Pa/cm² to be labelled Type II if tested to BS EN 14683.&lt;br&gt;must fit closely over the nose, mouth and chin of the wearer. the use of deformable nose bands or nose bridges is recommended which can enhance fit by conforming to the nose contours.&lt;br&gt;manufacturer must have quality management system in place with evidence of compliance to ISO 9001 or BS EN 13485 or equivalent.&lt;br&gt;Label: information to be supplied with the device and use of symbols in accordance internationally recognized symbols.&lt;br&gt;must indicate masks type. ‘Type II’ (if it complies with BS EN 14683) or should state ‘not fluid resistant’ as appropriate, Should have an expiry date.</td>
<td></td>
</tr>
<tr>
<td>Type IIR (Fluid resistant surgical mask (FRSM))</td>
<td>- Single use /Disposable</td>
<td>Design and Performance:&lt;br&gt;must have a splash resistance pressure of 16.0 kPa (120mm Hg) or above to be labelled Type II if tested to BS EN 14683.&lt;br&gt;must provide a bacterial filtration efficiency (BFE) of 98% or above to be labelled Type IIR if tested to BS EN 14683.&lt;br&gt;must have a differential pressure of less than 60Pa/cm² to be labelled Type IIR if tested to BS EN 14683.&lt;br&gt;must fit closely over the nose, mouth and chin of the wearer. the use of deformable nose bands or nose bridges is recommended which can enhance fit by conforming to the nose contours.&lt;br&gt;manufacturer must have quality management system in place such as evidence of compliance to ISO 9001 or BS EN 13485.&lt;br&gt;Label: information to be supplied with the device and use of symbols in accordance internationally recognized symbols.&lt;br&gt;must indicate type of mask. ‘Type IIR’ (if it complies with BS EN 14683) or should state fluid or splash resistant as appropriate if equivalent test for splash resistance has been carried out.&lt;br&gt;Should have an expiry date.</td>
<td></td>
</tr>
<tr>
<td>Medical Device/PPE</td>
<td>Device Type</td>
<td>Medical Device Essential Technical Requirements for derogation applications to the MHRA</td>
<td>Relevant standards for design and performance</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Disposable half mask respirators</td>
<td>FFP3 valved, FFP3 unvalved</td>
<td>Design and Performance:¶ Mask covers the nose and mouth and the chin and may have inhalation and/or exhalation valve(s). The mask consists entirely or substantially of filter material.¶ Should have 2 elastic straps (may be adjustable) that go around the head and neck.¶ Shall be offered for sale packaged in such a way that they are protected against mechanical damage and contamination before use.¶ Manufacturer must have quality management system in place such as evidence of compliance to ISO 9001 or BS EN 13485.</td>
<td>BS EN 49:2001+A1:2009 Respiratory protective devices — Filtering half masks to protect against particles - Requirements, testing, marking. OR Technical Specification to satisfy the requirements of Annex II of PPE Regulation (EU) 2016/425</td>
</tr>
<tr>
<td>FFP2 valved, FFP2 unvalved</td>
<td>Design and Performance:¶ Mask covers the nose and mouth and the chin and may have inhalation and/or exhalation valve(s). The mask consists entirely or substantially of filter material.¶ Should have 2 elastic straps (may be adjustable) that go around the head and neck.¶ Shall be offered for sale packaged in such a way that they are protected against mechanical damage and contamination before use.¶ Manufacturer must have quality management system in place such as evidence of compliance to ISO 9001 or BS EN 13485.</td>
<td>BS EN 140:1999 Respiratory protective devices — Half masks and quarters masks - Requirements, testing, marking. BS EN 143:2000 Respiratory protective devices — Particle filters - Requirements, testing, marking. OR Technical Specification to satisfy the requirements of Annex II of PPE Regulation (EU) 2016/425</td>
<td></td>
</tr>
<tr>
<td>Re-usable half mask respirator — particle filter</td>
<td>Re-usable half mask respirator — with P3 particle filter</td>
<td>Design and Performance:¶ Mask covers the nose and mouth and the chin and has one or more replaceable P3 particle filters.¶ Should have adjustable straps that go around the head and neck.¶ Shall be offered for sale packaged in such a way that they are protected against mechanical damage and contamination before use.¶ Manufacturer must have quality management system in place such as evidence of compliance to ISO 9001 or BS EN 13485. Note: P3 filters are separate consumable and must be compatible with the model of respirator. This will usually be stated on the information provided with the mask/filter. Marking and Packaging Requirements: as specified in BS EN 140:2001 and BS EN 143:2000 Manufacturer’s Instructions and Information to be provided: as specified in BS EN 140:2001 and BS EN 143:2000</td>
<td></td>
</tr>
</tbody>
</table>
### Powered Respirators with hoods/helmets (Powered air purifying Respirators; PAPR)

- Design and Performance:
  - Rechargeable battery powered respirator with a hood or helmet and one or more replaceable P3 particle filters.
  - Shall be offered for sale packaged in such a way that they are protected against mechanical damage and contamination before use.
  - Manufacturer must have quality management system in place such as evidence of compliance to ISO 9001 or BS EN 13485.
  - Marking and Packaging Requirements: as specified in BS EN 12941.
  - Manufacturer’s Instructions and Information to be provided: as specified in BS EN 12941.

### Eye Protection

- Face shield or visor
- Eye shields/safety glasses/goggles

- Design and Performance:
  - A face shield or visor is a device worn on the head for covering the whole of the face and providing a barrier to liquid splashes.
  - All face shields/visors must comply with the following:
    - Must be optically clear.
    - Should be resistant to fogging.
    - Adjustable head band.
    - Must be resistant to droplets and splashes.
  - Eye Shields/safety glasses are devices for protecting the eyes against exposure to liquid droplets.
  - All safety glasses must comply with the following:
    - Must be optically clear.

### Table 2: Mask KN95 specifications [1]

<table>
<thead>
<tr>
<th>Parameters/Type of Mask</th>
<th>Medical KN95 (GB 19083-2010)</th>
<th>Commercial KN95 (GB2626-2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labelling Information on respirator</td>
<td>Number and year of publication of standard Type and grade of filter elements (i.e., KN95)</td>
<td></td>
</tr>
<tr>
<td>Nasal splints</td>
<td>Must be adjustable</td>
<td>N/A</td>
</tr>
<tr>
<td>Mask Harness</td>
<td>No less than 10 Newton (1kg) per strap Ear-loops are allowed</td>
<td></td>
</tr>
<tr>
<td>Fit</td>
<td>The mask shall be designed as to provide a good fit and overall fit factor of the mask shall not be less than 100</td>
<td>The disposable facepiece structure shall ensure the tight fitting with face, and be free from deformation during the service life.</td>
</tr>
<tr>
<td>Filter performance – (must be = X% efficient)</td>
<td>= 95%</td>
<td>= 95%</td>
</tr>
<tr>
<td>Parameters/Type of Mask</td>
<td>Medical KN95 (GB 19083-2010)</td>
<td>Commercial KN95 (GB2626-2006)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------</td>
</tr>
<tr>
<td>Test agent</td>
<td>Sodium Chloride (NaCl) Particles</td>
<td>Sodium Chloride (NaCl) Particles</td>
</tr>
<tr>
<td>Flow rate</td>
<td>85 L/min</td>
<td>85 L/min</td>
</tr>
<tr>
<td>Inhalation Resistance</td>
<td>= 343.2 Pa</td>
<td>= 350 Pa</td>
</tr>
<tr>
<td>Flow rate</td>
<td>85 L/min</td>
<td>85 L/min</td>
</tr>
<tr>
<td>Exhalation Resistance</td>
<td>N/A</td>
<td>= 250 Pa</td>
</tr>
<tr>
<td>Flow rate</td>
<td>N/A</td>
<td>85 L/min</td>
</tr>
<tr>
<td>Synthetic Blood Penetration</td>
<td>2ml of synthetic blood sprayed on mask at 10.7kPa and no penetration shall occur on inner side of mask</td>
<td>N/A</td>
</tr>
<tr>
<td>Surface Wetting Resistance</td>
<td>Outside surface spray rating shall not be less than specified in Grade 3 of GB/T47-45-1997</td>
<td>N/A</td>
</tr>
<tr>
<td>Microorganism Index (Bioburden)</td>
<td>• Total bacteria count ≤200 CFU/g&lt;br&gt;• Total fungus colony count colony count CFU/g ≤100&lt;br&gt;• Coliform bacteria: Not Detectable&lt;br&gt;• Pseudomonas aeruginosa: Not Detectable&lt;br&gt;• Staphylococcus aureus: Not Detectable&lt;br&gt;• Hemolytic streptococcus: Not Detectable</td>
<td>N/A</td>
</tr>
<tr>
<td>Biological Filtration Efficiency</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Total inward leakage (TIL)</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Exhalation valve leakage requirement</td>
<td>-</td>
<td>Depressurization to 0 Pa = 20 sec</td>
</tr>
<tr>
<td>Force applied</td>
<td>-</td>
<td>-1180 Pa</td>
</tr>
<tr>
<td>CO2 clearance</td>
<td>N/A</td>
<td>= 1%</td>
</tr>
</tbody>
</table>

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made of woven fabrics such as cloth, and/or non-woven performance, indicate that the use of non-medical masks, standardized requirements, and overall expected resistance of 3 mbar). The lower filtration and breathability inhalation resistance of 2.4 mbar and maximum exhalation (maximum pressure difference of 0.6 mbar/cm² or maximum minimum performance in terms of filtration (minimum 70% medical mask standard has been developed by the French Standardization Association (AFNOR Group) to define device nor personal protective equipment. However, a non-breatheability. A non-medical mask is neither a medical fabrics and materials results in variable filtration and such as polypropylene. Nonmedical masks may be made of different combinations of fabrics, layering sequences and available in diverse shapes. Few of these combinations have been systematically evaluated and there is no single design, choice of material, layering or shape among the nonmedical masks that are available. The unlimited combination of fabrics and materials results in variable filtration and breathability. A non-medical mask is neither a medical device nor personal protective equipment. However, a non-medical mask standard has been developed by the French Standardization Association (AFNOR Group) to define minimum performance in terms of filtration (minimum 70% solid particle filtration or droplet filtration) and breathability (maximum pressure difference of 0.6 mbar/cm² or maximum inhalation resistance of 2.4 mbar and maximum exhalation resistance of 3 mbar). The lower filtration and breathability standardized requirements, and overall expected performance, indicate that the use of non-medical masks, made of woven fabrics such as cloth, and/or non-woven fabrics, should only be considered for source control (used by infected persons) in community settings and not for prevention. They can be used on ad-hoc for specific activities (e.g., while on public transport when physical distancing cannot be maintained), and their use should always be accompanied by frequent hand hygiene and physical distancing. Decision makers advising on type of non-medical mask should take into consideration the some of these features of nonmedical masks i.e. filtration efficiency (FE), or filtration, breathability, number and combination of material used, shape, coating and maintenance.

Due to the conventional/Intermediate technology-based manufacturing activities, many of the standards/regulations specified by the standards bodies and regulatory bodies could not be complied. However, in the short supply situation, it could serve the general public to a large extent to have temporary/partial prevention of infection. The material used for fabrication of mask was cotton or cotton/polyester fabric either dyed or undyed. However, the current situation is to look at the standard specifications. It is noted that the fabric used for fabrication of the mask may contain hazardous substances such as aryl amines, formaldehyde, tracer metals, pesticides etc. Hence, apart from functional properties, ecological properties which related to absence of some of the above mentioned carcinogenic or toxic substances needs to be considered.

### 6. Ecological considerations of face masks employed as PPE or Medical device

Masks have been proven to be a key control measure to suppress Covid-19 transmissions and save lives. However, wearing certain types of face masks for long periods of time could also result in exposure to, and inhalation of potentially hazardous chemicals and carcinogens into human lungs [4,5,6,7].

Various scientific studies over the years have brought out use of formaldehyde in certain N-95 masks and Surgical masks, and such formaldehyde has caused various allergic contact dermatitis [5]. Recently, top German scientists have also found that various face masks (including surgical masks) contain toxic and banned chemicals, including formaldehyde.
and aniline [6,7]. Another leading industry textile chemist Dr. Dieter Sedlak, Managing Director and Co-founder of Modern Testing Services Augsburg, Germany, in partnership with Modern Testing Services Global, Hong Kong also found elevated concentrations of hazardous chemicals such as formaldehyde, aniline, hazardous fluorocarbons (PFCs) and other potentially carcinogenic substances on surgical face masks [8,9,10,11]. In December 2020, a European manufacturer recalled their 7-month protective mask since aniline was detected in these masks [8]. Unfortunate part is that the material description of such masks did not mention the use of formaldehyde, aniline and any such harmful substances. The following paragraphs describe the hazardous nature of some of these chemicals as used in the manufacture of textiles in general and face mask in particular.

**Formaldehyde [7,11]**

Formaldehyde is a colourless, strong-smelling, flammable chemical that is used in building materials and in clothing. It is also commonly used as a fungicide, germicide, and disinfectant, and as a preservative in mortuaries and medical laboratories. Formaldehyde is listed on a product label by other names, such as formalin, formic aldehyde, methanediol, methanal, methyl aldehyde, methylene glycol or methylene oxide. However, formaldehyde is declared as carcinogenic and has been banned for its use in textiles. Further, WHO's Concise International Chemical Assessment Document on Formaldehyde mentions the following:

“Since formaldehyde (also a product of intermediary metabolism) is water soluble, adverse effects resulting from exposure are observed primarily in those tissues or organs with which formaldehyde first comes into contact (i.e., the respiratory and aero digestive tract, including oral and gastrointestinal mucosa, following inhalation or ingestion, respectively).” Sensory irritation of the eyes and respiratory tract by formaldehyde has been observed consistently in clinical studies and epidemiological surveys in occupational and residential environments. At concentrations higher than those generally associated with sensory irritation, formaldehyde may also contribute to the induction of generally small, reversible effects on lung function.

**Aniline [8,9,10,12]**

There are nearly 24 amines which are proven carcinogenic substances and form part of manufacture of azo dyes for colouration and other substances. On reduction of these azo dyes, they split into aryl amines and anchor base for the colour molecule. One of them is aniline which is also termed as p-amino-azo-benzine. Aniline is a clear to slightly yellow liquid with a characteristic odour. It is used to make a wide variety of products such as polyurethane foam, agricultural chemicals, synthetic dyes, antioxidants, stabilizers for the rubber industry, herbicides, varnishes and explosives. It is also known as aminobenzene, aminophen, benzenamine, and phenylamine.

**Fluorocarbons [12,13]**

Fluoro-chloro- hydrocarbons which find application in air conditioners, fridge and other cryogenic equipment are completely banned since 2010. Concomitantly, the use of fluoro chemicals as water repellents and carbon tetra chloride as stain removing agent have been banned due to their ozone layer depleting characteristics. It is also reported that one halogen molecule or its ionic form remain in the atmosphere for several decades in the atmosphere and etches the ozone layer which is mainly responsible for protection of flora and fauna from harmful UV rays reaching earth surface from the Sun. The depletion of ozone layer increases in the intensity of UVB radiation which causes health problems especially skin. In addition, the carcinogenicity is also causing hazardous effects to human when it penetrates into the body.

**Fluorochemicals (PFCs) used as water-repellent finishes [13].**

These are chemical compounds that contain carbon-fluorine bonds. The issue with fluorocarbons lies in its two side products, called PFOS and PFOA. Both are PBT (Persistent, Bio-accumulative and Toxic). Fluorocarbons tend to be slowly broken down in the environment and therefore many are considered persistent organic pollutants. As per US CDC and EPA, PFOA can remain in the human body for long periods of time and can lead to adverse health outcomes. In laboratory animals, large amounts of PFOA have shown to affect growth and development, reproduction, and injure the liver.

Covid-19 has been proven to first affect the upper respiratory system and later progress to lower respiratory system. Since various studies have shown that inhalation of formaldehyde and aniline can also affect the upper respiratory tract, further studies should be undertaken whether wearing masks containing such toxic chemicals and their adverse impact on Covid-19 patient's upper respiratory system. Further studies should be undertaken to understand the short-term and long-term effects to people wearing such masks. In the meantime, the authorities should introduce strict regulations to ensure that masks (particularly child masks) do not contain such toxic chemicals.

**6. Some of the Initiatives of M/s Thermaissance- A start up Enterprise [14]**

In order to meet the growing demands to contain with the covid -18 pandemic, new start companies have come up with elite entrepreneurship to develop innovative products under broad class of medical textiles with the policy intervention of union government of India under 'Atmanirbhar Bharat program'. As a case, one of the start-up companies has developed several innovative products as described in the following paragraph.

M/s Thermaissance is a technical textiles manufacturing enterprise in India that has developed various innovative,
smart fabrics using nanotechnology. These fabrics are Anti-viral (effective against Human Coronavirus), Anti-bacterial (effective against Pneumoniae, MRSA, VRE and CRE) and Anti-fungal (effective against mucor species). These fabrics are also super breathable, fire resistant, pH neutral and do not contain any toxic/hazardous chemicals. Using such self-sanitizing fabrics, M/s Thermaissance have launched various medical textiles such as Scrubs, Reusable Coveralls, Reusable PPE Kit, White Lab Coat, Head Cap, Reusable Face Mask, Patient Clothing, and Reusable Gloves.

M/s Thermaissance and its products are registered with US-FDA. The innovative technologies adapted by the enterprise have been recognized by the Government of India under NITI Aayog, and AGNIi program (https://www.agnii.gov.in/innovation/covid-19-killer-products). Further, the unique innovation of the company has won various accolades including Top 50 Innovative Healthcare Companies in the world by International Forum on Advancements in Healthcare (IFAH).

