



Gheorghe Asachi  
Technical University of Iași



Faculty of Industrial Design  
and Business Management

# BOOK OF ABSTRACTS

The 8th International Symposium

Technical Textiles - Present and Future



Iași, Romania  
23 November 2023



The 8<sup>th</sup> International Symposium Technical Textiles - Present & Future  
23 November 2023

## „Technical Textiles-Present and Future” International Symposium

*online*

**23 November 2023**

# BOOK OF ABSTRACTS





**The 8<sup>th</sup> International Symposium Technical Textiles - Present & Future**  
23 November 2023

Organized by:



[Gheorghe Asachi Technical University of Iasi, Romania](#)



[Faculty of Industrial Design and Business Management](#)

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## **About the TTPF 2023 International Symposium**

Organized by the Faculty of Industrial Design and Business Management of the „Gheorghe Asachi” Technical University from Iași, Romania, on 23 November 2023 in an online format, the International Symposium “Technical Textiles – Present and Future” TTPF 2023 is a scientific event that has become a tradition in the field of textiles since 2009.

Reaching the eight editions now, the TTPF 2023 Symposium has become a scientific forum in the field of technical textiles. It supports interdisciplinary research areas and provides a real opportunity for participants to share the latest findings and discuss perspectives on the sustainability challenges facing our field of interest.

Over the years and from edition to edition, the symposium has brought together leading researchers, textile experts from industry, teachers from academia and professional training to share their achievements and best practices in the field of technical textiles with relevant stakeholders from the national and international scientific field, including undergraduate and postgraduate students as future professionals.

In this context, the eighth edition of the International Symposium „Technical Textiles – Present and Future” TTPF 2023 will be the second edition of the symposium for which the accepted papers will be published as Open Access Proceedings by Sciendo (De Gruyter Poland) and indexed in various databases.

The topics of TTPF 2023 will focus on the latest scientific advances in the field of technical textiles, but also on companies’ needs for innovative solutions to environmental and sustainability issues in the field of technical textiles: Technical Textiles for Agrotech, Buildtech and Geotech Applications; Technical Textiles for Clothtech and Hometech Applications; Technical Textiles for Indutech and Mobiltech Applications; Functional and Smart Textiles for Meditech, Protech and Sportech Applications; Technical Textiles for Oekotech and Packtech Applications; Technical Textiles and Sustainability; Textile Education and Training for the Technical Textiles Field; Management and Entrepreneurship.



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## BRIEF PROGRAM

EET time zone

<b>10:00 -10:30</b>	<b>TTPF 2023 OPENING CEREMONY (<a href="#">1<sup>st</sup> link</a>)</b>
	<b>Rodica HARPA</b> , Symposium Chair, Gheorghe Asachi Technical University of Iasi, ROMANIA
	<b>Carmen-Maria LOGHIN</b> , Vice-Rector Scientific Research, Development and Innovation, Gheorghe Asachi Technical University of Iasi, ROMANIA
	<b>Savin-Dorin IONESI</b> , Dean of the Faculty of Industrial Design and Business Management, Gheorghe Asachi Technical University of Iasi, ROMANIA
	<b>Ilda KAZANI</b> , President of BASTE, Polytechnic University of Tirana, ALBANIA
<b>10:30 - 12:00</b>	<b>PLENARY SESSION I - Keynote Lectures (<a href="#">1<sup>st</sup> link</a>)</b> CHAIR: Mirela BLAGA, Gheorghe Asachi Technical University of Iasi, ROMANIA
10:30 -11:00	<b>Vincent NIERSTRASZ</b> , University of Borås, SWEDEN <b>RESOURCE EFFECTIVE PROCESSES FOR FUNCTIONAL AND SMART TEXTILES</b>
11:00-11:30	<b>Ada FERRI</b> , Politecnico di Torino, ITALY <b>ASSESSMENT OF HEAT AND MOISTURE MANAGEMENT OF SPORTSWEAR THROUGH IN-VIVO TESTING</b>
11:30 -12:00	<b>Radek SOUKUP</b> , University of West Bohemia, CZECH REPUBLIC <b>TEXTILE-BASED TEMPERATURE AND HUMIDITY SENSORS FOR TECHNICAL TEXTILES APPLICATIONS</b>
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<b>12:15 -13:30</b>	<b>PARALLEL SESSIONS</b>
13:30 -14:00	LUNCH
<b>14:00 - 15:00</b>	<b>PLENARY SESSION II - Keynote Lectures (<a href="#">1<sup>st</sup> link</a>)</b> CHAIR: Anne-Marie GRUNDMEIER, University of Education Freiburg, GERMANY
14:00 -14:30	<b>Abhijit MAJUMDAR</b> , Indian Institute of Technology, Delhi, INDIA <b>SOFT BODY ARMOUR: MATERIALS AND TECHNOLOGY</b>
14:30-15:00	<b>Izabela Luiza CIESIELSKA-WROBEL</b> , University of Rhode Island, College of Business, USA <b>FROM SURFACE TO SENSE: MERGING 3D PRINTING TECHNOLOGY WITH TACTILE CLOTHING INSIGHTS FOR THE VISUALLY IMPAIRED</b>
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EET time zone

10:00 -10:30	<b>TTPF 2023 OPENING CEREMONY (<a href="#">1<sup>st</sup> link</a>)</b>		
	<i>Rodica HARPA, Symposium Chair, Gheorghe Asachi Technical University of Iasi, ROMANIA</i>		
	<i>Carmen-Maria LOGHIN, Vice-Rector Scientific Research, Development and Innovation, Gheorghe Asachi Technical University of Iasi, ROMANIA</i>		
	<i>Savin-Dorin IONESI, Dean of the Faculty of Industrial Design and Business Management, Gheorghe Asachi Technical University of Iasi, ROMANIA</i>		
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14:00 - 15:00	<p align="center"><b>PLENARY SESSION II - Keynote Lectures (<a href="#">1<sup>st</sup> link</a>)</b>  <i>Chair: Anne-Marie GRUNDMEIER, University of Education Freiburg, GERMANY</i></p>		
14:00 - 14:30	<p><b>Abhijit MAJUMDAR</b>, <i>Indian Institute of Technology, Delhi, INDIA</i></p> <p><b>SOFT BODY ARMOUR: MATERIALS AND TECHNOLOGY</b></p>		
14:30-15:00	<p><b>Izabela Luiza CIESIELSKA-WROBEL</b>, <i>University of Rhode Island, College of Business, USA</i></p> <p><b>FROM SURFACE TO SENSE: MERGING 3D PRINTING TECHNOLOGY WITH TACTILE CLOTHING INSIGHTS FOR THE VISUALLY IMPAIRED</b></p>		
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	<i>Andreea NISTORAC, Alexandra BODOGA, Eugen Constantin AILENEI, Maria-Carmen LOGHIN</i>	<i>Ciprian - Sorin VLAD, Iulia Ioana MIRCEA, Larisa IVAȘCU, Eugen ROȘCA</i>	
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## **SESSION 1.1.**

**Technical Textiles for Clothtech and Hometech Applications.  
Technical Textiles for Oekotech and Packtech Applications**

**Chair:**

**Andreja RUDOLF, *University of Maribor*, SLOVENIA**



## TOPOLOGY BASED 3D MODELLING OF TEXTILES WITH MACHINE EMBROIDERY STITCHES

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### ***Abstract.***

Beyond decorative purposes, embroidery can be used for many applications, e. g. for smart textiles, for load-adapted fiber-plastic composites and also for healthcare based on free standing lace embroidery. For the engineering design of such products, it is necessary to investigate the geometry at the yarn level. This paper presents an algorithm, corresponding data structures, and their implementation in software for the design of the 3D geometry of the embroidered textiles which is based on the CAD data used for the production process. The textile structure is created with available software tools and converted into an open XML-based format. The geometry of sewing threads is computed based on a topology-based model and imposed in the structures as an additional system. The final embroidered structure can be exported at yarn (mezzo) level in various CAD and FEM formats for computations, which significantly shortens the designing process.

***Keywords:*** embroidery, sewing, stitches, mezzo level, yarn level, modelling, geometry, FEM



## COMPARISON OF TOWELS PRODUCED WITH SUSTAINABLE FIBRES IN TERMS OF WATER ABSORPTION AND FAST DRYING PROPERTIES

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### *Abstract.*

Recent developments have seen an increase in the use of sustainable fibers to replace cotton fibers in terry fabrics, particularly textiles that require exceptional water absorption and fast drying qualities. The properties of towels produced from these fibers are meticulously combined with the properties of towels produced from 100% cotton fiber. In this research, the water absorbency and quick drying properties of towels produced from yarns produced by combining cotton fibers with modal, lyocell and cellulose acetate fibers were investigated and comparisons were made with towels produced from yarns containing only cotton fibers. Various factors such as vertical capillarity, surface water absorbency, drying rate and water vapor evaporation rate were examined and compared with the sample containing 100% cotton fiber in the yarn composition. The findings highlighted that samples containing lyocell and cellulose acetate fibers exhibited superior absorbency and drying properties compared to their 100% cotton fiber counterparts. Therefore, this study underlines the feasibility of replacing cotton fibers with sustainable alternatives such as lyocell, modal and cellulose acetate in the field of terry cloth production. The study seeks to develop terry cloth fabrics possessing superior water absorption and rapid drying characteristics. The main objective of this study is to contribute to the development of terry fabrics with superior water absorption and fast drying properties. Therefore, it emphasises the need to promote the use of sustainable alternatives to replace cotton fibres in order to achieve a balance between sustainability and performance in the textile industry.

**Keywords:** *sustainable fibers, towel, water absorbent, water evaporation, sustainability.*



## LASER TECHNOLOGY IN DENIM: THE CASE OF MAVI PRO EDITION

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### **Abstract**

Denim fabrics, with a history dating back to the 17th century, were initially used in the construction of pants preferred by workers in America. After the 1950s, influenced primarily by Hollywood stars and later by the atmosphere created by World War II, denim became a preferred material for various types of clothing worldwide. Denim garments are considered timeless pieces in the fashion industry, enduring through seasons and finding a place in the wardrobes of individuals with different statuses and lifestyles, characterized by a constant quest for novelty. Yet, the changing demands of fashion and evolving trends each season have shifted the focus in denim garment production towards various finishing and treatment processes, in addition to pattern-making and tailoring features. In the textile industry, almost all stages involve intensive resource consumption and waste generation, with finishing processes being the most pollution-intensive and toxic in nature. Considering the dimensions of the climate crisis and the impact of the industry on climate change, the use of alternative environmentally friendly methods for finishing treatments on denim fabric becomes crucial. An innovative approach to achieving a vintage look in denim, as an alternative to the traditional sanding process, is to utilize laser technology. A Turkish brand, Mavi, has adopted this method in its products, introducing a new approach to sustainable denim. The "Pro Edition Collection," is examined as a case study in this paper. When evaluating the men's collection, consisting of 14 pieces, it is observed that using laser technology to achieve a vintage appearance results in energy and water savings compared to similar collections. This approach also offers new design opportunities. In an era where the search for alternative methods and approaches for sustainable denim production is on the agenda, this research provides valuable insights for both the industry and researchers.

**Keywords:** *sustainable denim, laser technology, sustainable innovation, denim collection.*



## RESEARCH ON THE CREATION OF SPATIAL FORMS USING THE MOLDING TECHNIQUE

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### ***Abstract.***

To obtain the spatial shape, the direction of the textile fibers is changed by moisture-thermal treatment or using the molding technique. The paper presents the process of creating spatial forms using the molding technique. The main purpose is to present how to use various software, machines and equipment used in the process of developing three-dimensional matrices. The stages of creating volumetric shapes in clothing products are also presented. The work presents the results of a theoretical and practical study, carried out within the studies at the Academy of Textiles and Technologies in Barcelona "Fabricademy". The use of CAD/CAM systems and manual techniques in the creation of clothing can bring many benefits such as: creativity and expression, efficiency and productivity, accuracy and consistency, reduction of errors and waste, flexibility and adaptability, improved collaboration, design in detail, easy reproduction, virtual design exploration, integration of technology and innovation. The use of manual techniques and CAD/CAM systems in the creation of clothing represents an integration of technology and innovation in the field of fashion, allowing designers to adapt to new trends and express their ideas in an advanced and effective way. These results can be used to diversify the range of clothing products using CAD/CAM systems.

***Keywords:*** *Wood molds, CAD/CAM systems, complex surface, hard wood.*



## EFFECT OF MELT FLOW RATE ON MORPHOLOGICAL AND CHEMICAL CHARACTERISTICS OF POLYLACTIDE BASED SOLUTION CASTING AND NANOFIBROUS FILMS

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### ***Abstract.***

In this study, morphological and chemical characteristics of PLA based films produced by solution casting and electrospinning were investigated. The polymer solutions were prepared by dissolving PLA at a concentration of 10% (wv-1) in dichloromethane (DCM)/ dimethylsulfoxide (DMSO) at a weight ratio of 75/25% (vv-1). These solvents were chosen as a good solvent and a non-solvent, respectively, for triggering pore formation in the structure. Three different PLA grades, i.e., 4032, 6202 and 6252, were used for determining the effect of melt flow rate (MFR) on the morphological, i.e., pore formation and nanofiber structure, and chemical characteristic of the solution casting and nanofibrous films. Morphological analysis has been performed using Tescan Vega3 scanning electron microscope (SEM). To evaluate the residual solvents in the structure, Fourier transform infrared (FTIR)-ATR Spectrometer was utilized. It was observed that even if all produced solution-casted films had porous structures, the morphological structure was found to be dependent on polymer solution viscosities, which varied according to MFR values of PLA. The polymer solution PLA6252 produced thicker fibers than its counterparts, possibly due to the low molecular weight enabling crystallization during fiber formation. FTIR analysis indicated that some residual solvents remained in the structure of electrospun nanofibrous mats in particular.

***Keywords:*** *Polylactide, solution-casting, electrospinning, melt flow rate, phase separation*



## **SESSION 2.1.**

### **Functional and Smart Textiles for Meditech, Protech and Sportech Applications**

**Chair:**

**Alison GAULT, *Ulster University, Belfast School of Art*, NORTHERN IRELAND**



## EXPERIMENTAL STUDY ON THE INFLUENCE OF AIR GAP ON HEAT TRANSFER THROUGH MULTILAYER TEXTILE CLOTHING

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### ***Abstract***

In recent years, extensive research has been conducted on the thermal protection offered by clothing. The assessment of clothing's thermal protection performance (TPP) involves measuring the energy that passes through fabrics and air gaps trapped between layers of fabric. Several factors influence TPP, including external heat flux, fabric composition, and the thickness of air gaps. Air gaps play a crucial role in thermal protection, as air provides effective thermal insulation with lower thermal conductivity compared to textiles. While much research has focused on emergency scenarios involving flash fire exposures, firefighters more commonly face low-level radiant heat flux during routine or hazardous conditions, which can lead to burn injuries due to prolonged exposure. This study presents experimental results from an investigation into how air gaps in multilayer textile systems influence heat transfer and the TPP of clothing when exposed to thermal radiation in routine conditions. The experiments have demonstrated a significant enhancement in thermal protection performance when there is an air gap between the fabric and the sensor. Similarly, small air gaps trapped between the textile layers are beneficial. These findings underscore the importance of designing and optimizing the distribution of air gaps within the textile layers of thermal protective clothing as a crucial approach to enhancing thermal protection.