7. Conclusion
a. Face Mask is one of the medical devices/PPEs which primarily protect the wearer from Covid-19 infection likely to be caused through nose and mouth. The type of protection varies depending on the criticality with regard to wearer. There are disposal and reusable masks which differ in material specifications. The mask being made available should meet the standard specification as per national or international standards. The quality specifications include material and design specifications and performance specification as per end use and regulatory terms of the government.

b. The material specifications though described on the product, as per the literature, it includes the constituent material. It is reported that there are some hazardous substances present in the surgical mask which are already banned even for clothing textiles like inner wear or outer wear apart from whether it is for adult or children use. Mask is more vulnerable than clothing and any material used for such application should be totally free from carcinogenic and toxic substances like formaldehyde, tracer elements, aryl amine and fluorocarbons. In addition, the manufacturer/trader must specify the absence of these hazardous substances and even must produce material safety data sheet (MSDS). MSDS should also describe safety features such flame retardant and does not contain carcinogenic flame retardants like brominated flame retardants.

c. While describing the product specification of a mask, supplier must include material specifications, design, safety and eco-friendly in regard to freedom from the presence of carcinogenic and toxic substances to reinforce the product integrity.

d. An attempt to overcome the hazardous substances by a startup enterprise – M/s Thermaissance are illustrated as potential solution for sustainable manufacture and use of these devices.

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Low Cost Semi-Automatic T-Shirt Folding Machine

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Abstract

The manual folding of clothes is time consuming, as well as it is prone to some human errors that can even make the clothes untidy. Therefore, it is better to replace the manual folding with an automatic clothes folding machine. The aim of the development of the proposed system is to fold T-shirts automatically merely by pressing a button. This proposed semi-automatic T-shirt folding machine requires one operator who has to place the T-shirt on the folding tray and activate the pushbutton. The machine then with the help of motors folds the T-shirt by itself. In this paper, a T-shirt is chosen as a test case out of many categories of clothing.

Keywords: automatic washing machine, clothing, folding machine, laundry automation, T-shirt


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1. Introduction

Textile and clothing industries account for about 4% Indian GDP, but about 11% of this sector do not use any sort of automation [1]. Although nowadays a lot of folding machines are available in the industry, these machines are not suitable for household usage due to their size and cost. These industrial folding machines mainly use a conveyor system for the folding operation that increases its size and cost. Therefore, the proposed automatic clothes folding machine is designed by using the flip-fold concept instead of using a conveyor system, and thus the size and cost of the folding machine is significantly reduced. Thus this machine can be deployed even for household usage. The proposed clothes folding machine can fold a wide variety of rectangular shaped clothing articles like T-shirts, trousers, shirts, pants, etc.

The idea of clothes folding machines originated from the washing machine out of the thrust of achieving a higher degree of automation. This machine can be exploited at locations such as laundry, hotels, hospitals, etc. where there is ample clothing. This machine promises to deliver folded T-shirts with precise folding and speed up time.

2. Literature Review

There are two main methodologies to implement the T-shirt folding machine. One methodology uses the conveyor belt, and the other uses a microcontroller controlled folding machine. While the conveyor belt based system is mainly used in industries, the microcontroller based folding mechanism is more suitable in laundries, houses, retail outlets, etc. Apart from these methods, the cloth folding has also been achieved by using g-fold technique by the state-of-the-art robots, but these techniques are very costly and thus not suitable for household applications [2]. A controller was designed for the flip-folder used in the folding machine. For this Extended Least Square (ELS) and Auto Regressive Exogenous (ARX) model approach was used [3]. A folding machine has been developed which can fold the cloth when it is placed onto a hanger. After washing the cloth, it is put on a hanger for drying. The machine checks whether the cloth has dried, and if dried properly, it executes the folding operation [4]. In this section, a review of various literature regarding cloth folding machines has been presented.

2.1 Photovoltaic Powered T-shirt Folding Machine

Photovoltaic powered T-shirt Folding Machine [5] is an automatic motor controlled T-shirt folding machine. The folding machine is fully automatic where one has to place the T-shirt on the folding tray and press the button. It will then fold the T-shirt by itself. The DC motors are attached to the folding tray that rotates according to a program stored in the microcontroller. The overall system is powered by a photovoltaic system. Result shows that by using this system, the time for folding clothes by humans can be cut down in half compared to conventional methods.

2.2 Automated Clothes Laundry Folder

The main feature of the laundry folding machine [6] is that this machine can fold the clothes in different kinds of folding such as quarter fold, French fold, etc. This machine used the conveyor system to guide the clothes through the folding process. This machine does not use any controller to control the folding process. However, the limitations of this design are that it requires a large floor space and it can only fold small pieces of articles. This machine is mostly used in the textile industry. It automated the process of folding and packaging of the articles like shirts and towels. This machine provides a tunnel belt which allows the material to be pulled from the bottom as well as from top. The mechanism is controlled by relays.
2.3 Automated Clothes Folding Machine
The Automated Clothes Folding Machine was mainly developed to execute the folding task at the domestic level [7]. The automated clothes folding machine is designed by using the flip-fold concept instead of using a conveyor system. By using this method, the size and cost of the folding machine can be reduced. This machine can fold rectangular articles, T-shirts and short pants. The speed of the machine is approximately four clothes per minute. The microcontroller is used to control the movement of motors in the folding mechanism. The inputs to the microcontrollers are the feedback sensors and the push buttons to begin the folding task when properly loaded with. Automated clothes folding machines can support normal T-shirts and rectangular articles such as towels.

3. Methodology
T-shirt folding is an important task in garment industries. The proposed system aims to demonstrate a method for automatic T-shirt folding. Using this system, one can easily fold the T-shirt at a faster rate and with higher accuracy.

3.1 Block Diagram

3.2 Hardware Implementation
Although there are various issues to be addressed while critically designing T-shirt folding machines, the most difficult part is the selection of the suitable motor. The motor must be cost effective as well as powerful enough to lift the folding material loaded with the T-shirt to be folded. At the same time, the choice of folding material is also important. The folding material should not be heavy, but it should be rigid and with adequate mechanical strength. Also, the surface of the folding material should be slightly rough so that the shirt won't slip away when folding action takes place. We have found foam as the material that possesses these qualities, so foam based folding material is used in the proposed system. The folding material is to be attached to the motor. But bare attachment will not make a strong bond; therefore, we have welded a steel rod with a motor shaft. Then folding foam is attached to this steel rod using a T-shaped PVC joint. This strengthens the attachment of the foam sheet with the motor. This wiper motor has a high torque of about 4-5 kg-m2/s2.

3.2.1 Arduino Uno
The heart of the Arduino Uno board is Atmel’s microcontroller ATmega328p. It is a low-power 8-bit microcontroller belonging to the AVR family and enhanced RISC architecture. This microcontroller is designed to optimize the processing speed and power consumption. Its low power consumption, small size, and low cost has made us choose this microcontroller board in the proposed system [8]. By executing powerful instructions in a single clock cycle, the ATmega328p achieves throughputs close to 1MIPS per MHz [9]. The Arduino Uno board carries 1KB EEPROM, 2KB SRAM, 32KB Flash, and six PWM pins.

3.2.2 Wiper Motor
A 1000 rpm 12V, 3A DC geared wiper motor, as shown in Figure 2, has been used to lift up the folding material. The difference between a normal wiper motor and geared wiper motor is that later can hold a position without drifting. Geared wiper motors can rotate and return accurately to the wanted position according to the program. A steel rod is welded on the shaft of the motor to lift up the folding material. The steel rod is connected with the folding material using a T-shaped PVC joint. This strengthens the attachment of the foam sheet with the motor. This wiper motor has a high torque of about 4-5 kg-m2/s2.

3.2.3 Folding Tray
The folding tray used in this prototype model is basically a foam sheet as shown in Figure 3. The foam material is used here because of its light weight feature that would not overload the wiper motor. There are various other advantages of using foam sheets. Because of its rough surface, it readily holds-on the T-shirt when it is being folded. The folding tray is actually connected with the wiper motor to lift up the T-shirt. PVC foam sheet enjoys various desirable features- it is waterproof, poorly hygroscopic, fire resistant, good insulator, poor heat conductor, non-toxic, poor chemically active, self-extinguishable, and easily workable with conventional tools. Additionally, it has excellent fatigue life and good bond strength with common adhesives and resins. Density of foam is a measure of its weight. In general, the higher the density of foam the better is its quality. The foam hardness required for a given situation mainly depends upon foam thickness.
3.2.4 Relay

Most of the relay has electromagnets which are able to mechanically operate a switching mechanism. Relays are used where it is necessary to control a circuit by a low-power signal with complete electrical isolation between control and controlled circuits; or where several circuits must be controlled by one signal. Most relays are manufactured to operate quickly. In a low voltage application this reduces noise and in a high voltage or current application it reduces arcing.

3.2.5 Power MOSFET

The power MOSFET module- IRCZ44 has been used in the proposed system. This belongs to the third generation HEXFETs from International Rectifier and it provides the designer a variety of desirable features such as fast switching, ruggedness, low on-resistance and cost-effectiveness. It also possesses several other features such as dynamic dv/dt rating, current sense, and simple drive requirements. The HEX Sense device provides an accurate fraction of the drain current through the additional two leads to be used for control or protection of the device. The provision of a kelvin source connection effectively eliminates problems of common source inductance when the HEX sense is used as a fast, high-current switch in noncurrent-sensing applications.

3.3 Software design

To develop this system, we have used the software Arduino and Arduino Uno microcontroller board. The programming has been done using c or c++ programming language in Arduino IDE.

3.3.1 Steps of Programming

STEP 1: The first step is the selection of a microcontroller board. The various factors that governs the selection of microcontroller boards for a particular project are- availability versus need of digital I/O pins, analog input pins, Analog output/ PWM pins, on board RAM, EEPROM, FLASH, ADC, DAC, etc. After doing a little research we figured out that the Arduino Uno microcontroller board is capable of executing the tasks required in the proposed system. Therefore, an Arduino Uno microcontroller board has been selected.

STEP 2: After installing Arduino software, the Arduino Uno board was connected to the USB port of the computer. The board type and serial port were appropriately selected in Arduino IDE.

STEP 3: The program code source file, called sketch, is uploaded onto the board, and then the board is disconnected from the PC and integrated into project set-up as directed.

3.4 Operation

Among many categories of clothing, the T-shirt is chosen as a test focus. Figure 4 shows how the T-shirt folding machine will fold the T-shirt.

Figure 4 shows that the shirt is placed front to back where the dotted line of the collar and buttons are shown. The red dotted lines are the parts where the machine will fold the T-shirt. Figure 4 (b) shows a folded T-shirt. Three wiper motors, controlled by Arduino, are used to execute the task of folding the T-shirt. When the push button is pressed, the process of the folding machine will start and motor 1 will rotate clockwise. Once it reaches the time set in the program, it will stop, and then it will return to the original position by rotating anticlockwise. Then motor 2 will operate and finally motor 3 will operate. In this way one cycle gets finished which results in the folding of one T-shirt. Here, the clockwise rotation of motor 1 brings the left side of the left red vertical line towards the right side, and anticlockwise motion of Motor 1 is to restore it to its original position. This is followed by Motor 2 which first rotates anticlockwise to bring the right side part of the right vertical red line towards the left side. Lastly, Motor 3 rotates to bring the lower part of the horizontal dotted line towards the upper side. This motion continues until all the T-shirts are finished.

Figure 5 shows the step by step images of the folding process of the T-shirt. When the push-button is operated, the motor 1 starts to rotate and folds the left part of the shirt, which is shown in Figure 5 (a). Similarly, Figure 5 (b), (c), (d), and (e) shows the various other folding operations carried out with the help of motor 2 and motor 3. Motor 2 folds the right part of the shirt and finally motor 3 lifts up the T-shirt and brings its lower half to the upper side and thereby completes the folding process. The Figure 5 (f) shows a completely folded T-shirt. Figure 6 shows the prototype of a T-shirt folding machine.
4. Results and Discussion

Table 1 compares the time required by manual folding operation and time required by the proposed system. We see that even an expert human operator takes approximately 4 seconds to complete the task of folding one T-shirt manually, but the proposed system completes this task in just 2 seconds. Similarly, the time to fold 1000 pieces of shirt will take one hour and 27 min for manual operation and only 33 minutes using the proposed system. This clearly shows that there is a lot of time saving by using the proposed T-shirt folding machine.
4.2 Application details

The clothing folding machine is easy to use, robust, durable and reliable. It is used in garment industries, textile mills, outlets, laundry, and even in houses. The application of this machine in these different places is discussed in this section.

4.2.1 Shirts Manufacturers and Textile Mills

The folding of clothes is a difficult and time-consuming task in manufacturing industries. Therefore, the proposed automatic T-shirt folding machine is very useful in T-shirt manufacturing industries. It can accomplish professional quality folding work, and at the same time, the clothing can be perfumed, softened, and treated while being folded.

4.2.2 Laundry

Laundries deal with a variety of clothes. Folding of these clothes is a difficult and time-consuming task. Therefore, the proposed T-shirt folding machine is highly useful in laundries. Although the proposed system is targeted for T-shirt folding, with small modification, we can deploy it for folding jobs of other clothes such as sweaters, trousers, skirts, dresses, etc. It needs only one operator to load the clothes and activate the machine by using a push button.

5. Conclusion

Result shows that the proposed system can significantly cut down the time for folding clothes. This machine is semi-automatic and it executes a complete cycle of T-shirt folding by a push of a button. In addition, the proposed system enjoys several other advantages such as it is easy to use, it can neatly fold the clothes, it can de-wrinkle the clothing, and it is safe, efficient, and economical. The proposed system can be used at a variety of places like garment industry, textile mills, retail outlets, laundry, hospitals and even in houses.

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Lean Management through Participative Systems: Need of the Day

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Abstract:
Lean management holds many concepts within itself. It aims at minimizing process waste and reducing production cost, without hampering quality, product value, and customer service. The impact of leaness in the manufacturing industry is not only increases the profitability and reduces workflow in the process but also increases productivity without disturbing the organizational infrastructure of the industry. Lean tools are helpful to identify and eliminate unnecessary steps at various levels of operations and simultaneously increase production. This article is summaries how various participative systems can be helpful to make manufacturing and management lean.

Keywords: 5S, JIT, KAIZEN, Lean, Quality circle, SMED, Waste control

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1. Introduction
Textile and apparel industry is one of the most important sources of earning foreign exchange in India. The industry is estimated at US$ 75 billion in 2021-22, it accounts for 7% of industry output by value, 2% of GDP, 12% of export earnings and 11% of the mercantile shipments. It has around 4.5 crore employed workers [1]. It enjoys competitive advantages due to locally available raw material and reasonable labour cost. The major threat faced by Indian textile and apparel industry is the competitive pressure put forth by foreign manufacturers in the marketplace with low-cost products. To tackle this problem, Indian textile and apparel industries should sought adoption of innovative approaches of waste management and cost saving, such as lean management systems. Lean management is an approach of getting rid of all types of fat wastages or burdens of an organization [2].

2. Lean management
In a fast-paced, dynamic, and ever-changing global economy, many firms are employing Lean manufacturing concepts to remove waste, improve processes, decrease costs, increase innovation, and shorten time to market. It's no surprise that Lean management is being used in a variety of sectors. The Lean idea looks to be a worldwide management tool due to its basic principles and good influence on overall company performance. The application of Lean techniques, ideas, and tools to the creation and manufacture of physical items is referred to as Lean manufacturing. Lean manufacturing is a production method based on the philosophy of increasing productivity while reducing waste in a manufacturing process, simultaneously.

The term 'lean' literally translates to 'having little fat'. Lean management's major goal is to provide value to customers by optimizing resources, i.e., making the process less fattening. Money, manpower, materials, machinery, and methods, often known as the five m's of management, make up the factors of production in every firm. Because it is used to buy or employ other resources, money is the most important and all-purpose resource. The managerial and non-managerial employees engaged in a company are referred to as manpower. Materials are physical raw materials and intermediate products that are processed and/or assembled into completed goods using various processes and technologies.

Machines are the tools that transform raw materials into completed or semi-finished goods. Methods, on the other hand, relate to the standard and regulated means of carrying out certain activities in accordance with specified systems and processes. The use of appropriate procedures aids in increasing operational efficiency, while the use of precise machinery aids in lowering costs and improving output quality. As a result, we seek to make the most use of these variables by implementing lean processes and creating a steady workflow based on genuine consumer needs. This entails making sound financial decisions, allocating labour appropriately among people, reducing material waste, making optimal use of machinery, and employing shorter and simpler methodologies [3].

3. Role of participative systems
Participative system is the most effective form of management within four types of systems put forth by Rensis Likert. In this management system, lower-level employees and subordinates are more involved in the decision-making processes. Compared to authoritative management system, employees in participative systems have more freedom to communicate and make specific decisions that will affect or improve their own work. Communication in this system flows both downward and upward. Free-flowing lateral communication and involvement of all individuals in framing organization's policies allow all employees to have a high level of responsibility and accountability for the goals [4].

Leaness in any industrial organization depends on a large extent on contribution from its employees, particularly shop
floor employees. These employees face shop floor problems daily and so have better understanding about their nature, effects and steps required to be taken to overcome the same. In the period after Second World War, Japanese industrial experts developed many participative management systems like Kaizen, Quality Circle, Five 'S' system, Just In Time, etc. and demonstrated that these systems can prove helpful in making the management lean. What is necessary is to understand basics of these systems and make conscious efforts in practicing the same on Shop floor.