***Keywords:*** *protective clothing, thermal protection, temperature, air gap layers.*



## INVESTIGATION OF THE EFFECTS OF POLYMER TYPE AND FIBER ORIENTATION ON BURST STRENGTH OF THE TUBULAR SCAFFOLDS BY MULTILEVEL FULL FACTORIAL DESIGN

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### ***Abstract.***

The replication of the native arterial structure holds significant importance in vascular graft studies. Besides their biological properties, the artificial vessels must possess sufficient mechanical qualities that align with the native blood vessels to withstand hemodynamic forces in the body and support biological functions. Burst strength is an indicator that shows the resistance of vascular grafts against blood pressure. Achieving adequate burst strength requires the precise determination and optimization of factors such as material selection and construction parameters including fiber orientation, wall thickness, multilayered design, and others. The effect of these parameters as interactions between them play an active role in final graft performance. In this study, polycaprolactone (PCL), poly(lactic acid) (PLA), and poly(L-lactide-co-caprolactone) (PLCL) are electrospun into 6-mm diameter tubular scaffolds under two different collector speeds, 200 and 10,000 rpm to obtain randomly distributed and radially oriented fibers and the impact of polymer type and fiber orientation on burst strength of the scaffolds is investigated. Statistical verification of fiber orientation and polymer type impact is carried out using a full factorial experimental design system. The results clearly demonstrate that these parameters, as well as their interactions, exert a statistically significant effect on the burst strength of the tubular scaffolds.

***Keywords:*** *scaffold, electrospinning, burst strength, fiber orientation, full-factorial experimental design*



## FOOTWEAR USED TO IMPROVE THE QUALITY OF LIFE FOR DIABETIC PATIENTS

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### ***Abstract.***

This paper emphasizes the significance of customized footwear for patients with Diabetes Mellitus, especially those at moderate to high risk of foot ulceration. The use of specially designed footwear for these patients can play a crucial role in preventing complications and improving their quality of life. Concepts are also highlighted and confirm the need for research into the development of customized footwear for patients with Diabetes. By scrutinizing the factors that influence the quality of life of these patients and researching the importance of footwear, product design can be formulated to meet the specific requirements of this vulnerable group. The iCAD3D+ technology was employed to support the creation of footwear 3D models for the diabetic foot as this application allows the detailed development of virtual products based on which demonstrations and concept presentations of the models can be made. Additionally, this software grants designers the capability to visualize and refine the product at any stage of the design process, facilitating the creation of a personalized and comfortable end product. The development and application of custom footwear according to this protocol could have a profound impact on patients with Diabetes and peripheral neuropathy. It has the potential to reduce the risk of foot ulcers and subsequent complications, ultimately contributing to an improved quality of life for this patient group and their active engagement in a broad spectrum of activities.

***Keywords:*** *customized footwear, 3D models, diabetes mellitus, peripheral neuropathy.*



## THE IMPACT OF TECHNICAL EMBROIDERY ON THE TEXTILE INDUSTRY: REVIEW AND PERSPECTIVES ON SMART TEXTILES

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### ***Abstract.***

Given the rapid expansion of the technical textiles sector, which stands as the primary locus of innovation and research within the textile and apparel industry, embroidery has emerged in diverse functional applications. This emergence is attributable to its distinctive capacity to fabricate three-dimensional lightweight structures and to apply threads onto the substrate material in a multidirectional fashion. Given the expansive nature of the smart textile's domain, which is inherently linked to technical textiles and wearable technologies, it is pertinent to categorize the principal applications of embroidery as technical domains. Within the realm of medical textiles, embroidery represents a relatively recent technique, yet it has demonstrated notable success in applications such as the development of wound dressings and the creation of pioneering solutions in tissue engineering. This success can be attributed to its unique capacity for fabricating intricate three-dimensional structures using delicate polymer materials. Another advantageous attribute inherent to products crafted through embroidery lies in the preservation of dimensional stability within the manufactured textile structures. Owing to these distinctive characteristics, embroidery finds extensive utilization in various technical applications, encompassing the development of heating grids, shielding mechanisms, conductive interconnections, as well as the creation of intelligent textile sensors and interfaces, among others. Furthermore, the versatility of materials and threads available for prototyping through this technique is noteworthy, including the application of conductive threads, metallic wires, laminated polymers, and carbon fibers, among others. Within the domain of intelligent textiles and smart textiles, especially in the context of healthcare applications, a particularly intricate sub-sector involves the research and development of textile sensors designed for the acquisition of biometric data and the measurement of various physical parameters. It is worth noting that most of these biosensors are realized through the transposition of fundamental principles into the textile structure. This study provides an overview of the broad applications of technical embroidery in the realms of smart textiles. These applications can be categorized into three primary groups: engineering, medicine, and smart textiles. Within the domain of engineering, embroidery plays a pivotal role in two key aspects: enhancing structural integrity and facilitating the creation of lightweight constructions. In medical applications, embroidery emerges as a critical technology, particularly in the development of implants. Nevertheless, this article concentrates its focus on the domain of smart textiles, an emerging field characterized by rapid growth and expansion, albeit relatively nascent in its development.

***Keywords:*** *technical embroidery, technical textiles, smart textiles, embroidered sensors, textile industry.*



## DESIGN OF KNITTED FABRICS FOR ANTI-VIBRATION GLOVE LINERS

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### **Abstract.**

People are exposed to vibrations from a variety of sources during their daily activities or work. The energy absorbed from these sources is radiated in the form of vibrations, some of which can cause occupational diseases that negatively affect worker performance and productivity. Among other protective equipment, various models of anti-vibration gloves have been developed. They consist of one or more layers of textile materials, especially knitted fabrics, combined with various impact-resistant materials such as silicone protrusions, foam, nubs, or rubber cavities filled with compressed air. The most commonly used textile materials consist of cotton yarns for the inner layers, high-performance yarns for the outer layer, and various elastic yarns to improve elasticity in the wrist or backhand area of the glove. Protective products such as anti-vibration gloves must be designed to preserve dexterity and the sense of touch when handling vibrating objects. An important aspect of designing materials to protect against vibration is knowing their natural frequencies. Failure to do so can result in resonance, a dangerous phenomenon that occurs during the use phase when the excitation frequency of an external force overlaps with the natural frequency of the system. This paper presents the characterization of interlock knitted fabrics, which could be used as linings for anti-vibration gloves, based on their measured natural frequencies. The free vibration method was used to measure the natural frequencies of the knits developed for potential vibration isolation applications. Fabrics made of cotton and cotton-bamboo blends with three degrees of stitch density were produced on large-diameter circular knitting machines with gauge 18E. Knitwear made from 100% cotton yarns (Ring and Compact) showed the highest values of natural frequencies. Knits made of 100% bamboo and the bamboo-cotton blends had natural frequency values about 25% lower than those made of 100% cotton. An important parameter is fabric thickness. As the thickness increases, the recorded natural frequencies decrease, which means that thicker materials are recommended for the development of vibration damping products, and the results confirm this conclusion.

**Keywords:** *Vibrations, natural frequencies, knitted liners, anti-vibration gloves.*



## **SESSION 3.1.**

### **Technical Textiles and Sustainability**

**Chair:**

**Manuela Lăcrămioara AVĂDANEI, *Gheorghe Asachi Technical University of Iasi, ROMANIA***



## TEXTILE FIBERS IN 3D PRINTING

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### ***Abstract.***

Rapid prototyping, as the concept of 3D printing was first defined by Dr. Hideo Kodama in 1980, and later in 1986 with Chuck Hull's first patent for stereo lithography, will open the door to an entire industry. Interest in new prototyping methods was realised in the late 1980s with the development and patenting of new techniques such as Carl Deckard's selective laser synthesis (SLS) and Scott Crump's fused deposition modelling. Dr Adrian Bowyer and the open source RepRap project in 2005, as well as the public domain entry of many of the patents filed in the 1980s, have triggered exponential growth in the market and interest in developing new 3D printing machines and materials for use in prototyping. Becoming an accessible technology but also thanks to its standardization, since 2009 3D printing has turned into a real industry. The main advantages that have led to the widespread adoption of the technology are mainly related to the ease with which one can go from idea to product in just a few hours with great design freedom, low labour, energy and raw material costs. Depending on the type of printing, different raw materials are used: traditional petroleum-based polymers, such as polypropylene (PP), polyvinyl chloride (PVC), and polyethylene (PE), polylactic acid (PLA), acrylonitrile butadiene styrene (ABS), nylon, natural polymer and hydrogels. Various additives, plasticisers and fillers have been developed to optimise the print quality in order to improve the crystallisation, flowability, toughness properties and reduce the glass transition period and melting temperature of the polymer matrix used in 3D printing. Textile fibres play an important role in the category of fillers designed to improve both the physical-mechanical properties and the biodegradability of prints. Research on this topic is diverse and addresses different categories of natural and synthetic fibres found in continuous yarns or filaments, fibres and nanofibres used in blends in composites for 3D printing. Through this paper, we want to review the research carried out until now, in which textile fibers are used in 3d printing with the aim of identifying opportunities for further research and new directions.

***Keywords:*** *prototyping, composites, 3D printing filament, thermoplastic.*



## **SUSTAINABLE CONSUMER BEHAVIOUR AND THE FASHION FOOTPRINT OF CHILDREN'S CLOTHING: A ROLE FOR MOTHERS**

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### ***Abstract.***

The concept of sustainability assumes a sustainable society based on corporate sustainability, but also on socially responsible consumers, and overall, the challenges are linked to both responsible production and responsible consumption. Nowadays, in the age of fast fashion, responsible production from the fashion brands' point of view means doing more with less resources and implementing a circular economy. As for responsible consumption through demand reduction, this depends above all on the awareness and responsibility of individual consumers for the environmental impact of their habits and actions. Therefore, a sustainable commitment for both sides should include the following: strategies to minimise environmental impact through quality clothing and eco-label certification to prove it (from the manufacturers' point of view) and buying quality clothing through sustainable purchasing choices to reduce the fashion footprint (from the consumers' point of view). More than ever, consumers are responsible for reducing their own fashion footprint and their awareness of the life cycle of fashion products must be linked to the 5Rs (zero-waste movement). When it comes to children's clothing, the aspects of reducing consumption and/or extending the life cycle of products take on a new meaning for mothers who are faced with the challenge of providing their children with garments that correspond to their physical development during the different stages of growth. This paper presents some results of a survey that targeted mothers with children aged between newborn and 18 years. The aim was to obtain responses on relevant elements outlining the profile of mothers as responsible consumers in terms of fashion footprint: general behaviour when buying children's clothes, ranking of factors influencing the purchase decision (including eco-labels) and finally, actions taken in relation to the 5 Rs.

***Keywords:*** *sustainability, responsible consumers, children's clothes, 5Rs, fashion footprint.*



## EFFECT OF MANUFACTURING TECHNOLOGY ON THE PROPERTIES OF RECYCLED NONWOVENS AND COMPOSITES MADE THEREWITH

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### ***Abstract.***

To reduce the environmental impact, the nonwoven waste can be recycled within the original manufacturing process or sold to other industries to return to the production cycle of other products in a circular economy. In this study, the nonwoven waste consisting of 50% hemp and 50% recycled polypropylene was defibrated and the obtained recycled fibres were converted into new nonwovens using two different technologies. One technology consisted of opening and blending of 100% recycled fibres, aerodynamic web formation, and needle punching. The second technology consisted of opening and blending of 75% recycled fibres and 25% bicomponent fibres, aerodynamic web formation, and thermal bonding. On the first technology, the recycled fibres were obtained using a cutting machine and an opener, while on the second technology a shredder was used for this purpose. The nonwoven fabrics produced with the two technologies were evaluated for their physical and mechanical properties. The study has shown that the thermal bonded nonwoven had higher bulkiness, higher mass and thickness uniformity, and higher tensile strength in comparison with the needle punched nonwoven. Thermoformed composite materials were obtained from each type of nonwoven fabric and characterized in terms of physical and mechanical properties. Composite materials manufactured from thermal-bonded nonwovens showed a higher tensile strength and a lower flexural strength than the composite materials manufactured from needle-punched nonwovens.

***Keywords:*** *recycled nonwovens, needle punching, thermal bonding, composite material, hemp reinforcement.*



## **CARBON FOOTPRINT OF RECYCLED RAW MATERIALS FROM TEXTILE WASTE IN A NEW PRODUCT LIFE CYCLE**

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### ***Abstract.***

The fashion industry promotes a fast consumption pattern of various items of textile, all deliberately designed with a short built-in life. Specifically, in the clothing sector, the so-called fast fashion trend is developing through the regular replacement of garments, whose availability and affordability lead to an increase in the quantities of textile materials used and thus the quantities of pre- and post-consumer textile waste. At this point, the textile waste recycling industry is still in its relatively early stages, its recovery as a raw material for new applications is limited by a distinct gap between current recycling technology and the cost-effectiveness of manufacturing new products on a commercial scale. The purpose of the paper is to present the environmental implications of recycled raw material in a new product life cycle using life cycle assessment evaluation. The paper presents a review of different methodological assumptions used in LCA studies on recycled raw material which can influence the result of the LCA study due to the input data allocation. The most common approach in the literature assumes that recycled raw material is equivalent to virgin raw material, which involves adopting the cut-off scenario allocation in carbon footprint impact. Furthermore, there is also a strong argument against this approach, depending on the type of recycling (up or downcycling), where the environmental impact of recycled raw material should be integrated, positive or negative impact, into the LCA evaluation.

***Keywords:*** *life cycle assessment, textile waste, recycling process, downcycling.*



## EMBRACING 3D PRINTING AND MODELLING FOR A SUSTAINABLE FUTURE IN FASHION

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### ***Abstract.***

Currently, the production process in the fashion industry has become very energy-intensive and wasteful. This time-consuming process has resulted in far too much waste of resources, with a negative environmental impact on future generations. Transforming this production process into a more efficient and sustainable one through digital technology has become an urgent goal of the textile industry. Changing how clothes are made will also contribute significantly to sustainable and digital progress in apparel production. For example, 3D modelling, virtual prototyping and digital sampling are replacing the traditional process of modifying patterns and samples to speed up garment development and reduce production costs. With increasing awareness of the need for sustainability, these technological tools (e.g., 3D modelling environment) have become essential for designers and engineers. The 3D-printed fashion industry continues to develop and grow. This article studies 3D fashion creation and delivery technologies: pattern making, simulation and printing. Techniques and systems for 3D modelling and garment simulation, software for processing and modelling 3D objects, and 3D printing are reviewed and implemented. The results are a 3D avatar with custom garments, which are tested and 3D printed after the design process is complete. The virtual customisation of garments is a sustainable option using new technologies, which also allows for the expression of creative freedom. For example, digital fashion garments and accessories can be easily adapted to meet needs and desires. Creating personalised garment elements can involve a complex mix of several complementary processes and materials: handcraft, embroidery, 3D printing and a different mix of conventional and unconventional materials. Physical properties and material durability are also explored in this article. The literature review methodology presents further demonstration cases to show the adaptability and customisation of the 3D printing approach for the fashion industry. Digitisation also allows for a high range of logistic flexibility. Using digital models expands the possibilities for research, development, design and testing innovative techniques such as the multiple mesh system.

***Keywords:*** 3D technology, digital fashion, 2D/3D design, digital transformation, sustainability.



## **SESSION 1.2.**

**Technical Textiles for Indutech and Mobiltech Applications.**

**Technical Textiles and Sustainability**

**Chair:**

**Benny MALENGIER, *Ghent University*, BELGIUM**



## EXPLORING SUSTAINABLE FIBRES FROM CREATION TO APPLICATION IN THE ULSTER UNIVERSITY BELFAST CAMPUS TEXTILE ROOF GARDEN

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### ***Abstract.***

This paper investigates a recent project that focussed on creating natural fibre composites for a range of applications and products. The project included the use of locally sourced materials including hemp, wool, flax, and wood pulp. Using action research as a methodology it tracks the design, development and creative use of materials and the various fibre combinations for the desired functionality of the products. One of the outcomes was the design and development of the natural fibre composites for use in the build of a textile roof garden based on the 6<sup>th</sup> floor of the newly built Ulster University Belfast Campus, in the heart of the city centre. The project was funded by the Department of Agriculture, Environment and Rural Affairs (DAERA) through the School Pollinator grant and the Physical resources department at Ulster University. The textile roof garden used the mixed materials in the overall design of the external planters and structures in the garden, to showcase the potential for the new materials and future applications. The textile garden was also designed to be used as an educational tool highlighting the intensity and complexity of the systems required in the growing, processing and refining of the bast fibres. The purpose was to also educate students, staff, and the public through the garden design and as an aid to reconnecting with textile materials. It was also to be a tool to review and reflect on the importance of textiles for individual choice and behaviour regarding textiles. To assess the biodegradability of the materials they were combined with the soil to view the rate of the material decomposition. The fibres were also measured for the nutritive qualities for the soil and to consider the possibilities for climate beneficial fibre production.