In any industrial organization, usually five types of resources are used – man, machine, material, method, and money. For making the organizational management lean, it is necessary to focus attention on reducing wastage is in all these resources. Japanese experts have demonstrated that the participative systems mentioned above can be helpful in reducing wastage is in all types of resources and making the management lane. Needful information about these aspects is given in this part of the article.

a. KAIZEN

The word KAIZEN is composed of two small words - KAI and ZEN. KAI means change and Zen means for the betterment. Thus, Kaizen means a change for the betterment, a change leading towards progress, improvement, and betterment of certain aspect. Search changes should be small changes which will not require too much money for implementation. Kaizen is based on the following beliefs [5].

• There is always a better way of doing anything. People never accept anything as the best.
• Quality improvement is a continuous process. In other words, quality is a race without finishing line.
• People should be managed from their hearts and not from their heads.
• There are many ways of improving any process. It can be made cheaper, better, safer, quicker, less wasteful, requiring less efforts, etc. It means that Kaizen has endless scope.
• Mistakes should be treated as treasures. They should be identified, analysed, and then rectified for improvement. World so far has progressed through correcting and then avoiding mistakes only.
• Any problem should be treated as an opportunity and challenge, and not as a calamity. Facing the problems squarely is always better.
• Small and many concept should be adopted than 'big and few' concept.
• Quality of any product is the quality of all people involved in it. Any loose link in the chain will cause damage to the product quality.
• Any Kaizen idea should not be only theoretical. Practical sense should never get lost.
• Kaizen is not a onetime activity. There must be same continuity in the process.
• Proper and regular follow u of Kaizen can convert the employees into an 'asset' of the organization and not as a 'liability'.

b. QUALITY CIRCLE

If worldwide review is taken, 'Quality Circle' system may occupy number one position among different participative systems developed by Japan. Credit for this system goes to Dr. Ishikawa. He experienced that many employees want opportunity to use their brain power in addition to body power and group working has many advantages over solo working. Based on this understanding, he structured Quality Circle system which requires involvement of shop floor employees for solving their work-related problems through group working. Quality circle is a small group of employees in the same work area or doing a similar type of work who voluntarily meet regularly for about an hour every week to identify, analyse and resolve work related problems leading to improvement in their total performance and enrichment of their work life. Employees participate in this system on their own, without any compulsion from the company because of this. Their attachment to the group is tighter and this indirectly leads to better relationship with the company also. Through regular meetings and participation, the members come closer to each other and this indirectly helps in improving their personal life also. When work related problems get solved, product quality gets improved and due to the improved productivity levels, wastages of different types get controlled leading to lean management [6].

c. SMED

Three basic characteristics of modern textile machinery are - better product quality, higher productivity and higher cost. Because of all these factors, it is necessary to control downtime of these machines. It is necessary to remember that 'money saved is money gained'. Machine downtime is of two types: scheduled downtime due to planned machine maintenance activities and necessary machine stoppages in the production process. Unscheduled downtime is due to machine breakdowns, power failures, labour shortages, etc. Japanese management expert Mr. Shigeo Shingo worked on how to control machine downtime for scheduled stop pages and come out with a participative management system called SMED (Single Digit Minute Exchange of Die). Exchange of die indicates machine downtime. Single digit means less than 10. Shingo was clear that all the activities cannot be completed in less than 10 minutes. Still, he used this terminology for attracting attention of concerned technicians. His clear intention is suggesting use of SMED is machine downtime for scheduled stoppage should be controlled as much as possible by attending to the following factors [7].

• Planning the activities properly before starting the same. This is possible only by studying the activity, identifying different elements required to be carried and deciding their relationship with each other.
• Engaging number of workers as per need. Proper attention should be given to their workload. Every worker
should be clear about what he is expected to do.

- Training the workers properly for their workload and work methods. Tools used should be of quality. Unwanted savings in tools can prove costly at the end.
- Proper supervision of maintenance activities for getting the expected results.

**d. Five 'S' System**

Housekeeping and cleaning are very common things practiced in every house all over the world to different extent. Hence, nobody thought that any industrial management system can be designed on them. Yet, Japanese experts thought in different direction and designed a participative management system titled 'Five 'S' System'. Five concepts involved in this system are – Seiri, Seiton, Seiso, Seiketsu and Shitsuke. All five words are starting with letter 'S', and hence, this system got recognised as Five 'S' system [8]. First two concepts Seiri and Seiton are related to housekeeping and third concept Seiso is related to cleanliness. The guidelines given are:

- Identify unwanted items and discard them immediately.
- Required items should be kept properly. There must be place for everything and everything should be in its place.
- Good cleanliness is necessary to be kept at the workplace, on working machine and in the surrounding area. What is necessary is to develop Total Cleanliness Culture (TCC).

These three principles are very. It is easy to understand but not so easy for regular follow up. Negligence towards this concept causes many losses which appear minor, but collectively they are not minor. One such loss is unwanted headache to the concerned persons. But if followed in true spirit, lot of benefits can be obtained which will help in making the management lean. Fourth principle Seiketsu advises are to maintain high standard of housekeeping and cleanliness at all the time. One should not consider these concepts as ‘one time activity’. Such trend can be achieved only through proper training of concerned persons and motivational atmosphere. And this is only asked by fifth principle of ‘Shitsuke’.

**e. Just In Time (JIT)**

In any industrial unit inventory is of four types:

- Inventory of raw material waiting for processing.
- Inventory of in-process material
- Inventory of finished material waiting for marketing
- Inventory of maintenance material

- Any inventory means blocked money and so it is necessary to keep proper watch on inventory level at different stages. Two guiding principles are:
  - No machine should stop for back material
  - Material should not weight excessively for want of machine

Entire process planning has to be done keeping these two points in mind. The participatory system 'Just in Time' focuses attention on these aspects which are very much critical in making the management lean.

**4. Areas for application**

There are many areas in any industrial set up for applying participative systems and making the management lean. The following description is a brief summary of how lean can be effectively implemented in various textile and apparel sectors [9-12].

**a. Work methods**

In textile industry numbers of activities are required to be carried out daily. These activities are related to production, machine maintenance, material handling and storing, transportation etc. The outcome from these activities depends to a large extent on the method followed. It is common experience in our industry that methods get blindly followed. Very rarely the method gets scrutinised for its effectiveness and efficiency. As such there is plenty of scope for method modification for getting improved results. Any method is composed of number of elements. Logical analysis of these elements for their utility, sequencing etc. can show ways for improved methods. And in majority of cases this change may not cost more. As such kaizen can be easily applied for method modification. Either by choice or by compulsion some work activities remain pending with everybody due to shortage of time. And every pending activity has its own damaging effects - tangible and non-tangible. By following analytical approach, it is possible to improve time management and thereby reduce number of pending activities. Kaizen approach can help a lot in this process.

**b. Non-value adding activities**

In textile industry fibre is converted into garment in most of the cases and into fabric in some cases. This conversion is a process of value addition. Raw material must undergo number of stages in sequence - from blow room to garment making. In such sequence there are two types of processes - value adding processes and non-value adding processes. Value adding processes are those processes where form of material gets changed after the process. Processes like blow room, carding, sizing, weaving, dyeing, printing etc. are all value adding processes. All these processes are essential and are to be selected and optimized as per the need. Usually, technicians are alert about these processes. Non-value adding processes are those processes where form of material remains unchanged after the process. Storing and transportation of material, testing of material are examples of non-value adding processes. These processes are also essential. Yet, as they are not adding value in the material in majority of cases they get neglected. On many occasions some unwarranted elements enter in such non-value adding processes and add to cost of processing. Hence, this becomes an ideal area for kaizen.
c. Waste in store keeping
Storing of materials of different categories is unavailable in any industry. Wastage of two types takes place in store keeping - visible waste and non-visible waste. Much lesser attention is given for reducing non-visible waste.

d. Waste in human resources
Staffing is an important function of management. The ideal policy is ‘right man for the right job’. But, in actual practice, many fail to reach such situation. Whenever the case is of ‘under-utilization of human capacity’ the cost of process goes up and the concerned persons get frustrated because of constant under-utilization of their capacities. Alternatively, when the case is of over utilization of human capacity the quality and productivity suffer. Thus, both the situations result in some sort of wastes only. The problem gets further aggravated because capacity of the person is never static but is dynamic. What is right choice today becomes a wrong choice tomorrow. Hence, constant alertness towards the situation is the only way available to any management.

e. Safety
Any accident in the industry always results in some sort of losses. These losses are unrecoverable. Even small errors can cause bigger accidents. Hence, top priority should be given for safety management.

f. Material handling and transportation
Very much essential, yet rather neglected activity in any industry is material handling and transportation. Transportation of material is a non-value adding activity. As such, in many cases, it receives much less attention from the concerned people. Though non-value adding activity it requires efforts and costs money. Condition of flooring and transportation equipment play important role in deciding efficiency of transportation process. Damage to quality of material because of poor transportation facilities is quite common in our industry. In worst cases even serious accidents take place because of negligence towards transportation of material. In some industries cases of unwarranted transportation are also noticed. Very few industries bother for preparing transportation maps. All these conditions lead to significant visible and non-visible losses which can be controlled by paying some attention towards transportation of material.

g. Information storing and retrieval
Information technology is considered today as the ‘Sun-Rise-Industry’. Managing information was of importance even in earlier days. In recent years the following changes have taken place:
1. The market has become truly a globalised market.
2. It is controlled by buyers who prefer fast responses from the manufacturers.
3. Because of time and distance constraints the market is mainly depending on e-media for exchange of information. Under such situation, storing of information and its quick retrieval has become highly important. Any lacuna in these fields may cost heavily to the organisation. Hence, even smaller, appropriate changes through participative systems can mean a lot to organization. When needed participative management systems can be used in other management areas also, such as non-consistent activities, irrational activities, irregular production pattern, waste of material, inconvenient management, indirect labour, etc.

5. Conclusion
In an industry real benefit of lean management systems can be achieved only when they are followed on organization wide. Every individual in the organization should be made to participate in this system. In actual practice no magic wand is available for achieving this stage. Lot of efforts is needed from top management for training the employees for good housekeeping and cleanliness practices. There must be stress on strict discipline as far as this system is concerned. And most important thing is creating autonomous feeling among the employees. High standard of housekeeping and cleanliness can be maintained only when employees participate from their heart and not only from their body. Excellency cannot be achieved under policing alone; what is needed is creating sense of belongingness amongst the employees. If all these measures are implemented successfully, the industry can definitely enjoy the competitive advantages of lean implementation viz. increased production with lower costs, shorter lead times, reduced defects, minimal physical wastages, reduced production cycles and process preparation times, reduced inventory at all levels of production, improved labour productivity, optimum utilization of equipment and space, decreased machine downtime, and ability to produce flexible range of products with minimum changeover expenses and time. Thus, lean management help an industry offer products at competitive price in the market with increased profit and return on investment.

References
Sr. No. | Type of Membership        | Membership Fee*
-------|--------------------------|---------------------
A.      | Corporate Member         | INR 20,000          
B.      | Patron Member            | INR 4,600           
C.      | Life Member              | INR 3,200           
D.      | Overseas Member          | USD 120             
E.      | Lifetime to Patron Member| INR 2,000           

*Plus 18% GST
Abstract:
It is well known that the conventional chemical modification process on cotton before its dyeing process is a multistep process where the use of water, energy and human labour is significant. However, in the present paper, we report for the first time the possibility of using a single step finishing process for cotton using ammonium sulphate in the scouring procedure.

In this study, it has been noticed that the dye uptake of the cotton fabric has increased with the newly designed single step ammonium sulphate-based treatment.

The preliminary investigation showed that the chemical structure of cotton didn’t change with any of the steps. However, the morphology of the cotton samples changed after the treatment.

Keywords: Ammonium sulphate, Cotton, Dye absorption, scouring, single step treatment

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1. Introduction
In the cotton industry, a number of finishing processes were used to improve the physical properties of the cotton material including dyeability [1-5]. Raw cotton consists mainly of cellulose with some non-cellulosic constituents (waxes, pectin, proteins, organic matter, and ashes) and these hydrophobic non-cellulosic components of the cotton are found in the cuticle layer and outermost layer (primary wall) of the cotton [6]. Because of the hydrophobic nature of the non-cellulosic components of the cotton, their removal is important prior to any chemical treatment on cotton (including dyeing) [6]. The process of removing the non-cellulosic components from the surface of cotton is known as scouring[7]. Most of the finishing processes were conducted on cotton after scouring [2, 3, 6] and all these finishing pre-treatments involve multiple steps. These multiple steps will cost more energy, water and human labour.

It is estimated that for dyeing, about 150 litres of water per kg of fabric are required and mostly the pre-treatments before the dyeing process (treating and washing) required more water [8]. Thus, developing a single step treatment for cotton processing is economically beneficial for the cotton industry. Moreover, some finishing processes widely used in the cotton industry are corrosive. For example, Caustic Mercerisation is a chemical process designed to swell cellulosic fibres, improving dye affinity, lustre and strength in cotton [4]. The original patent granted to John Mercer in 1851 describes a method for changing the properties of the cotton fabric, yarn or fibres by treating with concentrated (25% w/w) caustic soda (sodium hydroxide) [9]. Following the removal of alkali by neutralisation with acid and rinsing with water, the effects on the properties of cotton were found to be permanent with subsequent wet finishing or washing processes. There was also an increase in strength and a large increase in the affinity for dyes [10]. Using the high concentration of sodium hydroxide is not a user-friendly process and removal of the high alkaline content from the textile material required more water and energy.

To date, the finishing processes that are applied to cotton materials to improve dyeability are multi step processes. It is envisaged that a single process capable of achieving improved dye absorption will lower the cost involved in the finishing process of the dyeing industry. Herein, we demonstrate a novel approach to the finishing process i.e., combining the scouring and finishing process in a single step. For this, conventional scouring using sodium hydroxide together with ammonium sulphate has been used as a treatment for cotton. Because of its nonhazardous nature and the capability of producing ammonia gas in the presence of alkali, ammonium sulphate has been used to formulate a single step treating process for cotton.

In the present study, the dyeability of cotton fabric, after the newly developed single step treatment, was investigated. The dyeing of cotton was carried out with reactive dye, which was then compared with the conventionally dyed cotton sample. In addition, the morphology and fine structural changes were investigated. This work is expected to provide the basis for developing a single step finishing process for cotton, and the assistance for a better understanding of the possibility of increasing dyeability with the ammonium sulphate based single step processes.

2. Materials and Methods

Materials
The fibre used in this study came from the Australian cotton
variety Sicot 71BRF (Gossypium hirsutum), which was grown under full irrigation in season 2012/13 at the Australian Cotton Research Institute (ACRI) in Narrabri (30.3° S 149.8° E). The cotton was machine-harvested and ginned with minimal pre-cleaning using a narrowed (40 saw) Continental Eagle 119 saw gin with one lint cleaning passage. The fabric used for the dyeability study is unsoured raw cotton fabric (141.6 g/m²) and was obtained from CSIRO, Australia. The cotton fabrics were prepared from Australian cotton fibres. Sodium hydroxide (NaOH) and Ammonium sulphate were purchased from Sigma Aldrich and were used as received. All reagents were of analytical grade and all aqueous solutions were prepared with distilled water.

**Methods**

**Scouring**

Raw cotton fibres/fabric in slack form were scoured using the conventional scouring method to remove waxes from the surface of cotton [11]. Cotton fibres/fabric were treated with aqueous NaOH (4%), Cross color SDCF (surfactant, 2g/L) and albaflow wetting agent (0.25g/L) at 100°C for 90 minutes. Treated fibres were washed with a large volume of distilled water until free of any traces of scouring agent. After scouring, fibres were dried overnight in an oven at 50°C.

**Single step scouring process with ammonium sulphate**

Raw cotton samples were treated with 4% (w/v) sodium hydroxide, 2% (w/v) ammonium sulphate, cross color SDCF surfactant (2g/L) and albaflow wetting agent (0.25g/L) at 1000°C for 90 minutes. The liquor to the material ratio used is 20:1. The samples of cotton were placed in an Ahiba dyeing pot with liquor held at 40°C for 10 minutes. After that, the temperature of the bath was raised to 100°C at a rate of 4°C/minute and kept up to 90 minutes. After being held for 90 minutes, the bath was cooled to 40°C (at 4°C/minute) and then drained. The treated samples were thoroughly rinsed with hot water and followed by cold water and oven dried at 50°C.

**Dyeing of scoured and ammonium sulphate treated cotton**

Dyeing was done at liquor to material ratio of 30:1 in an Ahiba laboratory-dyeing machine using the standard procedure obtained from the dye manufacturer. Dyeing was carried out using 0.1% w/w Procion Blue HERD. Samples were added to a solution of NaCl (70g/L), Albaflow FFW (0.5 g/L), and Verolan NBO (1 g/L) and held at 30°C for 10 mins, before dye was added. The temperature was raised to 90°C (2 °C/min) and held for 30 mins. The bath was then cooled to 70°C (2 °C/min) before soda ash (10g/L) was added and the bath held for 35 mins. The dyed samples were rinsed in cold water, spun dry, and then further dried in a 105°C oven for 10 mins.

**Characterisation**

Fourier Transform Infrared (FTIR) spectra of the samples were obtained using a Bruker Vertex 70 FTIR spectrometer equipped with an ATR (attenuated total reflectance) mode. Samples were placed on top of the diamond crystal and pressed against a pre-mounted sample clamp on the sample to confirm a good contact between the fibre and the incident infrared beam. All the infrared spectra were collected at a spectral resolution of 4cm⁻¹, with 64 co-added scans, over the range of 4000 cm⁻¹ - 400 cm⁻¹. A background scan was acquired before acquiring the spectra of the sample. The data was processed using OPUS 5.5 software to obtain structural differences between the samples.