***Keywords:*** *textiles, fibre, composites, wool, flax, hemp,*



## EFFECT OF VOLTAGE ON PAN-BASED CARBON NANOFIBERS PROPERTIES DURING ELECTROSPINNING

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### **Abstract.**

The aim of the study is to investigate the effect of the electrospinning applied voltage on the carbon nanofiber properties. In this study, polyacrylonitrile (PAN) was selected as a precursor polymer for the carbon nanofiber preparation. A proper homogenous solution was prepared by dissolving PAN in N,N-Dimethylformamide (DMF) and electrospun into nanofibers under different voltage values (10, 15, 20 and 25 kV). These nanofibers were subsequently transformed into carbon nanofibers (CNFs) through stabilization in air and carbonization in nitrogen atmospheres involving high-temperature treatments. The morphology of both PAN nanofibers produced under different voltages and their analog carbon nanofibers were analyzed using scanning electron microscopy (SEM). The thermal properties of PAN nanofibers were investigated through differential scanning calorimetry (DSC) analysis. Structural changes in carbon nanofibers were examined using Raman spectra analysis method. High-temperature processes such as stabilization and carbonization reduced the diameters of the nanofibers. Among the effects of increasing voltage, the carbon nanofibers produced at 20 kV exhibited the lowest nanofiber diameter and also had the lowest Full Width at Half Maximum (FWHM) value in Raman analysis. A relationship was investigated between the DSC analysis results of as-spun PAN nanofibers and the Raman analysis results carbonized nanofibers.

**Keywords:** Carbon nanofibers, electrospinning, stabilization, carbonization, electrospinning parameters



## ONE-PIECE WEAVING OF A DOUBLE-WALLED TUBULAR 3D-FABRIC WITH TWO CONNECTING ELEMENTS

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### ***Abstract.***

3D-woven fabrics are used as reinforcement in composite materials for numerous applications in fields such as industrial, aeronautical, medical or sports. The paper presents the design and manufacturing process of a double-walled tubular 3D-woven fabric. The two coaxial tubes are connected to each other by two diametrically opposed elements, which divide the annular area into two spaces of equal size and help to maintain the distance between the tubes. All the elements are linked, being made by a single weaving operation, in a flattened state of the tubular elements. The design process has as initial data the inner diameters of the two tubes and establishes the steps of calculation algorithm to determine the main parameters of the 3D-multilayer woven structure (width and number of warp yarns for each cross-sectional area of weave design). Different variants of weft yarns insertion order are explored, with the presentation of advantages and disadvantages of each. Woven samples made on an ARM Selectron Patronic shuttle loom equipped with 18 shafts, using polyester and cotton yarns, demonstrated the validity of the proposed design process. Using yarns and densities suitable for certain destination, the proposed 3D structure can be used for industrial filters (for liquid/solid/air filtration), heat-insulating pipes (if the annular space is filled with insulating materials – foam, fibers, etc.), or as reinforcement for composite materials (e.g. double wall piping systems from glass fiber reinforced plastic). Future research will include the weaving of the proposed 3D-structure with glass yarns, making and testing of glass fiber reinforced composite with double-walled structure.

***Keywords:*** *engineered fabrics, 3D-woven structures, double-walled woven tube, technical textiles, tubular reinforcement for textile composites.*



## EFFECT OF ADDITIONAL APPLIED VOLTAGE AND LASER BEAM POWER ON ELECTROSPUN NANOFIBERS

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### **Abstract.**

In this study we propose a novel improvement to the electrospinning process, a low-cost, simple and highly efficient method to produce nanofibers. One advantage of electrospinning is the morphology control of nanofibers. The setup proposed consists of one control ring placed along the jet trajectory and subjected to an additional applied voltage and three laser diodes (808 nm wavelength) positioned symmetrically around the needle of the electrospinning syringe and placed at an angle of 120 degrees from each other. We experimented with 900 mW diodes. A polyethylene oxide PEO (molecular mass of 900kD)-water solution prepared at 4wt% was used in our experiments. A scanning electron microscope was used to evidence the effect of the two devices on the morphology of nanofibers. The analysis of the SEM images revealed that our approach is producing fibers having average diameters below 230 nm and a coefficient of variation (CV) of no more than 21%. Also, the obtained nanofibers were free of beads and presented a regular structure. Our set-up combining control ring and laser diodes led to a decrease in the nanofiber compared to the diameter of the nanofibers obtained through traditional electrospinning. Therefore the reduction in the average nanofiber diameter was of 11%.

**Keywords:** *electrospinnig, nanofibers, additional voltage, laser*



## ELECTROSPUN NANOFIBERS IN THERMOELECTRIC ENERGY HARVESTERS: A REVIEW

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### ***Abstract.***

In the current context of heightened pollution and energy shortages, the pursuit of alternative and environmentally friendly energy sources presents a significant challenge for today's scientific society and community. Moreover, the expansion of portable electronic devices in recent years has greatly increased the demand for flexible and portable power sources, especially for those electronics that require continuous operation (e.g., pacemakers, cochlear implants, activity trackers, etc.). In this regard, thermoelectricity, which involves the direct conversion of temperature gradients into electricity without the need for moving parts or working fluids, is considered an exceptionally attractive solution to address these pressing concerns. Nowadays, the fiber-like form factor has become a new flexible thermoelectric design strategy. Conductive polymers (CPs) offer promising prospects as organic semiconductors for thermoelectric applications due to their adjustable physical and chemical characteristics, mechanical flexibility, lightweight nature, reversible doping, good biocompatibility, and scalability in production. Despite these advantages, CPs have not fully achieved their potential in traditional processing methods. Electrospinning, a straightforward and highly adaptable technique, presents an opportunity for the mass production of continuous ultrafine thermoelectric fibers from a wide range of polymers. Electrospun fibers offer several advantages, including uniformity, porosity, substantial surface area, and mechanical strength. These attributes open up new avenues for the application of CPs and address numerous challenges associated with their use. However, electrospinning CPs, which are soluble and brittle by nature, require a specialized approach. Various strategies have been developed to tackle this issue, including direct electrospinning of CPs into fibers, co-electrospinning of blends containing CPs and other spinnable carrier polymers, and the synthesis of electrospun fiber templates. This article presents a comprehensive review of polymeric nanofiber used in thermoelectric energy harvesters. More emphasis is placed on the fabrication methods, properties, and applications of nanofiber conductive polymers in thermoelectric energy harvesters, providing insights into their potential for efficient and sustainable energy generation.