The microstructure of the treated and untreated cotton fibres was characterised by Scanning Electron Microscopy (SEM, ZEISS Supra 55 SEM VP microscope -Karl Zeiss, Germany) at an accelerating voltage of 3 kV. The sample surface was gold coated before observation. The cross-sectional morphology of the treated and untreated samples was also analysed by SEM. The cross sections of the samples were prepared according to the standard procedure. In brief, treated and untreated fibres were embedded in TAAB TLV medium resin and then sectioned into 100-200 nm slices using an ultra-microtome (Leica EM UC6 Ultra microtome) [12]. The as-prepared cross sections were gold sputter coated (Bal-Tec Sputter Coater SCD 050) prior to imaging at an accelerating voltage of 5kV.

The colour yield (K/S values) was calculated using a Datacolor color 600 measuring & matching instrument and was used to determine the shade depth of dyed cotton fabrics. Colour strength was evaluated using K/S values generated by Datacolor 600 spectrophotometer. K/S value is the function of colour strength and is represented by Kabelka and Munk equation (Equation 1). The higher the value of K/S, the greater the colour strength [13].

Where R is the reflectance of the dyed fabric, K is the sorption coefficient and S is the scattering coefficient [13]. Illuminate D65 and CIE 10-degree observer were used for the measurements. During measurement the fabric samples were held flat and securely clamped using the sample clamp. Ten measurements were taken on each sample.

Finally, all the dyed samples were investigated by CIE Lab system to get colour strength, L*, a* and b* values using the Datacolor color 600 spectrophotometer. ΔE values were calculated to evaluate the colour differences between samples using the equation 2 [14].

\[
\Delta E = \sqrt{(\Delta L^2 + \Delta a^2 + \Delta b^2)} \quad \text{---2}
\]

The wash fastness properties of both scoured and ammonium sulphate treated dyed samples were measured according to the ISO 105-C03 standard. For wash fastness measurement a piece measuring 10cm by 4cm was cut from each of the dyed fabrics. The specimen to be tested was placed between two specified pieces of white fabric measuring 5cm by 4cm, and the three pieces were held together by stitching around the edges. Then the ISO3 test method was conducted on the samples. For ISO 105-C03, the sample was washed with 5g/l of soap and 2g/l of soda ash in a solution of liquor ratio 50:1, at a temperature of 60°C for 30mins, followed by rinsing and drying. The colour variation of the fabric and the degree of staining on the adjacent fabrics were measured using a spectrophotometer.
3. Results and Discussions

The Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) spectrum of untreated and treated (scoured and ammonium sulphate treated) cotton fibres in the range of 600 to 3800 cm⁻¹ is shown in Figure 1.

![ATR-FTIR spectrum](image)

Figure 1: Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) spectra of raw, scoured and ammonium sulphate single step treated cotton samples

The broad band in the 3600-3100 cm⁻¹ region corresponds to the –OH stretching vibration and all the samples have shown this adsorption band [15-17]. The FTIR peak around 2900 cm⁻¹ corresponds to the –CH stretching peak, which remains unaltered in the three samples [15-17]. The peak at 1427 cm⁻¹ corresponds to –CH₂ bending, after scouring and ammonium sulphate treatment this peak remained unchanged, which indicates that the –CH₂ group didn't change with the treatment [15-17]. The peak around 1160 cm⁻¹ corresponds to C-O-C stretching vibration, and in treated cotton fibre this peak appears unchanged. Overall, all samples exhibit similar vibrational bands around 3300, 2900, 1428 and 1057 cm⁻¹, which are related to the OH stretching, CH stretching, CH₂ symmetric bending and C-O stretching respectively[15-17]. This shows that no chemical structural changes occurred in cotton after scouring and ammonium sulphate treatment. However, from the closer examination of the spectra, it can be seen that some changes have occurred between samples at 1630 cm⁻¹. In the literature it was reported that the FTIR peak at 1630 cm⁻¹ is related to the adsorbed water molecules –OH bending vibrations [17, 18]. For raw cotton fabric, the peak at 1630 cm⁻¹ is not dominant, while for scoured and ammonium sulphate treated samples this peak is noticeable. As compared to the raw cotton, the treated cotton sample's surface is more exposed (the wax and impurities were removed), this could be the reason for the higher water adsorption.

Figure 2 shows the Scanning Electron Microscopic (SEM) images of raw, scoured and ammonium sulphate treated cotton samples. It can be seen from the micrographs that the wax layer which was present on the surface of the raw cotton fibre (2a) was unevenly removed from the cotton after scouring (2b) and made the surface more roughened. However, the SEM images of the ammonium sulphate treated cotton fibre surface have shown that the wax is completely peeled from the surface of the cotton (2c). Thus, it can say that after the ammonium sulphate single step scouring process cotton fibres primary wall peeled out evenly without roughened the surface. This complete removal of the waxy layer help to increase the absorption ability of cotton. This is supported by the infrared spectroscopic data. (In FTIR we have observed that ammonium sulphate treated samples showed a dominant adsorbed water peak.

![Scanning Electron Microscopic (SEM) images](image)

Figure 2: Scanning Electron Microscopic (SEM) images showing the surface morphology of raw (a), scoured (b) and ammonium sulphate single step treated (c) cotton fibres

To study the morphological changes further, the cross-sectional morphology of the samples was imaged using a Scanning Electron Microscope (SEM) and is shown in Figure 3. From the cross sectional images, it can be found that the ammonium sulphate treated samples were swelled and become more round in shape as compared to the raw and scoured samples. This is could be due to the swellability of the ammonia on the cotton [19].
Table 1 shows the dyeing results of scoured and ammonium sulphate treated cotton samples. K/S value of a dyed material has a close relationship to the amount of dye absorbed by the material. It was observed that ammonium sulphate treated cotton samples have the highest K/S value than the scoured samples. Visibly also it was seen that ammonium sulphate treated samples look more bluish than the scoured samples as shown in Figure 5.

<table>
<thead>
<tr>
<th>Samples</th>
<th>K/S value (avg± S.D)</th>
<th>∆E (avg± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoured</td>
<td>1.46 ± 0.03</td>
<td>0.99 ± 0.49</td>
</tr>
<tr>
<td>Ammonium sulphate treated</td>
<td>2.06 ± 0.04</td>
<td>4.58 ± 0.23</td>
</tr>
</tbody>
</table>

Table 2: The L, a and b values obtained for the dyed samples

<table>
<thead>
<tr>
<th>Samples</th>
<th>L value</th>
<th>a value</th>
<th>b value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoured</td>
<td>61.69 ± 1.01</td>
<td>-5.02 ± 0.11</td>
<td>-21.42 ± 0.63</td>
</tr>
<tr>
<td>Ammonium sulphate treated</td>
<td>58.12 ± 0.21</td>
<td>-5.87 ± 0.05</td>
<td>-18.6 ± 0.211</td>
</tr>
</tbody>
</table>

The CIE L*a*b* values of the dyed samples were determined [22], to get detailed shade information about the effect of the single step ammoniumsulphate scouring process on cotton fabric and the results are shown in Table 2. The L values for ammonium sulphate treated samples were lesser than the scoured samples. From the a and b values, it can be seen that ammonium sulphate treated samples were darker in shade. The significance of colour differences between treated samples was determined by calculating the ∆E values (shown in table 1).

The improved dyeability of ammonium sulphate treated cotton fabric could be due to the swelling of the cotton that has occurred on treatment with ammonia. In addition, several researchers reported on the swelling action of ammonia on cotton [23, 24]. Here the swelling of the cotton has occurred with the ammonia, that was formed from the ammonium sulphate treatment.
sulphate solution. There are a number of advantages of this single step treatment over ammonia swelling. Firstly, the concentration of ammonium sulphate used is lower and secondly, this is a one step process. The data obtained from electron microscopy, cross sectional analysis also supported the swelling of as-formed ammonia from the solution. Moreover, from the microscopical analysis, the surface of cotton is more dewaxed after ammonium sulphate treatment. This helped cotton to absorb more dye solution and this can be seen in the FTIR with the dominant water adsorption peak at 1630.

Table 3 summarises the wash fastness properties of the dyed samples and it was found that the fastness for the ammonium sulphate treated sample was excellent and showed no difference (rating 5) with the washed sample by the spectrophotometer.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Change in Shade</th>
<th>Staining on white fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoured</td>
<td>4-5</td>
<td>3-4</td>
</tr>
<tr>
<td>Ammonium sulphate treated samples</td>
<td>4-5</td>
<td>4</td>
</tr>
</tbody>
</table>

4. Conclusion

The motivation for this study was to investigate the effect of a single step ammonium sulphate process capable of improving the dye absorption of cotton or not. From the preliminary studies, it has been found that ammonium sulphate based single step processing can improve the dye pick up in cotton. As shown in the SEM images, after treating with ammonium sulphate, cotton fibres became swollen and the surface became more exposed. This could be the reason for the improved dye pick up. It was found that the dyeability of the cotton has changed without changing the chemical structure of the cotton. Hence, it can be predicted that the intrinsic properties of the cotton will not be affected by this treatment. Furthermore, the wash fastness of treated cotton after dyeing was superior. From the initial works, it was envisaged that the single step ammonium sulphate based process can be promising lower energy, lesser water and reduced labour oriented processing route for the dyeing industry.

Acknowledgement

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Circular Economy: Consumer Perception towards Upcycled High-Value Products

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Abstract:
India had an annual consumer expenditure of almost 134 billion dollars on clothing and footwear in the year 2019. This is essentially a consumer goods industry, having one of the most complex and polluting manufacturing processes that use extravagant amounts of resources in agriculture, processing, manufacturing, finishing, shipping, and retailing. It has resulted in an alarmingly high level of Green House Gases, industrial effluents, pollution, and fast depleting resources. Therefore, making optimum use of the manufactured product, especially during its end-of-cycle stage is important. This post-consumer waste consists of varied garments or household textiles that consumers no longer need and discard, either because they are worn out, damaged, outgrown, or out of fashion. Most of this waste goes into landfills; hence upcycling products when they reach the end of their lifecycle can help resolve the concern.

The paper investigates upcycling of collected post-consumer garment and textile waste into higher-value products such as reversible jackets, neckpieces, tote bags, etc. The completed products were used to judge consumer perspective on appreciation, willingness to buy as well as the upcycled product. The survey highlighted that 57% of participants were unaware about upcycling of garment waste and post-intervention followed by display and appreciation of products made 89% agreed to make conscious efforts to upcycle products. The survey suggests a need to spread awareness about upcycling, which has immense potential to get one step closer to a green, waste-free future and circular economy.

Keywords: circular economy, garments, post-consumer, upcycling


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1. Introduction:

1.1 Textile waste

The textile and fashion industry is one of the biggest and oldest industrial sectors in the world. It is the most essential consumer goods industry [1]. Over the centuries it has developed into one of the most complex and polluting industries. It has evolved some of the most complex, long, and variegated processes of raw material procurement, fabric manufacturing, garment construction, packaging, distribution, and selling. Its role in the linear economy is damaging not only because of production but also consumption which produces a lot of waste. Textile manufacturing processes use an extravagant amount of fast-depleting natural resources which result in the release of alarming levels of Green House Gases and effluents in water bodies, bringing each manufacturing step under the scrutiny of environmental sustainability [2].

The environmental impact of this industry is remarkably widespread, use of technology combined with a surge of internet and digitalization has enabled rapid spreading of information and trends that result in consumer's having a lot of options. Low price, good design, coupled with an exciting shopping experience for cheap, and means increase in purchase and overflowing wardrobes and therefore the need to consider options available for disposal of their clothes.

1.2 Classification of textile waste

Textile waste is divided into three categories based on their source of procurement and potential for getting used into fashion articles [3].

a. Production waste consists of leftovers from the garment manufacturing process.

b. Pre-consumer waste is products which are unsold or have not reached the consumer as they are damaged or part of excessive production.

c. Post-consumer waste consists garment or household textile that the consumer no longer wishes to use or discards, either because it is worn out, damaged, outgrown, or has simply gone out of fashion.

1.3 Causes of post-consumer textile waste generation

1.3.1 Fast fashion

Over the past two decades, the rhythm of fashion has accelerated towards what is known as “Fast Fashion” [4]. The practice of producing cheap knock offs as quickly and as frequently as possible, encourages consumers to buy impulsively. These clothes are usually worn only for a season and then discarded [3]. This promotes the current take-make-waste system of usage.

1.3.2 Change in lifestyle:

The increasing purchasing power of people in India and
following of a seasonal wardrobe, which is a largely western concept, has encouraged people to buy more clothes.

1.3.3 Lack of consumer awareness about upcycling:
Consumer disposal behavior plays a significant role in the journey of a garment or piece of textile towards a landfill or upcycling unit. Their perception towards upcycling of product in its end of cycle and their willingness to use an upcycled product plays a significant role towards reducing textile waste.

1.4 Upcycling as a waste management strategy
Upcycling has always been deeply rooted in traditional Indian lifestyle. We have always valued these resources and felt connected to the old charm and warmth of a traditional garment. But the traditional methods of upcycling are soon becoming a lost art. Through upcycling not only can we save clothes from going into landfills but make products which are unique.

Upcycling is a value added activity on a used textile or garment to create a product of higher value than its original version. It does not break down or disintegrate the original fabric into its fiber stage nor does it change the product into another raw material, hence it is considered to be less resource-intensive. The process of upcycling requires the ability to take up a creative or innovative project followed by hard work and dedication to creating a sustainable product due to a love for environmental awareness [5, 6].

1.4.1 Advantages of upcycling
a. Reduction of environmental burden: With the reusing of old available textiles as raw material for the new product, burden on procuring virgin materials is greatly reduced. This leads to reduction in use of pesticides, insecticides and precious natural raw materials. It means a reduction in air pollution, water pollution, greenhouse gas emissions and often a conservation of global resources. This promotes a cost-effective recycling of the earth's natural resources

b. Contribute to generate business: The process of upcycling requires creativity as each article is unique, this leads to encouraging businesses opportunities at skilled crafts men level.

c. Contribution to social responsibility: At the industrial level companies can realize larger profits and earn environmental credits because they minimize solid waste treatment and disposal costs. They also reduce the cost of purchasing material thus increasing profitability and generate an alternative income stream.

d. Creation of unique statement pieces: Customers who are always keen to find new ways to stand out in the crowd can comfortably use upcycled clothes as each is a unique statement piece usually handcrafted by a creative mind. This will help clients make a statement wherever they go [7].

1.4.2 Problem while upcycling
• Redesigning a used garment is often a time-consuming and labour-intensive process. A huge amount of time and effort is often invested in finding an appropriate transformation of a particular fashion product or accessory.

• Availability of a up-cycled product at a reasonable price has been found to be the main criteria for the purchase the product. If new clothes are available at lower price compared to an upcycled article, the consumer will prefer to buy garments of virgin material compared to the recycled clothes. The focus should be given to cost reduction during repairing or redesigning of the article.

• There is almost no control over the choice of raw material available for recycling. Which is the greatest drawback as in industrial manufacturing the raw material can be sourced within a specific type and quality at a pre-negotiated price. Further, virgin raw materials can be sourced in bulk too [8].

2. Material and Methodology
All material was gathered, sanitized and sorted prior to upcycling.
2.2 Method

Two methods of upcycling were used in the design process

2.2.1 Upcycling fashion garment through modification

Here an existing piece of fashion was revamped into something new. For instance, adding a patch of another fabric to cover a damaged part of the article or turn a part of denim into a jacket. The garment could also be redyed, bleached or treated to some surface ornamentation. The finished product often has a striking resemblance to the original article.

2.2.2 Upcycling fashion with remnants

In this process, rather than modifying a complete, existing garment or accessory, textile remnants from other processes of the fashion industry are used to create a brand-new piece of fashion.

A framework was initially developed for the utilization of post-consumer garment waste. Various factors such as type of garment/textile, amount of value addition to be added to the article, impact of the value addition/orientation, cost of the product, societal and environmental impact along with consumer behavior have been considered in the proposed framework. The proposed framework is shown below (Figure 2.1)

| A. Sourcing and Collection of garment waste. |
| B. Sorting based on fiber, weave, color etc. |
| C. Sanitization and washing of garments. |
| D. Identification of defects in the garment. |
| E. Creation of design board keeping environmental impact, consumer preference and cost in mind |
| F. Drafting, construction or surface ornamentation done based on design planned. |

3. Result and Discussion

The completed products were used as a part of the survey that received 96 responses in total. The survey also explored participants opinion on pricing of the upcycled articles. Each product consisted of multiple prices in order to understand the acceptability of the product at its optimum price.

3.1 Product 1: Reversible Jacket from pink and blue viscose polyester blended sari (Figure 3.1 a, b & c)
The reversible jacket was introduced to the participants as a fashion article that can be paired up with a lehenga for traditional festive occasions or pants to create an indo-western ensemble. Here 59% respondents felt the article should be prized at Rs.1100 and 18% people said it should be prized at Rs.1500. The reason for the garments acceptability could be because the product involved a lot of detailing. For example, there were no visible seams, had detailed sleeves and brocaded center-panel which added a richness to the design. The respondents also felt that they were getting two unique garments for the price of one.