***Keywords:*** *nanofibers, electrospinning, conductive polymers, thermoelectric materials.*



## **SESSION 2.2.**

### **Textile Education and Training for the Technical Textiles Field**

**Chair:**

**António DINIS MARQUES, *University of Minho*, PORTUGAL**



## HACKTEX VIRTUAL TRAINING MATERIALS FOR SMART TEXTILES

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### ***Abstract.***

Smart textiles represent a domain in full development for the textile industry, with a huge potential of growing in the near future and attractive for young specialists due to better paid jobs. This perspective need for specialists with knowledge and skills tailored to the needs of the sector has to be met by the universities. The existing curricula at B.Sc. and M.Sc. levels of many universities do not cover or cover insufficiently these topics. The Erasmus + project HACKTEX prepared a set of virtual training materials on smart textiles and another one on entrepreneurship focusing on smart textiles that will ensure not only technical knowledge, but also will support the idea of transferring the acquired knowledge toward the market. They are addressed not only to textile students, but also to students in connected domains, related to the production and use of smart textiles. The virtual training materials on smart textiles discuss significant issues related to raw materials, technological processing, testing and standardization in the domain and sustainability. The materials are designed to be user friendly and prepared in video format and as reading materials, helping students and specialists wanting to learn more about the field understanding what is required to develop a functional smart textile product that can answer the needs of the customers. The materials for entrepreneurship are designed to be a map on what to consider when developing your own business with smart textiles, how to choose the best suited business model and what steps are required. A database with information on companies already on the market completes the training materials. A guide connecting all information is also provided.

***Keywords:*** *multidisciplinary engineering, lessons, video format, entrepreneurship.*



## DIGITAL FASHION – A MUST IN OUR DAYS

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### ***Abstract***

Digital fashion answers to three major challenges of the present: digitalization, sustainability and access of people with disabilities. Digitalization is an actual issue, its importance being emphasized during the pandemic crisis. Digitalization in the fashion field will help the designers and will allow the transition to 4.0 fashion industry. In the mean time, by using a digital platform, knowledge data base and a virtual simulation of the product, the need of a physical prototype is eliminated and also allows on-line communications between designers, clients and producers, so that there is no need for face to face meetings, saving the traveling costs and pollution. This is supporting the sustainability issue, an important topic for the fashion industry as it is a well known fact that the textile and clothing industry is one of the great polluters. It is a well-known fact that for people with some kind of disabilities the digital solutions are the key. The digital fashion platform and textile material library developed in the frame of the project Erasmus+, Digital Fashion, 2021-1-RO01-KA220-HED-000031150 will be presented in this paper. In order to fulfill the main objective of the project, four project results were taken into consideration, starting with a survey about the digitalization level in fashion companies and ending with the learning possibilities for the students, designers and employees of the fashion industry.

***Keywords:*** Erasmus project, digitalization, survey, on-line platform.



## ENVIRONMENTAL INITIATIVES THROUGH GENDER-BASED TRAINING

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### ***Abstract.***

In the past few decades, the EU has taken great strides towards gender equality. This is the outcome of laws mandating equal treatment, gender mainstreaming, and the consideration of gender as a factor in creating all other policies and taking special steps to support women. The main goals are to put an end to gender-based violence, fight against gender stereotypes, close the gender pay and pension gap, close the gender care gap, achieve equal participation in all economic sectors, and achieve gender parity in politics and decision-making. In this context, the European project AR4ReClothing - “Stimulating gender-based innovative training methods to promote CLOTHING REcycling through Augmented Reality” — aims to involve textile professionals (manufacturers, designers, stylists, fashion designers, textile industry students, etc.) in promoting the environmental and social benefits of upcycling clothing through innovative training methods that better ensure environmental sustainability. This paper presents the content and principles of the innovative training methods developed by the project consortium, aimed at educating and training people on gender equality and raising awareness of the problems related to environmental protection.

***Keywords:*** *textile handbook; personalised; hands-on platform; mobile application; gender-sensitive training.*



## THE IMPORTANCE OF TEXTILE MATERIALS DATABASE

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### ***Abstract.***

The digitalization process is now very important for all the areas of our life and fashion industry is not an exception. The digitalization process is important for the sustainability issue, very actual issue in fashion field. In the frame of the project Erasmus+, Digital Fashion,2021-1-RO01-KA220-HED-000031150 an online digital fashion platform is developed. In order for this platform to be operational and to solve the needs of students, fashion designers and people from the clothing industry, it is important to have a good database, well-structured and full of data. One of the project results of the project is focusing on building three knowledge libraries, one for textile materials, one for garment models and one for fashion styles. The on-line platform developed in the project is based on these database, the data being provided by all the partners. In this paper will be presented the need, the structure and the use of the textile material database. For the textile and garments models database, there will be presented the information provided by the team from the Faculty of Industrial Design and Business Management from Iași. These results can be used to construct a data base for technical textiles for protective garments.

***Keywords:*** *Erasmus project, library of knowledge, fabrics, raw materials*



## USE OF MICROLEARNING AND MICROCREDENTIALS IN TEXTILE ENGINEERING EDUCATION

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### ***Abstract.***

Learning does not stop at graduation, it continues throughout life. For this reason, one of the continuous learning methods is microlearning. It consists of organizing course content into teaching units that can be easily remembered. Microlearning has many benefits: it improves recall and knowledge retention, it can be highly customizable and adaptable, and it is easily accessible. There are bite-sized individual lessons that contain only one measurable skill-based learning outcome, some form of digital instruction, and at least one quick assessment of the content. Microlearning is a form of competency-based education (CBE). CBE allows individual learners to personalize their learning by choosing only the skills they need to improve to qualify for the careers they want, whereas in traditional education students can focus on those skills that will benefit them in their careers. CBE is also a term that aggregates needs-based and goal-based approaches to teaching and learning, including offering open digital micro-credentials (what many call open badges). While others prefer to use the term micro-credential to represent greater learning content than the open badge. Microcredits are credentials, earned through microlearning. These credits allow learners to demonstrate to current or future employers that they have or have improved the required skills. This is useful in a career. Academic institutions typically create microlearning programs to obtain micro-credentials. The article outlines how a Moodle learning management system (LMS) can be utilized to create content that follows microlearning principles and issue microcredits after completing a course.

***Keywords:*** *microlearning, microcredentials, Moodle, competency, learning.*



## **SESSION 3.2.**

### **Technical Textiles and Sustainability. Management and Entrepreneurship**

**Chair:**

**Larisa IVAȘCU, *Politehnica University Timisoara*, ROMANIA**



## REORIENTING THE ROLE OF TEACHERS AND TEACHING ACTIVITY DURING THE COVID-19 PANDEMIC PERIOD. A CASE STUDY ON AN AGRICULTURAL TECHNOLOGICAL HIGH SCHOOL FROM ROMANIA

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### ***Abstract.***

The Covid-19 pandemic has raised significant challenges for the education community around the world. In Romania, a particular challenge was the urgent switch from onsite to online teaching, without any prior training of teachers in this direction, nor the provision of adequate technical support from the very beginning. Online teaching and learning involve some pedagogical content knowledge, mainly related to designing and organizing better learning experiences and creating distinct learning environments, with the help of digital technologies. The aim of this paper is to analyze the reorientation of ways of teaching activity, the modification of perceived roles, and the changes brought about by online pre-university education. Hence, in order to identify how some pre-university teachers felt these sudden changes, research was undertaken in an Agricultural Technological high school in Romania. The focus was on the analysis of the way in which the didactic act was carried out during the online education period, compared to the post-online one (traditionally, with the integration of technology), with the identification of the difficulties encountered by the teachers and the reorientation of the educational act. The qualitative research consisted of conducting semi-structured interviews with teaching staff from the institution where the study was carried out. Although online teaching was a challenge for the entire pre-university education, in Romanian agricultural high schools, where pupils mostly come from disadvantaged backgrounds, social differences were amplified. The present research clearly showed that the Agricultural Technological High School faced online teaching with great difficulty, not being prepared for this situation in terms of resources. Of course, a high adaptability of the teachers was noted, who used their own resources and learned to use educational platforms and digital tools in record time to still manage to keep the teaching-learning process active.