3.2 Product 2: Off-Shoulder shirt from blue, yellow, red woven checked full-sleeved shirt (Figure 3.2 a & b)

The shirt had been discarded due to a burn caused on the shoulder of the garment while ironing. It was converted into an off-shoulder top with the bias-cut pockets as the focal point. Contrary to results of other garments here the respondents were actually willing to pay more as the price target was increased. 26% respondents felt the garment was priced appropriately at Rs.150, however 50% felt that the correct price should be Rs.200 and 23% participants agreed on the prize of Rs.300 for the article. The reason for the willingness to pay more could be that the freshness of colours still remained on the garment as it had not yet gone through a heavy wear and tear routine prior to being discarded thus not making the garment looked faded and worn-out.

3.3 Product 3: Blue denim yoked jacket converted from faded blue denims (Figure 3.3 a, b & c).

These old set of denim were converted into a yoke jacket. It was further enhanced with a piece of leftover black embroidered fabric from another garment. It was constructed in such a simple style as to be comfortably used in daily wear or college wear by teenagers. The respondents were quite similarly divided as 44% felt the garment should be priced at Rs.350, whereas 41% felt it should be prized at Rs.500. However only 12% participants felt the garment can be priced at Rs.700. The reason for such a difference in price acceptance could be that similar new jackets are available in the market for Rs 500 and accordingly most people tend to compare prices of new and upcycled products.

3.4 Product 4: Violet ombre effect crop-top converted from a T-shirt (Figure 3.4 a & b)

A faded violet knitted T-shirt was given a new look by partially bleaching it to create an ombre effect. This finishing was preferred as the garment already possessed a slightly faded look which was used to advantage. The garment was further trimmed from the hem to create a mid-length crop top which can be comfortably worn. According to the survey 39% respondents felt the garment was appropriately priced at Rs.150, closely followed by 30% respondents who felt that the garment could also be bought for Rs.200 and 23% respondents felt that the garment could be priced at the cost of Rs.250. The reason could be as participants felt they would get a new garment from the local store at Rs. 250 and more so according to most people Rs.150 is a suitable price for this kind of t-shirt.
3.5 **Product 5:** Tote bag converted from a blue denims (Figure 3.5 a, b & c).

The twill fabric of old jeans is considered to be strong and capable of lifting a lot of weight, thus it is a good choice for shopping bags and tote bags. As a result 40% respondents felt the bag was appropriately priced at Rs.100. Only 25% people felt the bag should be priced at Rs.150 and 30% people think it should be priced at Rs.200. Although most respondents also suggested if more embellishments were added to the bag then it could be priced a little more.

3.6 **Product 6:** Neckpiece converted from textile pieces leftover from other up-cycling project (Figure 3.6).

A lot of fabric pieces are usually leftover when garments are converted or upcycled. These fabric pieces are usually of odd shapes and sizes. The necklace is made from textile waste which is leftover from such projects. Respondents found the necklace unique so 38% felt it should be priced at Rs.100, whereas a similar 36% felt it should be priced at Rs.200 however only 23% participants appreciated the effort of creating individual beads as a time consuming effort and felt the accessory should be priced as Rs.300. Nowadays fabric accessories are in trend and can be worn with a simple kurta or saree when embellished with metal pendants or beads.

4. **Conclusion**

The survey highlighted that 57% people are unaware about upcycling. Post-intervention and display of upcycled garments 89% participants agreed to make efforts to upcycle textiles. 52% respondent's considered wearing up-cycled clothes, and 95% believed upcycling will lead to a green future.

Post-consumer waste has strong reuse potential by increasing the life span of the product and/or its materials. The concept of reimagining, reusing and reinventing waste will reduce environmental burden by closing the loop on textile manufacturing. Conscious effort to help consumers appreciate upcycled products and sensitize them to use of products not made from virgin material is important [9, 10]. Also reducing cost of up-cycling cannot go unmentioned.

The real beauty of upcycling is to take a pre-loved garment and turn it into something beautiful and useful. Upcycling is a growing force behind a nascent sustainable industry, with potential to take us closer to a waste-free future.

References:

Demand of Artificial Intelligence (AI) in the Textile Industry

Dr. Chet Ram Meena

As textile industries are booming day by day with the new innovations and developments. The new innovations are capable to full filling the need of various segments such as conventional and technical textiles in the field of home apparel and industrial applications. Innovations have made our life easy and smooth. In the necessity of few segments such as fitness trackers and wearable techniques, smart fabrics and smart clothing etc.

Fashion and textile manufacturing is a very vast industry. It practices the basis of the conversion of fiber into yarn, yarn into fabric. These are later dyed or printed to make garments. Different types of fibers are used to make yarn. There are various processes with the complication of finishing and finishing processes for a wide range of product. If we get the help of AI to perform these textile processes, the speed of our work will increase a lot and we will be able to benefit a lot more speedily.

Clothing and textile manufacturing have traditionally been labour-intensive industries, which is characterized by low-fixed capital investment; a wide range of product designs and, hence, input materials; variable production volumes; high competitiveness; and often high demand on product quality. However, due to high demand for garment quality and increased consumer awareness is leading to the use of automated tools and equipment in recent years during garment manufacturing. Automation in garment production is becoming a reality due to the technical developments and the use of modelling and simulation. Due to its labour-intensive nature, the apparel industry can seek great benefits out of the AI intervention in their businesses. As seen in how many of world's largest fashion, clothing and apparel brands seem to have a significant percentage of their products manufactured in Asian countries such as China, India, Bangladesh, Vietnam, etc.

As reported that the global apparel market is projected to grow in value from 1.5 trillion USD in 2020 to about 2.25 trillion USD in 2025. It is showing that the demand for clothing and shoes is on the rise across the world. The increase in demand for quality products has led the textile industry to embrace automation and AI to reduce labour and production costs and deliver products according to customer likings. In another report claimed that the global textile market size was valued at 961.5 billion USD in 2019 and is estimated to exhibit a CAGR of 4.3% from 2020 to 2027 owing to the increased demand for apparel in developing countries like China, India, Mexico, and Bangladesh. Textile is a labour-intensive industry and technologies like AI and IoT have helped in easier data processing, predictive analysis, developing smart apparel, and efficiently take up massive work without human intervention. Let us now discuss some of the applications of artificial intelligence that will help transform the textile industry for innovative business developments. AI will have a huge role to play in redefining the textile industry in the coming years, by enhancing business growth and introducing sustainable fashion.

### Introduction to Artificial Intelligence

Artificial Intelligence is a stream of computer science whose main aim is to demonstrate intelligence very similar to human intelligence despite the fact of being a computer system. Its intelligence can include anything like; learning, prediction, perception, speech recognition, decision-making, translation, social intelligence, motion, and its manipulation, and so on. In other words, it is also known as Machine Intelligence, the intelligence demonstrated by the machines. AI refers to a simulation of human intelligence in smart machines which are programmed to think like humans, and mimic their actions. It is a wide-ranging branch of computer science which concerned with building machines capable of
performing tasks that typically require human intelligence. Artificial Intelligence is the ability to design smart machines or to develop self-learning software applications that imitate the traits of the human mind like reasoning, problem-solving, planning, optimal decision making, sensory perceptions etc.

The high demand for the quality increased leading to the application of automated artificial intelligence in textile industries recent years. The automation with applications of artificial intelligence in textile production is becoming much popular due to the technical developments and the use of modelling and simulation. The capacity of artificial intelligent approaches to outperform human actions in terms of knowledge discovery gained the attention of business and research communities all over the world, and this field of study witnessed rapid progress in the last two decades.

The main components of artificial Intelligence are feature Engineering, Artificial Neural networks (ANN) and Deep learning that majorly contribute towards the implementation of various intelligent systems.

Artificial Intelligence in the Textile Industry

Some of the important applications of artificial intelligence in textile industry are mentioned below. Out of several types of artificial intelligence, Artificial Neural Network (ANN) is widely used in textile industry in the following fields:

1. Yarn Manufacturing: At every stage, the production process was completely revolutionized by the use of AI from blow room to carding, drawing, lap formation, combing, speed framework, ring spinning, winding, packing, and conditioning. All required production parameters with little human participation are determined by AI-Based control panels.

2. Fabric Defect Identification: The fabrics are graded more objectively and to produce more consistent outcomes. AI benefits from the fine, solid, and staple fiber lengths, accurately determined by using artificial neural network systems.

3. Pattern Inspection: Model cutting and design making is an essential operation in the apparel Industry, where materials are cut to the prescribed design, and various patterns are formed on the cloth. CAD is an AI sub-set that enables computerized patterns to be produced in which designers can build and digitize the basic structure of the patterns.

4. Colour Matching: Dacolor was extensively utilized for color management to validate that the original color design is consistent with the completed textile color. Dacolor proposes to take into consideration its AI function the historical data from visual evaluation outcomes of human operators and to generate tolerances that in turn lead to contributively inspections that are closely matched to the visual inspection samples.

5. Sewn Seam: Artificial intelligence system can be used to find the sew-ability of different fabrics during the production according to the performance of the final product.

6. Computer Aided Design (CAD) Systems: The Integration of AI and CAD can boost product development & designing procedure with powered knowledge and reasoning capabilities. It has fundamentally impacted the usage and utility of CAD system. While the best CAD software solutions started as a simple tool, it is now incredibly advanced with complex features allowing the users to perform various tasks that are otherwise not possible via a conventional method.

7. Production Planning and Control: The new generation of so-called advanced planning and scheduling overcomes many of those limitations by applying optimization algorithms instead of fixed logic that can trade off priorities and alternatives to come up with a more feasible plan that balances both resources and material date and quantities. AI-developed plans and schedules will extremely be "better" than any human could create. Process will run more efficiently; product quality will improve and more work will be completed on time and at a lower cost.

8. Final Inspection: It is an inspection in the manufacturing process, and refers to the inspection performed in the final stage of manufacturing process. AI inspect software uses modern deep learning convolution networks to learn the visual differences between normal and defect pixels in any set of correlated images.

9. Supply Chain Management and Merchandising: In textile industries, AI can be utilized for automating transport and packaging. The management of the supply chain is vital for the seamless movement between merchants and manufacturers of materials. Merchandising is another room that may apply AI to evaluate and process information chunks, customer experience personalized, consumer behavior tracked and market trends predicted.

The Influence of Artificial Intelligence in the Textile Industry

I. Trend-Spotting: In view of the rapidly changing fashion trends, anticipating fashion trends is obviously not only a difficult but also a time-consuming endeavour. The AI tool, which has been trained in data quality and quantity, analyses prior fashion data, assesses customer requirements and preferences, evaluates competition movements, and identifies market trends.

II. Machine Assisted Designs: AI tools may be analysed and the interred photos learned and hence a whole new fashion can be made by itself. With the promise of AI in design realized, numerous technological titans already undertake major strides to incorporate the technology.

III. Customers Experience: AI helps to fashion firms are attempting to bring customization to the forefront during their purchasing visit.

IV. Enabling New Applications: Smart clothes combined with electric sensing technologies can complete the same, like how fitness trackers can enable their users to live a better and more attentive lifestyle. After the COVID-19 epidemic,
consumers highlighted healthcare and medical care in their wearables and clever clothing.

Limitations of the Artificial Intelligence

a. Need for Massive Data Corpus: In general, intelligent systems, before getting deployed as a real-world solution, learn an optimized model with the help of a large amount of data while training and validation. The availability of huge data volumes and the ability to handle them are the major limitations for the conventional systems and software applications to evolve as AI-enabled editions. The need for sophisticated modelling techniques that can estimate the model parameters with high precision using limited data samples is imminent.

b. Multimodal Interactions: The effectiveness and meticulousness of perception-based recognition applications that encompass computer-vision methods can be improved by leveraging the ability to interpret and process multiple modes of data simultaneously. This enables the recognition paradigm to ideally emulate human intelligence that works in conjunction with various senses like touch, vision, hearing, etc.

c. Beyond Human Control: With the extraordinary capability of AI technology to understand and learn vast libraries of information at a faster pace, there are few threatening instances where an AI framework gained an emotional quotient and surpassed the extremities of human logical thinking.

In this current period, AI is being used in many areas to solve various problems with intelligence similar to human beings. However, the global competitive environment and a target to achieve low cost of production are the main reasons for the AI's wider applications in the textile industry starting from the raw materials, selection and sourcing, through manufacturing till retailing. Artificial intelligence in the textile industry brings cutting-edge revolution and disruption that's never been seen before. The AI's production process and business management is being reshaped by textile manufacturers. AI can access and accumulate historical and operational information in real-time and provide an insight that can enhance operational efficiency. It is easier to amend processes to increase the capacity of human workers if you have a clear view of the processes of operations. Much progress is undergoing in AI system is one of the best choices in the textile industry to integrate the features like enhancing quality, increasing production, lowering operating costs, and exercising in house control over overproduction, leading to quick response, just-in-time production and digital integrated production, and hence increased sales. The application of artificial intelligence in textile industry has a bright future similar to other areas of application.
Industry 5.0 Basic Introduction
V. V. Gharat
Managing Director - Gharat & Associates

It is a great pleasure to mention that Textile Association India-Mumbai had successful Conference in Feb. 2019 as Wake Up Call & now it is time to complement or correct it to Industry 5.0.

Industry 5.0 – not another revolution, A complement or correction

The term Industry 5.0 popped up as a reaction to the vision of Industry 4.0. Driven by the impact of the Pandemic, the focus on topics such as Sustainability / Resilience which is very essential subject to Experts, Policymakers & Consulting organizations.

How Industry 5.0 fits in the (post)-pandemic

With Industry 5.0, many people wanted to bring the human, social, and environmental dimensions back into the equation. They felt this wasn't the case in Industry 4.0 and initially mainly focused on the human touch.

It is indeed not a coincidence that the attention for Industry 5.0 is accelerating now. Just as the COVID-19 pandemic accelerated digital transformation, it accelerated the focus on other challenges of our time & the importance of People, Environment, Societal changes.

Industry 4.0 offers mass production with very marginal Human Involvement or No Human Involvement. Industry 5.0 brings Personalization & Human touch back to manufacturing or operation process. Robots are carrying all programmed Jobs with perfection & repeatedly. The programmes are set by human intelligence & it is been carried out but in case of some complicated problems Robot get confused towards failures or many times disasters. Hence Human intelligence is required to resolve issues hence Industry 5.0 exists. Collaborative Robots are well positioned to became Industry 5.0 tools, helping Human to create Personalized products demanded by consumers.

The Fifth Industrial Revolution is the combination of humans & machines at workplace. Industry 5.0 brings benefits to Industry, Workforce & Society. It empowers workers as well address evolving skills & training needs of employees. It helps in increasing competitiveness of industry & attracts excellent talents.

Industry 5.0 will revolutionize Manufacturing systems across the Globe by taking away dull, dirty & repetitive tasks from humans wherever possible. Intelligent Robots & human systems will penetrate manufacturing supply chains with production at shop floor to an unprecedented level.

The Collaborative Combination of Human Intelligence & many companies are started developing it. It is need of time because auto pilot or auto vehicles are not so successful.
performed dangerous, monotonous or physically demanding work, such as welding and painting in car factories and loading and unloading heavy materials in warehouses. As machines in the workplace get smarter and more connected, Industry 5.0 is aimed at merging those cognitive computing capabilities with human intelligence and resourcefulness in collaborative operations.

The pairing of human & machine opens the door to countless opportunities in manufacturing. Since the use of Industry 5.0 may not be clearly understood by manufacturers hence proper educating is important.

Manufacturers should start actively strategizing ways to integrate human and machine in order to maximize the unique benefits.

**Industry 5.0 is aimed at Supporting – not Superseding – humans**

**Highlight of industry 5.0 compared to Industry 4.0**

Don't mistake the upsurge in robotics as an opportunity to eliminate headcount and replace workers who perform repetitive tasks on assembly lines. Manufacturers who understand the value of human intuition and problem-solving capabilities are positioning themselves to thrive.

Many of us often think that manufacturing workers is a poor substitute for a robot, “But in practice, these things are really difficult because intelligent worker is making perfect judgments in view of his long experience. And it turns out that when you take that person away, you end up with some problems that are hard to solve. While robots are much more consistent than humans & better at precision work, but they're inflexible and incapable of the adaptability, critical thinking that defines us as humans.

Working together with people, robots can fulfil their designated purpose of providing assistance & making our lives better. Universal Robots uses the term “Cobots” for collaborative robots to emphasize the importance of people in robotic technology. Industry 5.0 will make the factory a place where creative people can work efficiently along with robots. They can create effective & personalized human experience.

**Industry 5.0 is making optimal balance of efficiency & productivity**

The objective of Industry 4.0 is to interconnect machines, processes and systems for maximum performance optimization. Industry 5.0 takes such efficiency and productivity a step further. It's about refining the collaborative interactions between humans and machines. In manufacturing operations, it is realized that the robots relieve them of physically demanding work and they can concentrate on other tasks.

Industry 5.0 recognizes that man and machine must be interconnected to meet the manufacturing complexity of the future in dealing with increasing customization through an optimized robotized manufacturing process.

**The progress of Industry 5.0 is unavoidable**

Once you've used technology to make a process more efficient, there's no point in reverting to the old way of doing things. It's why we use computers with word processing software instead of typewriters. Similarly, Industry 5.0 is the manufacturing world's future.

While Industry 5.0's headway can't be stalled, there are still essential questions and ramifications that must addressed by manufacturers and policymakers.

Excessive automation & highly integrated systems are vulnerable to systemic risks such as total network collapse.

It's not a question of whether a manufacturer can benefit from its personnel working alongside robots, but how they can best leverage new technologies to drive optimal outcomes from human/machine interactions.