***Keywords:*** *Covid-19 pandemic, digital technology, pre-university education, on-line education.*



## CHALLENGES OF SUSTAINABILITY ASSESSMENT IN THE MANUFACTURING INDUSTRY

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### ***Abstract.***

Over the years, the pharmaceutical industry has attracted the attention of both researchers and practitioners, both because of its importance and its relationship to a theme, namely health, which is central to human existence. Why the pharmaceutical industry and sustainability? It is known that the evolution of the pharmaceutical industry has had and has an impact on people's lives, both because it has an important contribution to creating well-being in terms of health and the quality of people's lives, but also because it is one of the most relevant sectors for the global economy, but also one of the biggest polluters. Studies in the academic literature on this topic show that the sustainability of pharmaceutical companies and the management challenges associated with it are discussed in general terms and to an insufficient extent. Environmental sustainability refers to the impact of processes, products and services on the environment, biodiversity and human health; it is a condition of balance, interconnectedness and resilience that allows human needs to be met without compromising supporting ecosystems and biological diversity. The social dimension of sustainability refers to the well-being of people and communities, health and safety at work, working conditions, human rights issues and labor rights. The economic dimension involves reducing costs through systematic management, research and development expenditures, investments in machinery and technology, labor productivity, or other forms of capital. Given the increasing global production and consumption of these chemicals in today's modern society, it is foreseeable that environmental contamination with these substances will become a growing concern. In our research, we sought to find out how important sustainability is in a Romanian pharmaceutical company, if its managers have a sustainable perspective in organizing the entire production chain, and what are the main challenges they face. We talked with some of the managers of a pharmaceutical company, from its different departments, from the production area as well as from the project area, respectively human resources, more precisely with 15 managers, the discussion being in the form of an interview, and from the analysis we pointed out that among the three dimensions of sustainability special attention is paid to the environment and, at the same time, we discovered that in the pharmaceutical industry maintaining sustainability standards represents a great challenge both for those who implement procedures (managers) and for those who must respect and apply them rigorously, this requiring continuous learning and adaptation to society's standards.

***Keywords:*** *waste, planet, sustainable management, social, economic .*



## GRAPHICAL METHOD FOR OPTIMIZING THE MACHINERY LAYOUT

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### *Abstract.*

The correct implementation of a material processing process is conditioned by the optimal organization of the workplaces, by the promptness of the means of transport, factors that are influenced by the way in which the machines are located within each production department. The achievement of an machinery layout plan is required if a new production capacity is developed, but an equipment re-layout may also be necessary if changes are made in the technological process, if the technological operations are not efficient or if new products will be introduced into manufacturing. One of the most used method for obtaining the machinery layout plan is the method of the systematic analyse of the space. The process of the machinery layout includes several stages, such as: building a matrix that identifies the circuit of materials from one area to another, determining the space required for each technological department, establishing the initial draft of the equipment layout and identifying the layout that leads to optimal results, and finally, obtaining the detailed layout based on the optimal solution established in the previous phase. The paper presents a graphical method for obtaining the machinery layout, a method that offers more benefits. One of the advantages is the fact that the method can provide dimensional variants of production departments and the possibility of adjusting them until a good dimensional variant is achieved. An analysis of the machinery layout can be done by checking the distances between the machines, between the machines and the walls of the building, etc. The lengths of the material movement routes along the technological flow can also be quickly calculated. There is the ability to quickly change the locations of the machines, to add new equipment or to add new building elements (walls, doors). The final variant obtained as a result of the optimization is exact, eliminating the errors that could have appeared if a classic method of solving the problem of machinery layout had been used.

**Keywords:** *machinery layout, systematic analyse of the space, CAD, optimization.*



## LEAN SIX SIGMA AND SUSTAINABILITY IN TEXTILE INDUSTRY: A SYSTEMATIC LITERATURE REVIEW

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### ***Abstract.***

This paper objective is to determine the relationship between Lean Six Sigma tools and Sustainability on textile industry. The research methodology used in this study was a systematic literature review to identify what types of Lean Six Sigma tools have an important and significant role on sustainability in textile industry. The research aimed to develop an integrated conceptual model for the integration of the Lean Six Sigma tools and Sustainability indicators in textile industry. The results of this study show that Lean Six Sigma tools has a positive impact on Sustainability in textile industry by improvement productivity, reduce costs, quality and rework cost in the economic performance; in environmental performance by waste water, energy and resource usage; in social performance, by safety in the workplace, culture using the tools approach.

***Keywords:*** *manufacturing, textile industry, reducing resources, performance, tools, lean*



## FAST FASHION VS SUSTAINABLE FASHION – A PERSPECTIVE FROM CONSUMERS IN SPAIN AND ROMANIA

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### ***Abstract***

Consumers across Europe are becoming more conscious of environmental and ethical concerns related to the fashion industry, leading to an increased demand for sustainable and ethically-produced clothing. Despite of the growing interest in sustainable fashion, fast fashion brands still remain dominant in terms of market share. Considering the socio-economic and environmental impact of consumers' preference on the fashion industry, the objective of this research was to study the consumer preference for fast fashion versus sustainable fashion. The data were collected from Meta database, as well as from Google Trends, based on various demographics, such as: age, gender, and location – the sample consists of fashion consumers from the main cities of Spain, Madrid and Valencia, with the Romanian cities, Bucharest and Iasi. By analyzing the consumers' preference for fashion in different urban centers, one can ascertain the degree to which specific fashion trends influence the clothing choices of their particular residents. This research emphasizes the importance of the studying consumers' preference, the need to shape them towards a more sustainable future, and, also, this paper argues that understanding the trends in apparel manufacturing in different urban areas will enable the development of strategies to reduce the global carbon footprint linked to the fashion sector.

**Keywords:** *sustainability; fashion industry; consumer' preferences; sustainable development*



## **SESSION 1.3.**

### **Technical Textiles and Sustainability**

#### **Textile Education and Training for the Technical Textiles Field**

**Chair:**

**Irina CRISTIAN, *Gheorghe Asachi Technical University of Iasi,*  
ROMANIA**

## SECOND LIFE OF A TEXTILE MULTI-COMPONENT WASTE - REVIEW

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### *Abstract*

Recycling with components sorting is one of the options to give a second life to textile waste when waste is not the proper word, actually, because, for that segment, it is a source of the material. This paper deals with the overview of people's behaviour in reuse and recycle principles, possibilities where to obtain textile waste, and the recycling options with examples from the current reality. Mostly, all clothes, especially technical clothing such as protective clothing, sport barrier clothes, technical textiles with semipermeable layers, etc., cannot easily decompose into a single raw component, see Figure 1. People decide to finish using textiles for reasons of season, fashion, damage, and individual preference. They give it for second use when cautious about the environment and society. The legislation makes special handling of such waste necessary when returning to the source. Only companies or non-profit organisations can do it; even governments outsource to them.

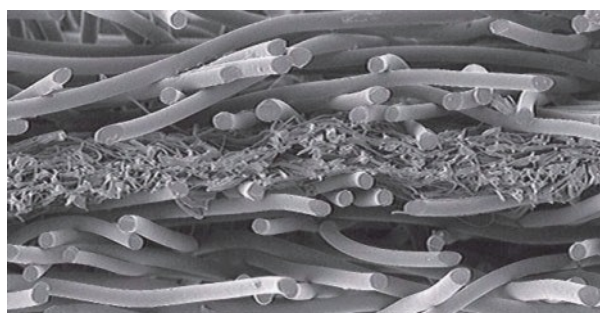


Figure 1. Example of the composition from 3 layers and laminated in a one-plane fabric

Some visions are pointed out, too, when their affordability and realisation are in the phases of testing with potential. One example is fully recyclable fibers PLA used to create an entire clothing product to follow fiber-to-fiber concept. Such a company needs responsible customers who do not throw out but give it back to the company after they decide to finish using it. Until visions turn to mass reality, we are referred to recycling at the levels allowed by nowadays technology as upcycling when creating new products; using another way as cleaning textiles; cutting and chopping for pieces, and composing nonwoven structures or composite layers; using as insulation materials against sound, heat or cold; decompose for energy and more. The perfect recycling of polymers should decompose to the level of monomers or polymers and spin it again.