These are basics of Industry 5.0 & may get more updates from experts who are working on concept.
Interview with Mr. Prashant Mohota

Mr. Prashant Mohota is a Managing Director of Gimatex Industries Pvt. Ltd., manufacturing Yarns & Fabrics domestically & for export to more than 80 countries. He holds the unique feat of being the 6th Generation business entrepreneur in the same family business. In 16 years of his own business life.

Under his spirited leadership he has taken several initiatives to make his organization, a lean, IT-savvy and innovative company with his various changes management approach.

On the occasion of a glorious journey over 125 years of Mohota Group in the textile industry and 25 years of Gimatex Industries anniversary, Mr. J. B. Soma, Hon. Asso. Editor & Publisher of JTA, took the opportunity to have the deliberate with Mr. Prashant Mohota on the Textile Value Chain.

First of all on behalf of the Textile Association (India), we heartily congratulate you, your full family and the entire Gimatex Industries team for very successfully completed its excellent journey of 125 years of Mohota Group and 25 years of Gimatex Industries.

Q: Sir, please introduce a brief about your Company
Gimatex Industries Pvt. Ltd., established in the year 1993, was set up with a vision to provide premium quality textile products to its customers using the Latest in textile technology. The company continuously invests in upgraded technology, people and infrastructure. Run by a highly dynamic and experienced management and supported by a strong skilled workforce of 5000 people the group has become a strong player in the market and a name to reckon with. Today Gimatex is a completely integrated textile facility with Ginning, Spinning, Weaving, Processing units & Garmenting under its fold. Its plants are located in the heart of cotton growing belt of India which ensures shorter lead times and quality selection of its raw materials. It is also part of the 1st Integrated textile park project of Vidarbha under the centre's SITP scheme. Also the company has diversified into the area of Scientific Cotton-Seed Processing by setting up a first Gossypol free Cotton Seed Protein meal plant along with an integrated Cotton Oil refinery. Gimatex has thrived using values of innovation, quality, and ethical practices as its pillars of growth.

Q: Mohota Group has a glorious history of over 125 years in the textile industry. Tell us about some of the important highlights, achievements, milestones during this journey
Following chart shows a road map of the a successful journey of our group.

Q: According to you, how has the industry improved over the last few decades?
Over the years we see that industry has significantly improved in terms of efficiency in its processes innovations for the products and delivering a cause effective and sustainable product solution for deserving customers. Huge improvement has taken place in terms of finishes in various fabrics so that it can sustain and last for longer use and as per the product application. Technology has improved significantly where we see machines talking to the computers and all kinds of data availability for making quick and improved decision making.

Q: How do you plan to celebrate 125 years of Mohota Group and 25 years of Gimatex? What is the future course for the company?
On 25th of March, 2022, Gimatex celebrated its 25th anniversary and 125 years of textile history of the Mohota group. On this momentous occasion, Gimatex inaugurated its new manufacturing facilities, namely the 10 TPD Open End Unit at Wani and the 25 TPD Spinning Unit at Hinganghat Integrated Textile Park. Furthermore, Gimatex also launched its Premium e-commerce Apparel Brand 'Minus One' in the same event.

Various Dignitaries from across India and abroad grace the occasion. Mr. Sanjay Jayavarthanavelu, Chairman of Lakshmi Machine Works was the Chief Guest and Mr. Ajay Arora, MD of D'Decor, was the guests of Honor. Other prominent personalities include Mr. Kishanjee Poddar (Siyarams), Mr. Hisahiro Koketsu (MD, Toyota), Mr. Pankaj Sarda (Jt. MD, Sarda Energy & Minerals), Mr. Manish Kumar, Mr. Anil Jain, Mr. Aditya Jain and Mr. Masayuki Yamamoto among many others.

It is pertinent to note that, Gimatex’s first manufacturing facility in Wani started operations in 1997 and has entered a period of constant expansions and rapid growth. The new Open End Unit at Wani adds yarn manufacturing capability to manufacture Recycled fibre based fabrics. At Hinganghat Integrated Textile Park, the new spinning facility adds further 32,000 spindles to their existing capacity of 1,68,000 spindles. Combined, these new units also contribute to tremendous employment in the local region to the tune of additional 500 people. The dedication, integrity and passion with which all the family members have served the company has led to the 6th generation of the Mohota family to continue in the same business.

Gimatex has always focused on value addition in the cotton
sector. By launching Minus One Gimatex has completed an integration from Cotton Fibers to Fashion segment and added tremendous value to the cotton lifecycle. Moreover, by using only Vidarbha cotton in their products, Gimatex is supporting the local farmers and alleviating the difficulties faced by them in recent times. Previously, Gimatex had installed a scientific cotton seed processing unit to add value to the Cotton chain, and with Minus One they have extended this philosophy further.

On this important occasion, GIMATEX has made a commitment of contributing Rs. 25 per pc sale of Minus One Apparel & Rs. 100 per Quintal sale on GIMA WHITEGOLD Cotton Seed Refined Oil. This contribution will be used for welfare of the Cotton farming community.

Additionally, to mark the celebrations of the milestone year, Gimatex has taken over the maintenance and upkeep of the main squares, fountains and decorative lightings of Hinganghat Town, from Subhash Chowk to Tukdoji Chow. They also felicitated 18 staff members who have served them for more than 35 years in a short program at their Club House.

Gimatex has always received great support from the local community. Through their development activities, they have always focused on the growth of the local areas and will continue to do so in future. As they mark their special occasion in 2022, Gimatex wishes that you continue to stand with them on their onward journey. Sabka Saath, Sabka Vikaas!

Q.: Cotton and cotton yarn prices and market have been in a flux for many months now. How has it been for Gimatex? How have you managed to keep margins and supplies intact in this situation? What is your advice to the industry?

Yes, the prices have Sky rocketed in the last one and half year particularly more so after the Corona Pandemic, it has been very complicated for spinners if we consider today’s cotton price we do not find any margin in terms of Yarn spinning for the reason that costs have significantly gone up in terms of labour, power as well as cost of all other inputs. Yes, we have been able to keep our margins only because of the right timing of fibre purchase and ensuring that quality cotton is acquired through our ginning operations.

Q.: A much-used statement is that Weaving and Processing are the weak links in the Indian textile industry. On this what are your views, given that you are an integrated textile manufacturer?

Yes, definitely the downstream processes like weaving / knitting and their processing as well as Apparels remain to be the weak links in the Indian textile industry. If we see besides us i.e. Bangladesh, we see that they have really developed themselves in terms of garment manufacturing which is ensuring a pull for the backward processes starting from spinning and therefore the country is self-sufficient in itself in catering or expanding in textile operations in time to come.

In India now with the aid of PLI and many other incentives scheme like RODTEP, ROSTCL, we see some shift happening towards large scale manufacturer coming in the field of garments where we need corporate entities to make an efficient garment operation.

Q.: Sir, do you have any expansion or diversification plans in future?

Recent investment – At Bela Unit for spinning 32000 Spindles for Viscose & Cotton Compact yarns, At Wani Unit Open end Unit for making PC & Cotton Coarse count yarns (7 to 20 ne) and Processing Unit at Ahmadabad, Dholka for Soft Flow machines for processing of Viscose based fabrics with Up-gradation of ETP to ZLD (Zero Liquid Discharge) setup, along with MEE & Sludge dryer.

Upcoming expansion - New 32 Thousand Spindles & new Airjet looms 120 and Weaving Preparatory.

Q.: How do you expect the Russia-Ukraine conflict to impact the Indian and international textile industry? How are you preparing to safeguard your interests? Please advice to the industry.

I am yet to exactly understand how this will impact but given the current scenario it seems that this war is going to last pretty long and it will definitely affect the consumer interest in European countries therefore, I believe India’s exports to Europe will definitely get affected in short term as well as long term.

Yeah my advice to the industry in the current scenario would only be to ensure that the customer base expands from European Nations to other alternatives like South American and far Eastern countries as well, so that we are able to hedge our rest in case Europe or some Western countries try to sanction India for taking a neutral stand on Russian Ukraine conflict. One should also try and ensure that whatever market is being created because of China plus one policy is also garnered by Indian operations or Indian Products.

Q.: What are your new products, Innovations and Technological advantage?

New Products details include GRS products in cotton (20%) and polyester, Spandex yarns & fabrics, Organic fabric, Specialized finishes in processed fabrics. We have manufactured Tencel lycra & viscose lycra fabrics and successfully delivered bulk quantities to top brands.

- Cottonseed & Soyabean Oil and Cottonseed & Soyabean DOC
- An innovative and first of its kind trouser, with stretchable waistband, which makes the user very comfortable, was designed by D & D centre, Ahmadabad. The product was a result of using an integrated approach for making super fine quality of 100% cotton products using Vidarbha Premium Quality cotton. This product was launched under the brand name of “Minus One”.
- Completing its vision to serve textiles with Farm to Fashion approach Gimatex Launched Gimaq brand of In-house clothing having 200+ SKU’s in its product range.

Technological advantage - Integrated plant gives better quality feedback from user angle. Also continuous...
upgradation in latest technology machines gives better quality control & efficient production systems.

Industry 4.0 – In house App for employees by the name of GIMA – SMART App for customers by the name of G-FORCE (Factual Operating Resource for Customer Ease) App for direct Production recording from Production machines.

Q: What is the Share of domestic business and exports and who are your key customers in India and Globally? Export sale 25.28% & 74.72% Domestic sale for financial year 2020-2021 of Gimatex and in India key customers are:
- Siyaram
- Asahi Kasei Corporation
- D’decor
- Shahi Export Pvt. Ltd.

Q.: What advantages you offer compared to other competitors and why should a customer source from you when there are so many other options available?
Advantage would be in terms of the basket of products that comes from the house of Gimatex as our product portfolio encompasses basic cotton, polyester & viscose yarn and lot of value added products which include Ecovero, Modals, Excels, Tencels and their related products. Also we manufacture range of fabric and process fabric made of varieties of yarns. This integration helps in getting better quality products in shorter lead times. The other advantages will be;
- Having a trustworthy partner having more than 120+ years of textile business experience.
- Various certifications like OEKOTEX, GRS, GOTS, BCI and Many others.
- Availability of all spinning technologies ie. Ring, Ring Compact, Open End & Vortek Airjet Yarn, slub & Core spun yarn both single and two ply (TFO).
- Possibility of extending relationship from Farm to Fashion ie from Cotton fibre to Garmenting.
- High reliability in terms of product quality and delivery.

Q.: How do you focus on sustainability and are there any recent initiatives taken towards sustainable manufacturing?
Sustainability, I believe is the Key Differentiator now as every buyer prefers to deal with companies having good sustainability factors. Our sustainability journey starts from using Sustainable fibres for our Yarn and Fabric productions like Organic Cotton/GOTS, BCI Cotton, Ecovero Viscose / Liva ECO, FSC Viscose, Recycled Polyester (GRS), Tencel /Lyocell, Bamboo, Dyed Yarns (Black/Melange).

Other Sustainable Practises Followed At Gimatex:
- Using own waste pre consumer waste for recycling.
- New energy efficient centrifugal compressor to replace exiting
- Rain water is harvested to the tune of 50,000 M. Cube per annum.

- Solar Power generation 2 MW capacity equivalents of 1246KWH.
- Use of recyclable packing materials.
- Use of non-harmful chemicals as per guidelines of "OEKO-TEX" Class-1 Appendix 6 complied.
- Continuous training & Skill Development programs for all workmen specially women.
- Focus on Power & Water conservation all year around.
- Continuous plantation & cleaning campaign with a motto of Green & Clean Gimatex. (Above 5000 Trees).
- CSR for better infrastructure, education, health and women empowerment.
- In-house use of electric vehicle for material transportation and man power movement.

Benefits to Customer:
- Traceability & transaction certificate as per product need.
- Cost Effective, genuine & diverse product range.
- Possibility of branding with various brands & suppliers promoting sustainability.
- Remunerative product mix for International & domestic markets.
- Contribution toward betterment of society & nature.

Q.: How the company is adopting Automation and Industry 4.0 in the manufacturing process?
Today technology has improved tremendously with huge digitalization on its way. All the new facilities that are getting set up come with Machines with state-of-the-art technology in terms of how these machines deliver their key information to computers or hand held devices. Even existing facility have been integrated with our ERP system to directly compile information. All information are recorded at source itself which improves the quality of data significantly. Many apps have been developed for in house use where all this information is presented for better decision making.

Q.: Finally, what are your future growth plans and vision for 2025? What do you want your company to be in 2025 and beyond?
Our company plans to grow both vertically & horizontally. Capacities will mostly by doubled by 2025 in our existing facilities and add B to C segment by launching our own brand in garments. Also we plant to enter the knit segment as well. We want to enter the digital space with D2C (Direct to Consumer) connect, creating our own Garment brand, which will stand out as innovative, and provide next level comfort to all users. With our presence across the value chain, we can use direct consumer feedback to provide better quality products to the consumer.

Dear Mr. Prashant Ji, we are very much thankful to you for sparing your valuable time with us and shared a lot which shall be aspiration to the young entrepreneurs.
TAI Central Unit

TAI conducted Office Bearers Meeting and G. C. Meeting

The Textile Association (India) – Central conducted their Office Bearers Meeting before the start of IInd Governing Council Meeting on 09th April, 2022 at Hotel Jenneys Residency, Coimbatore.

During the meeting, Mr. R. K. Vij (President), Mr. T. L. Patel (Vice President), Mr. Haresh B. Parekh (Vice Chairman), Mr. Mahendrabhai G. Patel (Hon. Gen. Secretary), Mr. S. Sivakumar (Hon. Jt. Gen. Secretary) and Dr. V. D. Gotmare (Hon. Treasurer) were present.

They discussed on various points, particularly on future activities to be organized, source of generating the financial growth.

Also discussed on the views briefly on the agenda points of G. C. Meeting to put before the G. C. Members.

After the Office Bearers Meeting, IInd Governing Council Meeting started with physically. About 21 G. C. members were present.

All the points as per agenda were discussed in depth and taken appropriate decisions on it.

This G. C. Meeting was hosted by the Textile Association (India) - South India Unit at Coimbatore. They have made excellent arrangement for the meeting and wonderful hospitality extended to all the members by South India. Thanks to all the Office Bearers and Managing Committee Members of TAI – South India Unit for hosting this Governing Council Meeting at Coimbatore followed by Dinner.
TAI Ahmedabad Unit

Launching of Souvenir on the Occasion of 75th Years of TAI Ahmedabad Unit

The Textile Association (India) - Ahmedabad Unit entered into 75th year of its inception. The journey so far had been greatly successful with many feathers getting added in to the cap in terms of meaningful conferences, academic activities, interaction with industry and many awards. This would not have been possible without strong support and cooperation of textile technocrats.

Since last two years TAI-Ahmedabad Unit has been campaign to update complete data from its members. Also it has been circulated and announced during the activities of Ahmedabad Unit to its member those will update their membership details & become new member of TAI through Ahmedabad Unit within 31st March 2022 all of them will be given a Silver Coin as memorable one on the occasion of 75th year, TAI-Ahmedabad Unit.

Before starting the distribution such precious gift to the member of Ahmedabad Unit a launch of distribution of Souvenir program arranged by the Textile Association (India) - Ahmedabad Unit on 15th January 2022 at Dinesh Hall, Ashram Road, Ahmedabad.
Mumbai Unit

“TECHNICAL TEXTILES - NEED OF TODAY AND TOMORROW”

The Textile Association (India), Mumbai Unit organized One Day Seminar on “Technical Textiles – Need of Today and Tomorrow” on 26th March, 2022 at Vapi (Gujarat). The seminar was inaugurated by the Chief Guest Mr. G. V. Aras, Consultant & Strategic Business Advisor and Former Director, A.T.E. Enterprises Pvt. Ltd.

Inaugural Session

Mr. Haresh B. Parekh, Convenor of the Seminar while giving the highlights said that this seminar is organised to discuss the Opportunities for the Technical Textile industry in the challenging scenario. This exclusive seminar is to discuss the need of technical textiles for today and tomorrow. The deliberations in this seminar will show the future trend to do more towards new arenas of research, innovation, market development and investments in technical textile business.

Mr. V. C. Gupte, Chairman, TAI, Mumbai Unit in his welcome address welcomed the Chief Guest, Key Note Speaker and Guests of Honour. He also welcomed the Awardees of The Lifetime Achievement Award & The Industrial Excellence Award, Speakers, Press, Media and delegates.

Mr. V. C. Gupte, Chairman, TAI, Mumbai Unit in his welcome address welcomed the Chief Guest, Key Note Speaker and Guests of Honour. He also welcomed the Awardees of The Lifetime Achievement Award & The Industrial Excellence Award, Speakers, Press, Media and delegates.

Dr. Anup Rakshit, Executive Director, Indian Technical textile association (ITTA) in his Key Note Address said that ITTA is playing very crucial role in developing technical textile activity across the nation and guiding organization in the field in all respects. He highlighted various sectors of technical textiles and government initiatives toward establishing technical textile business in the country.

Mr. Amit Agrawal, Chairman, Indian Technical Textile Association (ITTA) in his address as a Guest of Honour discussed about ITTA’s vision toward technical textile business in India. He also mentioned about the policy initiatives on Technical Textiles introduced by Ministry of Textiles, Government of India.

The Textile Association (India), Mumbai Unit felicitated Mr. Pramod Khosla, Chairman & Managing Director, Khosla Profile Pvt. Ltd with “The Lifetime Achievement Award” and Mr. Narendra Dalmia, Director & CEO, Strata Geosystems (India) Pvt. Ltd with “The Industry Excellence Award” for their outstanding contribution in the field of technical textiles.
Mr. Pramod Khosla, Chairman & Managing Director, Khosla Profil Pvt. Ltd. receiving The Lifetime Achievement Award by the hands of Chief Guest

Mr. Narendra Dalmia, Director & CEO, Strata Geosystems (India) Pvt. Ltd. receiving The Industrial Excellence Award by the hands of Chief Guest

Release of Book of Papers:
(L to R): Mr. A. V. Mantri, Mr. Haresh B. Parekh, Mr. V. C. Gupta, Mr. R. K. Vij, Mr. G. V. Aras, Mr. Amit Agarwal, Mr. Vikas Sharan, Dr. Anup Rakshit

Mr. G. V. Aras, Consultant & Strategic Business Advisor and Former Director, A.T.E. Enterprises Pvt. Ltd. while giving his inaugural address said that there are lot of opportunities in Technical Textiles industry but we are not able to grab them to prove ourselves in the international market. We don't have the capacity for bulk manufacturing which can fulfil the requirements of big buyers. He also focussed that it is need of the hour to get skilled manpower in this area. He suggested that textile educational institute should make technical textiles as a compulsory subject in their curriculum. He also emphasized that due to Covid problems in China the production capacity has been considerably reduced and hence Indian textile industry has tremendous opportunity to increase the productivity and grab the international market. He also praised the Indian textile industry for increase in the manufacturing of mask and medical kits business during this pandemic period.

Mr. A. V. Mantri, Hon. Secretary, TAI, Mumbai Unit, proposed the Vote of Thanks.

Mr. A. V. Mantri, Hon. Secretary, TAI, Mumbai Unit, proposed the Vote of Thanks.

Panel Discussion Session I: Mr. Narendra Dalmia, Director & CEO, Strata Geosystems (India) Pvt. Ltd., Dr. Mohit Raina, Managing Director, Raina Industries Pvt. Ltd., Dr. Chandan Chatterjee, Executive Director, ADS Foundation, Mr. R. K. Vij, Advisor-Polyester, Indorama Synthetics (India) Ltd., Mr. Yogesh Kumar Garg, Managing Director, Dilo India Pvt. Ltd

Technical Session

Theme Address
Mr. Pramod Khosla, Chairman & Managing Director, Khosla Profile Pvt. Ltd. delivered theme address on ‘Importance of Technical Textile in Indian Textile Industry'. In his address he discussed about the various sectors in the technical textiles and emphasized on the newly introduced composites. He also gave the guidelines for Textile Technicians for manufacturing Technical Textile.

SESSION – I

Panel Discussion
A Panel Discussion on the topic 'Emerging Opportunities in Technical Textiles' was featured an important event of the seminar. The discussion moderated by Dr. Chandan Chattarjee, Executive Director, ADS Foundation and the panel was comprised of senior leaders from the textile
industry. The panel members came up with some radical thoughts which could be helpful for the growth of Technical Textile industry.

Mr. Narendra Dalmia, Director & CEO, Strata Geosystems (India) Pvt. Ltd. talked about geosynthetic material development and shared examples of its application. He mentioned how technology can resolve national problem in this road construction area. According to him there is huge opportunities in technical textile business.

Dr. Mohit Raina, Managing Director, Raina Industries Pvt. Ltd. highlighted about role of FRP in civil engineering applications and how a corrosion issue can be solved using textile materials. He elaborated good examples on sustainable solution to solve various problems.

Mr. R. K. Viz, Advisor-Polyester, Indorama Synthetics Pvt. Ltd. focussed his discussion on the role of manmade fibre in development of technical textiles. He stressed on PIL scheme of GOI and its benefits.

Mr. Yogesh Kumar Garg, Managing Director, Dilo India Pvt. Ltd. took up a point on weaving machines for technical textile manufacturing. He also highlighted about role of Jute, banana, pineapple natural fibre role in technical textile development.

SESSION – II

During the Technical Session, following papers were presented by the eminent speakers.

- Mr. Paresh Shah, Vice President, Rabatex Industries Pvt. Ltd. presented the paper on “Rabatex : Warp preparation solutions for technical textiles”
- Mr. Anurag Tandon, India Sales Manager, Avgol Nonwovens India Pvt. Ltd. presented the paper on “Polyester Market Growth”.
- Mr. Anjani K. Prasad, Managing Director, India Cluster, Archroma India Pvt. Ltd. made presentation on “Sustainable Technical Textile-Chemical View”.
- Mr. Sudipto Mandal, Assistant Manager-Sales & Marketing, Oerlikon textiles India Pvt. Ltd. presented paper on “Innovative manmade Fibres Solutions & Technology for textile and technical Textile application, Supporting sustainable textile value chain”.

SESSION – III

Panel Discussion

The Panel Discussion was on the topic 'Technological Advancements in Technical Textiles' which was featured as last session of the seminar. The discussion moderated by Dr. Arup Rakshit Executive Director, Indian Technical Textile Association (ITTA). The panel was comprised of experts from the field of the technical textile industry. They came up with new ideas which could be helpful to the technical Textiles industry.

Mr. Prashant M. Mangukia, Director, Yamuna Machine Works Pvt. Ltd. spoke upon manufacturing of finishing machines and their innovative features. He highlighted working of finishing machines at various technical textile manufacturing units involved in technical textile development.

Mr. Sanjay Sathe, Sr. Vice President & Head Product Management, Archroma India Pvt. Ltd. stressed upon the sustainable innovative solution to effluent problem faced by Technical Textile industry. He also spoke on safety and efficiency issue faced by industry and solution on using various novel products from Archroma.

Mr. Narendra Kajale, Vice President, Technology & Innovations, Texport Syndicate (Ind) Ltd. took up the point of textile industry dependency on fossil fuel. He also spoke on climate change, protection from heat using technical textile materials, energy storage issue and human safety aspects. He also elaborated performance simulation model of garment as smart technical textiles.
The Textile Association (India), Mumbai Unit organized An Interactive Session with Fashion, Textiles and Apparel Schools Students on “Fashion Styling, Sustainable Textile Materials and Innovations” on 26th February, 2022 in the Conference Room of TAI, Mumbai Unit Office.

The eminent speakers were Dr. V. D. Gotmare, Ph.D. (Tech.), Hon. F.T.A. Former Head, Textile Manufactures Department, Veermata Jijabai Technological Institute (VJTI) and MS. Shwetta Upadhyay, CC in Fashion Image & Styling, Institute Marangoni (Milan, Italy), Master in Retail Mgmt, CFD (IITC), FDT(JD-IFT).

Mr. Birendranath Bandhopadhyay, President, Kusumgar Corporates Pvt. Ltd. talk about new product development in technical textiles safety jackets to be used in Indian defence force. He shared valuable information on technical textile viz. shape memory textiles, Sports textiles, parachute fabric and technical textiles based on recycled materials.

The panel discussions were followed up with very good questions from the participants, which were answered by the panel members.

The seminar was a grand success and was attended by more than 225 delegates.

The lecture was attended by students from NIFT, Amity University, SNDT, Fashion School of Patkar Varde College, SASMIRA, Nirmala Niketan, etc. along with some of the faculty members. The response to the lecture was very enthusiastic. This activity was exclusively for the students.

The lecture was attended by 35 students pursuing their career in fashion designing.
The Textile Association (India) – Mumbai Unit in Association with TAI Central organized a virtually webinar on “Technical Textiles – Opportunities & Challenges” on 23-04-2022. Dr. D. S. Nadiger, Chairman PAC – TAI & Vice Chairman, TAI Mumbai Unit was the Moderator of the webinar. Dr. Chandan Chatterjee, Executive Director, ADS Foundation & Dr. Anup Rekshit, Executive Director, Indian Technical Textile Associations (ITTA) were the eminent expert speakers.

Shri. Rajiv Ranjan, President, TAI, Mumbai Unit delivered the welcome address and set the ball rolling to focus on the theme. Shri. R. K. Vij, President, TAI, Central Office addressed the webinar and deliberated on the importance of the topic of the webinar in the context of the development of the Technical Textiles Sector in India.

Dr. G. S. Nadiger informed that the Technical Textiles is historically termed as industrial textiles to differentiate with apparel and clothing application. In the context of global demand and high value addition as compared to the classical use of textiles of these technical textiles, several proactive measures have been taken by Govt. of India and Industry. Over last two decades, illustrating the production and supply of personal protective equipment during Covid 19 pandemic as an example of facing challenges by India.

Dr. Anup Rakshit, made a detailed presentation about various categories of technical textiles and their developments globally and in India. Several initiatives taken by the Indian Govt. and a proactive response of Indian Industry were presented. He briefed on the various development of systems for harmonic classification of technical textiles. In addition, he stressed on the PIL scheme of GOI which address the competitiveness with the level playing field globally with right kind of economy of scale of operation. A brought out a very positive note of the growth of technical textiles in India and also listed the challenges for future growth on Technical Textiles including R&D, market development and export promotion were highlighted.

Dr. Chandan Chatterjee described the development of the sector in MSME sector with a focus on niche application in different clusters. In spite of the limitations on the economy of scale of operation, some of the technical textile enterprises have shown exemplary performance in meeting the niche application in various industry applications.

Webinar was well organized and was very good on the Technical Textiles. Presentations were very much informative and knowledgably. It was very depth presentation by all the 3 eminent speakers by keeping things in simple, moderated inputs and very much useful points.

At the end, question answers session was witnessed by lively questions and answers. Dr. Nadiger and Dr. Rakshit responded to the queries raised by the students. Overall, Seminar was useful for the industry and the young aspiring technocrats. It was a very hard work initiative and follow up taken by Mr. Haresh B. Parekh and entire team of TAI Mumbai Unit. About 175 participants attended.

**Appeal to TAI Members**

You are requested to update your contact details to enable us to update the mailing details

You can fill up the form online

https://textileassociationindia.org/membership/online-form/
ITMA 2023 Space Application response exceeded expectations over 93 per cent of space booked by application deadline.

ITMA 2023, the 19th showcase of the world’s largest textile and garment technology exhibition is on track to occupy 12 halls of the Fiera Milano Rho exhibition complex.

The exhibition has drawn enthusiastic response from leading textile and garment technology manufacturers, according to CEMATEX (European Committee of Textile Machinery Manufacturers), the show owner of ITMA.

More than 93 per cent of the exhibition space has been sold by the application deadline of 15 March 2022. A total of 1,364 applicants from 42 countries have booked over 111,000 square metres of net exhibition space.

Mr. Ernesto Maurer, President of CEMATEX, said: “The response to ITMA 2023 has exceeded our expectations despite the economic and geopolitical uncertainties confronting the global business community. We appreciate the strong endorsement from the industry. The space booking status shows the industry's confidence in ITMA as the best global launch pad of the latest technologies and innovations.”

Mr. Charles Beauduin, Chairman of ITMA Services, the organiser of ITMA 2023, added: “After weathering over two years of the pandemic, the global business community is eager to get down to real business. Businesses are looking at long-term investments in key technologies to remain competitive. As the world’s most established showcase of its kind, ITMA is the quintessential platform for the industry to buy and sell, and to collaborate face-to-face.”

Mr. Dinesh Boloor, Chief Sales Officer, Lohia Corp Limited agreed: “We are eagerly looking forward to ITMA 2023 as it is an ideal global platform for us to showcase our complete range of end-to-end solutions for the production of polypropylene multifilament yarns for various technical applications. During the pandemic, it has been difficult for us to leverage any major exhibitions for face-to-face interactions with our existing and potential customers, and ITMA 2023 offers that leverage.”

Many companies have taken advantage of the quiet business environment during the last two years to research and develop more innovative solutions. Hence, they are all set to use ITMA 2023 to unveil their technologies.

Mr. Beauduin advised, “We would like to urge those who have not applied for space to do so soonest to get into their preferred sectors as space is filling up rapidly.”

Top countries and sectors
CEMATEX applicants have booked over 65 per cent of the space. The three countries with the highest number of applicants are Italy, Germany and Spain. From the rest of the world, the top countries are China, Turkey and India. The top sectors based on applicant numbers are finishing, spinning, weaving, printing, knitting, winding and nonwovens.

With sustainability and circularity high on the agenda for many textile and garment makers, the recycling sector has attracted keen interest. Applying to exhibit at ITMA for the first time is Recover Textile Systems.

Recover’s CEO, Alfredo Ferre said: “Our recycled cotton fibres help reduce the environmental impact of cotton garments and is an essential strategy to achieve the climate targets set for 2030. We have participated in several forward-thinking industry initiatives that help attain our vision of ‘circular fashion for all’.

“We are exhibiting at ITMA 2023 for the first time and sees ITMA as an ideal platform for us to showcase our products, and to meet and collaborate with all the stakeholders in the sustainability and circularity space.”

Supporting organizations
Industry collaboration is also pivotal to the success of the global textile and garment industry, and the organiser has reached out to various trade and professional associations. ITMA 2023 has already garnered the support of over 80 industry organisations.

They include global and regional organisations such as Asia Dyestuff Industry Federation, Better Cotton Initiative, European Apparel and Textile Confederation, European Specialist Printing Manufacturers Association, International Apparel Federation, International Textile Manufacturers Federation and Sustainable Apparel Coalition.

ITMA 2023 will be held at Fiera Milano Rho, Milan, from 8 to 14 June 2023. The exhibit profile has been expanded to include a dedicated chapter on textile reinforcement structures for composites. More information can be found on www.itma.com.

For participation enquiries, please email: application@itma.com.

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“Challenges and Opportunities in Medical and Apparel Textiles”

Shri Vaishnav Institute of Textile Technology (SVITT) under the aggies of Shri Vaishnav Vidhyapeeth Vishwavidyalaya (SVVV), Indore organized a two day National Textile Conference “TEXCON-2022” on 22nd & 23rd February-2022. It was supported by Man-Made Textiles Research Association (MANTRA), Surat (Gujarat).

The inaugural ceremony commenced virtually with the virtual lightning of the lamp in the presence of dignitaries–Chief Guest, Mrs. Roop Rashi, IA&AS, Textile Commissioner, MOT, Govt. of India,

Dr. V. R. Sampath, Director, SVITT introduced and gave the overview about TEXCON-2022 to the gathering and highlighted the emerging importance of technical textiles. He focused on the latest technological advancements and innovations in medical textiles and the entire value chain through multi-disciplinary approaches. Dr. Upinder Dhar, Hon’ble Vice Chancellor, SVVV highlighted the glorious history of textile revolution from Harappa-Mahenjodaro era to today's smart textile era. He briefed about the journey of textile from old un-mechanized process to mechanized process to present modern and smart textiles. Dr. P. P. Raichurkar, Director MANTRA highlighted the different textile clusters developed in different parts of India. He has also highlighted about the advancement of medical textile over the time. Souvenir of TEXCON- 2022 was released by all the present dignitaries. Shri Purushottamdas Pasari, Patron and Hon’ble Chancellor, SVVV highlighted that the Indian textile business always plays an important role in growth of Indian economy. He talked about the journey and contribution of Shri Vaishnav Trust in the area of education, medical and other philanthropic services since last 137 years.

Chief Guest, Mrs. Roop Rashi in her inaugural address emphasized on the importance of Indian textile sector in global market. She described statistically about the increase in consumption of cotton and MMF since 1985. She has also emphasized on quality of the product. Finally, Shri Kamalanarayan Bhuradiya proposed the words of thanks.

First session was opened with graciously words of session chair Dr. P. P. Raichurkar, Director, MANTRA, Surat. Dr. Bhuvanesh Gupta, Professor, Department of Textile &Fibre Engineering, Indian Institute of Technology, New Delhi, India, delivered keynote speech on “Fascinating world of biomedical textiles and human healthcare”. Second session was begun with the opening remark of the session chair Dr. Anand Rajawat, Director, SVIIT, SVVV, Indore. Dr. Monalisa Mukherjee, Professor and Director, Former HOD, Amity Institute of Click Chemistry Research and Studies (AICCRS) Professor, Amity Institute of Biotechnology (AIB) India, gave a lecture on Emergence of Heptazine-Based Graphitic Carbon Nitride within Hydrogel Nanocomposites for Scarless Healing of Burn Wounds.

Dr. Prakash Vasudevan, Director, The South India Textile Research Association (SITRA), Coimbatore, India. His talk was on Research on Medical Textiles- A Global Perspective.Session co-chair.

Thereafter three concurrent technical sessions were conducted, in that 25 technical papers were presented under research and review category. These papers were in the area specialty fabric, smart textile, functional textile, specialty yarns and green technology.

Third session was enthusiastically opened by the session chair Prof. Uttam Sharma, SVITS, SVVV, Indore. Dr. Deepti Gupta, Professor and Associate Dean, Department of Textile &Fibre Engineering, Indian Institute of Technology, New Delhi, India, delivered a keynote lecture on Nanotechnology based finishing of Textiles. Dr. P. P. Raichurkar, Director, MANTRA, Surat, Gujarat, India delivered a lecture on Medical textiles: artificial body parts. Third plenary lecture was on Covid-19 and Surat Textile Industry. It was delivered byMr. R. S. Bachkaniwala and President, MANTRA, Surat, Gujarat.

Fourth plenary session chaired by Dr. K.N. Guruprasad, Director, SVIS, SVVV, Indore. Mr. Rahul Bansal, Head, Business Development, Birla Cellulose, India, reviewed different improvement strategy of the sustainability of products in a cost-effective way. Dr. Surajit Kumar Basu, Former Director, MANTRA, Surat, Gujarat, discussed on effect of properties of input material and process parameters on properties of nonwoven by spunlace technology. Dr. Sadhan Ch. Ray, Ex-Professor and Former HOD, Department of Jute and Fibre Technology, University of
Calcutta, informed about advances in knitting science and showcased how they opened up new horizons in apparel and technical textiles. Mr. Sudarsan Rajgopalan, Managing Director, Medicare, India, depicted opportunities into manufacturing of Technical Textiles (Medical Textile).

Mr. Sushanta Naik, Assistant Professor, SVITT, SVVV, Indore conducted a workshop on “Textile Design using MS Paint”. 50 participants of various educational (Diploma to Research scholars) from all over India participated in the workshop with different.

The Chief Guest of the Valedictory Ceremony was Mr. Umasankar Sinha Mahapatra, Senior Vice President & Group Head, Innovation & Sustainability (ECG), Business Head, Health & Hygiene, Welspun India Limited. In Valedictory ceremony, Dr. Namit Gupta, Chairman, TEXCON – 2022 presented conference report.Dr. V. R. Sampath, Director, SVITT, SVVV, Indore announced the best research paper and best review paper awardee names. Dr. Shyamal Maity, MANTRA, Surat, received best research paper certificate (virtual) for his presentation on “Electro-Conductive Fabric Prepared by Chemical Polymerization and Electrochemical Polymerization of Pyrrole on to Textile”. Chikoti Vakya Priya and Sahithi Natva, NIFT Hyderabad received best paper certificate (virtual) in review category for their presentation on “Nanotechnology Application in Antimicrobial Textiles and Its Significance in Post-Pandemic Scenario”. The brochure of TEXCON 2023 was released. Chief Guest, Mr. Umasankar Sinha Mahapatra narrated the journey of India from zero to 2nd largest suppliers of PPE kit by mere 2 year spans. He praised the organizers for choosing very relevant topic in pandemic atmosphere. He pointed out the scope of Medical Textile in global and national level in current in pandemic situation and further. Dr. Shamayita Patra, Organizing Secretary, TEXCON–2022 proposed the words of thanks.

The Journal of Textile Association and Textile Value Chain were the media partners. In TEXCON 2022, faculties, scientists, research scholars and students were participated from various institutes of the country. The delegates from Industries, Textile Mill Association (M.P.) & Textile Association (India) were also presented in both days of conference.

**Automatic fabric inspection leads the way to the future**

Today’s textile markets are highly competitive, throughout the entire value chain from fiber to fabric. Customers expect unique products, at the right quality and free from unacceptable defects, every time. Fabric producers need to manufacture economically, with best-possible use of resources. The major challenges require comprehensive management strategies – and definitely automated fabric inspection.

In the classic fabric production process, manual inspection and lab testing are time consuming operations which need to be optimized with automated solutions. Adding automation to the process will reduce production costs and satisfy customers by delivering 100% inspected fabrics. The advantages of data generated at automated fabric inspection bring the added benefit of helping customers to prepare for the future. The Uster EVS Fabriq Vision is an excellent example for proof.

**The fabric quality assurance system**

Fabric producers need to guarantee reliable quality. This requires a consistently high rate of defect detection. Uster EVS Fabriq Vision ensures this is achieved by using automated control during intermediate and final inspection, removing the need for costly manual inspection. The system’s ability to capture any visible defects allows fabric yield to be optimized and prevents claims.

Real-time process monitoring detects, records and locates all defects in every roll of fabric. Fabriq Vision is able to capture any visible defect, at line running speeds. It can be used in a variety of positions on most manufacturers' machines. Inspection is objective, accurate and consistent. The automatically generated defect map serves as the basis of improved fabric quality which leads to maximum fabric yield for various applications.

The key to consistent quality is the optimized grading efficiency. Uster EVS Fabriq Vision provides real-time alerts for operators, showing all defects and automatically creating roll inspection charts. All detected faults are collected in an album for review. Here the operator can quickly mark faults and select those which can be deleted. Users can set their own quality standards for different types of fabric and increase the efficiency of the grading process.

**Data is the key to a bright future**

Multiple spectrosopes inspect the material and unique algorithms identify all defects automatically, recording them in a dataset for each produced roll. The Album Software ensures optimum inspection efficiency and throughput.
Classification using artificial intelligence will become available for more applications to speed up the reviewing process. Uster Fabric Inspection solutions bring the added benefit of helping customers to prepare for a digital future.

Uster Fabriq Expert is the real-time quality analysis system providing fully-customizable quality analysis tools. Information on process and product quality, based on data from each fabric roll inspected with the Fabriq Vision or another Uster fabric inspection system are well displayed on the PC screen. Uster Fabriq Expert helps managers and operators to optimize product and process quality, without the need for an additional quality reporting routine.

Thanks to Fabriq Expert process-related quality problems can be eliminated by immediate reactions and suitable corrective measures. Fabriq Expert provides real-time quality statistics, which can be used to identify root causes and main problem areas. Customizable quality analysis tools such as pareto charts, histograms and pie charts make it very easy to recognize problem 'hot spots' and take the right corrective actions.

Yield – what finally counts
After final inspection, fabric will often be cut into smaller rolls, which will then be delivered to various customers. Optimized cut control (OCC system) provides a tool for automated cut optimization, as well as additional components which can be installed on any existing debatching or cutting line.

Upgraded process efficiency comes with clever software. The cut optimization software automatically identifies the correct cutting position to achieve maximum fabric yield according to quality requirements. Invisible synchronization marks are also automatically applied and indicate the position of defects and cut positions in a roll, so these are always under control, allowing the cutting table to run at maximum possible speed for maximized fabric yield.

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One stone can sometimes make a massive impact. On April 5, Trützschler celebrated the laying of a foundation stone for its new 164,000-square-meter factory near Ahmedabad in India. It will open up enormous potential to meet our customers’ needs in India and around the world. And the state-of-the-art facility is another big step forward for our growing business.

Since 1977, Trützschler India has operated at its current location in the Narol area of Ahmedabad. It's now time to relocate to a larger and more modern facility that can further strengthen the company's competitive edge and boost its capacity to serve customers. The new factory in Sanand will feature a 67,000-square-meter production area plus a two-floor office building covering 6,000 square meters, including

L To R: Dr. Michael Schürenkrämer, Shareholder of Trützschler Group SE, Dr. Roland Münch, Chairman of the Supervisory Board of Trützschler Group SE, Mr. Anuj Bhagwati, Managing Director of A.T.E., Mr. Joseph Thomson, Managing Director of Trützschler India, Mr. Jayesh Bhatt, Member of the Board of Directors of Trützschler India, Mr. Kashyap Bhavsar, Vice President Finance of Trützschler India, Mr. Ashish Sharma, Vice President Sales, Marketing and Service of Trützschler India
The stone-laying ceremony Pooja
B to T: Dr. Roland Münch, Mr. Anuj Bhagwati,
Dr. Michael Schürenkrämer, Mr. Jayesh Bhatt

landscape gardening architecture. The plans for the site already include possible expansion phases – because Trützschler India is always focused on growth.

The stone-laying ceremony was performed by Dr. Michael Schürenkrämer, Shareholder of Trützschler Group SE, Dr. Roland Münch, Chairman of the Supervisory Board of Trützschler Group SE, Mr. Jayesh Bhatt, Member of the Board of Directors of Trützschler India, and Mr. Anuj Bhagwati, Managing Director of A.T.E. Together, they launched the process of building a modern factory that will boost Trützschler’s capacity to produce spinning preparation machines and card clothings. In addition, the site will also include a new facility for making nonwoven equipment.

Modern manufacturing
Trützschler's new factory is designed to incorporate an impressive range of innovative and sustainable features. It will have a solar rooftop, natural daytime lighting, solar-powered air conditioning and solar-operated street lights, as well as charging points for electric vehicles, heat-reflective tiles, a rainwater collection system and a zero-wastewater discharge approach. It will also use cutting-edge systems to monitor and reduce emissions, and will use automation and Artificial Intelligence to optimize its processes. In this way, the new site is being designed to meet the requirements for ISO 9001:2008 and ISO 50001-2018, while also fulfilling the criteria for the “Gold” rating from the Indian Green Building Council (IGBC).

The new site will carry forward its constant focus on boosting efficiency and productivity – while reducing waste and emissions. This enables the company to maximize the value it creates for customers in India and around the globe, while also minimizing its environmental footprint. The company already operates a lean manufacturing approach and 5S concept, with initiatives such as quality circles, daily reviews and regular cross-functional interactions.

Training from Trützschler
Alongside its manufacturing facilities, this new location will also host a Customer Training Center. Experts from Trützschler will share their knowledge and help customers to stay up-to-date about the latest trends and technologies. An expanded Trützschler Training Academy will also enhance the company's capacity to train young people with employable skills so that they can support their families. This project is fully aligned with the government's “Skill India Mission”.

“Trützschler India is committed to serving the growing domestic and international demand with our cutting-edge products,” said Mr. Joseph Thomson, Managing Director of Trützschler India. “With this new facility, we aim to further strengthen our position in the textile market in India.”

Navyasa by Liva available at Phoenix Palladium Mall
Navyasa by Liva will now be available and Mumbai's Most Premium Destination - Phoenix Palladium Mall

A contemporary saree brand by Aditya Birla Group, this will mark Navyasa by Liva’s 5th store since its launch a month ago.

Navyasa by Liva, a contemporary saree brand from the house of Aditya Birla Group, expands its retail presence with the opening of their fifth store at Phoenix Palladium, Mumbai. Located in South Mumbai, Palladium is inarguably the most premium shopping destination of the city. Endorsed by Deepika Padukone, navyasa by Liva brings a modern and revolutionary take on the saree with their contemporary designs.

To celebrate the launch, fashion influencers Juhi Godambe, Rupali Hasija (Curl Girl), Naina Ahluwalia, and Prerna Chhabra visited the store and experienced the sarees.

Located on Level 2 of the mall, the store is aesthetically designed to suit the fashion sensibilities of the young audience with its artfully decorated and vibrant interior just
like the saree collection itself. The store will be an experience in itself with a magic mirror which is a digital marvel for shoppers. Navyasa by Liva is the first saree brand to use magic mirror, a cutting edge digital technology. It allows you to browse and virtually try on 150+ saree styles.

Navyasa by Liva sarees are fluid, flowy and are made with nature-based fabric Liva. They allow women to move around with spirited optimism and #freetobe in their element as well as explore life comfortably whether at work, party, lunch or a cafe.

The collection features ethereal prints and chic styles. Each saree tells a colour-rich story with a modern twist. The unique bold designs and diverse themes are designed to allow style to converge with fashion. Renowned designers Abir and Nanki, along with the internal design team at Liva have been instrumental in bringing the collection alive.

To cater to their largest clientele, which is the contemporary, urban women, Palladium Mall is the ideal location for the brand’s latest expansion. Home to the most exquisite Indian and global luxury brands; Palladium attracts the city’s finest and most exclusive patrons.

Mr. Rajnikant Sabnavis, Chief Marketing Officer, Grasim Industries (Pulp and Fibre), said, “Navyasa by Liva has received great response from new-age women and is witnessing a consistent rise in demand. The brand is an ode to true contemporary, cosmopolitan Indian women who believe that style is a combination of fashion and comfort. After the success of our four flagship stores, the natural next step was to launch additional stores in relatable spaces which cater to our audience. Phoenix Palladium fits the criteria in every way.”

Navyasa by Liva flagship stores are also operational at Ambience Mall Vasant Kunj, DLF Saket in Delhi, Orion Mall in Bangalore, and Inorbit Mall in Mumbai.

STOLL completes its product range for the volume market with a new CMS model. With three knitting systems, the newcomer called CMS 503 ki is even more productive than its neighbor in the range, the CMS 502 ki, and covers the same range of applications as the latter. A wide range of fully fashion articles can be produced with maximum efficiency. And it does so with low operating effort and high operational reliability. Equipped with STOLL’s proven technology, the CMS 503 ki is as easy to handle as ever and operates with high reliability.

With the new knitelligence® machine generation, the CMS 503 ki is also prepared for the special requirements of the modern digital age.

Process automation, transparency, digitization, faster response times, shorter production cycles, networking, and new business models are just a few aspects that open up completely new opportunities.

The CMS 503 ki is offered in gauges E3,5,2, E7,2 and E14/12. Other gauges can be requested. The working width is 45”.

Series production of the highly economical machine will start on April 1, 2022, and the innovation will make its first public appearance at the ITM from June 14 to 18, 2022, at the Tüyap Exhibition and Congress Center in Istanbul, on the KARL MAYER Group’s stand, number 714 A, in Hall 7. According to Area Sales Manager Lutz Vogel, many Turkish flat knitters have been successfully investing in the various CMS 530 and CMS 502 generations for years in order to successfully expand their businesses. “Now our customers are eagerly awaiting the new CMS 503 ki,” explains the sales professional with an expectant look at the trade show.

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GIMATEX celebrated its 25th anniversary & 125 years of Mohota group

On 25th of March, 2022, Gimatex celebrated its 25th anniversary and 125 years of textile history of the Mohota group. On this momentous occasion, Gimatex inaugurated its new manufacturing facilities, namely the 10 TPD Open End Unit at Wani and the 25 TPD Spinning Unit at Hinganghat Integrated Textile Park.

Furthermore, Gimatex also launched its Premium e-commerce Apparel brand 'Minus One' in the same event. Various Dignitaries from across India and abroad graced the occasion. Mr. Sanjay Jayavarthanavelu, Chairman of Lakshmi Machine Works was the Chief Guest and Mr. Ajay Arora, MD of D'Decor, was the guests of Honor.

Other prominent personalities include Kishanji Poddar (Siyarams), Mr. Hisahiro Koketsu (MD, Toyota), Pankaj Sarda (Jt. MD, Sarda Energy & Minerals), Manish Kumar, Mr. Anil Jain, Mr. Aditya Jain and Mr. Masayuki Yamamoto among many others.

It is pertinent to note that, Gimatex's first manufacturing facility in Wani started operations in 1997 and has entered a period of constant expansions and rapid growth. The new Open End Unit at Wani adds yarn manufacturing capability to manufacture Recycled fibre based fabrics. At Hinganghat Integrated Textile Park, the new spinning facility adds further 32,000 spindles to their existing capacity of 1,68,000 spindles. Combined, these new units also contribute to tremendous employment in the local region to the tune of additional 500 people. The dedication, integrity and passion with which all the family members have served the company has led to the 6th generation of the Mohota family to continue in the same business.

Gimatex has always focused on value addition in the cotton sector. By launching Minus One Gimatex has completed an integration from Cotton Fibers to Fashion segment and added tremendous value to the cotton lifecycle. Moreover, by using only Vidharbha cotton in their products, Gimatex is supporting the local farmers and alleviating the difficulties faced by them in recent times. Previously, Gimatex had installed a scientific cotton seed processing unit to add value to the Cotton chain, and with Minus One they have extended this philosophy further.

On this important occasion, GIMATEX has made a commitment of contributing Rs. 25 per pc sale of Minus One Apparel & Rs. 100 per Quintal sale on GIMA WHITEGOLD Cotton Seed Refined Oil. This contribution will be used for welfare of the Cotton farming community.

Additionally, to mark the celebrations of the milestone year, Gimatex has taken over the maintenance and upkeep of the main squares, fountains and decorative lightings of Hinganghat Town, from Subhash Chowk to Tukdoji Chowk. They also felicitated 18 staff members who have served them for more than 35 years in a short program at their Club House.

Gimatex has always received great support from the local community. Through their development activities, they have always focused on the growth of the local areas and will continue to do so in future. As they mark their special occasion in 2022, Gimatex wishes that you continue to stand with them on their onward journey. Sabka Saath, Sabka Vikaas!

Dr. M. Burji addressed on Business Opportunities in Textiles

Dr. Manjunath Burji, Assistant Professor, DKTE Society’s Textile & Engineering Institute, Textile Department, addressed to the Technocrats, Students & Ministry Officials of Karnataka on the topic “Business Opportunities in Textiles” in the event under the theme “Udyami Aagu Udyoga Needu” conducted at Dr. APJ Abdul Kalam Auditorium, Visvesvaraya Technological University, Belagavi on 08/04/2022.

One day workshop under the above theme was organised to encourage the Entrepreneurship in Karnataka Region and to sanitize aspiring Entrepreneurs on various schemes, incentives, policies and sectorial programs offered by
Government of Karnataka. The program was conducted under the leadership of Hon'ble Dr. Murugesh Nirani, Minister of Large & Mega Industries, Government of Karnataka.

DKTE Entrepreneurial Ecosystem worth of Rs. 50 crores was explored to the participants. Role of Business Incubator in every organization has important significance to convert Students, Technocrats & Engineer into successful Entrepreneurs with providing necessary business and manufacturing infrastructure without investment, i.e. to test the idea of common man into techno commercial product.

Aspirant carrying innovative business is known as startup. Startup policies with benefits from Ministry of Commerce, Govt. of India exposed with importance of national innovative startup policy (NISP). DKTE Centre of Excellence in Nonwovens with focused incubation in coating supported by Ministry of Textiles, Govt. of India is open for product development and to try new business avenues in Technical Textiles with specialized products along with subsidy and funding are encouraged. Activities important to increase economy & export of India were highlighted. According to funds availability business opportunities and models of small, medium and large industries in spinning, weaving, knitting, processing, garmenting, printing & embroidery were delivered. Mega process & printing infrastructure consisting of modern equipments known as Ichalkaranji Powerloom Mega cluster (IPMC) is available for quality weavers to transform their product into finished & export market. Karnataka environmental challenges and strength of cotton growing belt for current generation to convert into premium value was noted by the participants.

His presentation was very much appreciated by the participants which was highly informative, interesting and knowledgeable. More than 400 members participated in the program.
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