**Keywords:** *sustainability, textile multi-component waste, recycling, sorting, reusing*



## SUSTAINABLE HORIZONS: EXPLORING TECHNICAL TEXTILES AND ENVIRONMENTAL RESPONSIBILITY

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### ***Abstract.***

Technical textiles have evolved into indispensable materials with multifunctional capabilities, finding application across diverse sectors such as healthcare, automotive, and concerns regarding their environmental footprint. This state-of-the-art review critically examines the intersection of technical textiles and sustainability, evaluating advancements, persistent challenges, and future trajectories. This paper explores the intersection of technical textiles and sustainability, emphasizing developments, research methods, and implications for the field. The study reviews the current state of research in sustainable technical textiles, considering materials, manufacturing processes, and applications. It highlights the growing importance of sustainable materials like recycled fibers and bio-based materials, alongside eco-friendly manufacturing methods such as circular economy principles which play a pivotal role in advancing sustainability in this domain. A comprehensive review methodology has been employed, synthesizing information from reviewed literature and industry reports. This approach provides a holistic view of the evolving landscape of sustainable technical textiles. One of the pivotal dimensions of sustainable technical textiles lies in the materials themselves. Recycled fibers, sourced from PET bottles and post-consumer textile waste, have gained prominence, spurred by breakthroughs in recycling technologies. Bio-based materials, including fibers and polymers, represent an eco-conscious alternative. Smart textiles, integrated with materials like shape memory alloys and conductive polymers, are not only enhancing functionality but also contributing to energy efficiency. This review discusses barriers, including cost constraints and technological limitations emphasizing the significant strides made in sustainable technical textiles, spanning materials, manufacturing, and applications. Notably, it discusses how recycled fibers, bio-based materials, and smart textiles contribute to sustainability objectives. The shift towards eco-friendly manufacturing processes and circular economy principles is reshaping the industry. This paper provides a contribution to the field by giving a complete overview of sustainable technical textiles, identifying key trends, challenges and opportunities. It is a useful resource for researchers, practitioners and policy makers who want to foster sustainability in the textile industry. Future research directions should focus on addressing barriers, fostering innovation, and advancing sustainability metrics for technical textiles, to fully harness the transformative potential of technical textiles in forging a sustainable environment and paving the way for a more environmentally responsible future.

***Keywords:*** *sustainable materials, sustainable manufacturing, environmental impact assessment, circular economy, smart textiles.*



## FORECASTING THE MECHANICAL BEHAVIOUR OF SUCROSE-CELLULOSIC STRUCTURES FOR TAILORING FLEXIBILITY THROUGH MOLECULAR DYNAMICS SIMULATIONS

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### ***Abstract.***

Automating fabric handling within sewing manufacturing presents a multitude of benefits in terms of efficiency and precision. Nevertheless, it introduces considerable initial complexity and potential rigidity. The intertwining trends of fabric adaptability and the integration of robotics into sewing manufacturing can yield more efficient, versatile, and cost-effective textile production. By combining the ability to work with diverse fabrics and designs with the precision and automation of robotic systems, textile manufacturers can enhance their competitiveness in the global market while satisfying the increasing demand for customization and quality. Fabric strength, a crucial attribute influenced by factors such as fibre type and finishes, necessitates careful consideration. Molecular dynamics (MD) simulations have emerged as a valuable tool for gaining comprehensive insights and an in-depth understanding of the mechanical properties of materials. Utilizing MD simulations to predict fabric bending stiffness properties holds promise for cost-effective textile research and development, especially when experimental data on mechanical properties are scarce. This study employs MD simulations to investigate the tensile response to uniaxial deformation in various cellulose-sucrose systems. Tensile-strength simulations were conducted across a range of temperatures within the system. Notably, cellulose-sucrose systems with higher sucrose concentrations exhibit more pronounced changes in stiffness properties as temperatures increase from 300 K and beyond.

**Keywords:** #MDsimulation, cellulose-sucrose system, tensile-strength simulation, textile handling, finishes, sewing automation.



## CONSIDERATIONS REGARDING THE INFLUENCE OF MATERIAL PROPERTIES ON THE GEOMETRY OF THE GARMENTS PATTERNS

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### ***Abstract.***

Sustainable fashion includes reducing carbon emissions, overproduction and pollution, protecting biodiversity and ensuring safe working conditions for garment workers. The designers and all the key stakeholders in this industry are aware of the problems of society and are trying to implement new solutions to transform this industry into a sustainable one: multifunctional design, eco-friendly materials and recycled fabrics, environmentally friendly treatment and dyeing technologies (GOTS certification guarantees the highest standard), reducing textile waste, recycling garments and turning them into vintage pieces, etc. In this industry, garments are still made traditionally: garment pieces are cut from textile materials, sewn and finished, so each step of the manufacturing process must be well executed to obtain a high-quality garment model. During the ironing stages of the manufacturing process, the shape of the garment pieces (a closed contour of straight and curved lines) can change due to the shrinkage properties of the textile materials (the garment may take on an uncomfortable shape and become scrap or waste). If this property of textile materials has high values, it must be considered when designing patterns for fitted garments, particularly in areas that significantly influence wearing comfort (e.g. armholes in fitted garments with shoulder support). This paper presents the influence of fabric shrinkage for a fitted jacket on the area that affects the appearance of the garment and the comfort of the wearer (armhole and sleeve head). These results are part of ongoing research on the topic mentioned as the title of this paper.

***Keywords:*** *patterns shape, materials properties, outline geometry, armhole*



## TRAINING GUIDE FOR DESIGNING 3D KNITWEAR FOR TECHNICAL PRODUCTS

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### ***Abstract.***

The usefulness of producing three-dimensional (3D) shapes using the weft-knitting technology has been demonstrated in recent years in the apparel industry, but mostly in the technical field. Flatbed automatic weft knitting machines are capable of producing sustainable shapes with complex designs that offer benefits such as waste minimization and optimization of yarn consumption before the final product manufacturing. Computer Aided Design (CAD) system software plays an important role in the development of a 3D knit fabric. It provides the digital interface necessary to develop the program containing instructions for the knitting parameters used by the knitting machine having its specific drawing functions and options. Designing a three-dimensional knitted shape on a CAD system requires a mixture of knowledge between two components: pattern programming and shape architecture. The relationship between shape and surface requires a deep understanding. This approach must be made with consideration of the programmer's skills, design parameters, and technical constraints. The geometry of a 3D model must first be translated into a suitable two-dimensional (2D) pattern that represents the specific design elements like a diagram. The second step is to build the knitted areas that will result in a proper knitted and optimised model. These areas can be either made directly on the shape or just imported from a data base previously created. The last step is to determine the technical parameters suitable for the knitting process. The paper presents the methodology developed by the authors as a training tool for designing 3D knitted shapes for technical end-uses. Considering the high complexity of programming stage with special software, such as M1plus® by Stoll by KARL MAYER, the purpose of elaborating this conceptual approach is to make this activity easier to understand and more attractive from a creative point of view.

***Keywords:*** 3D knitted shapes, CAD system, pattern programming, shape architecture, educational tool, technical applications.



## **SESSION 2.3.**

### **Management and Entrepreneurship**

**Chair:**

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## LABOR FLEXIBILITY: A FRAMEWORK OF ANALYSIS

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### ***Abstract.***

Flexibility is the ability of a system to adapt to different environments and situations to cope with changes in the policies and rules related to the business environment. Labor flexibility is represented by a set of measures that act on labor rights, proposing a model of harmony/balance between employers and workers (employees). Considered an integral part of the modernization of the labor market, the term labor flexibility appears mainly in crisis. With the outbreak of the COVID-19 pandemic, the great challenges to which organizations were subjected to maintain functionality, maintain employees, and achieve the proposed objectives, together with the huge pressure on the employees who were facing the scenario of being out of a job or without income, led to finding the most suitable forms of work to overcome those challenged times. Before this crisis organizations knew about the existence of certain working methods but viewed them as too modern and difficult to implement, and not regulated by law in most European states. Labor flexibility became a necessity during the pandemic, currently being privileged as normality for both employers and employees, being regulated by law in most countries. The purpose of this paper is twofold: to offer an overview of labor flexibility, and to explore and identify how the forms of labor flexibility have been adopted, respectively adapted, by various European companies to face the challenges encountered as a result of the COVID-19 pandemic period. The exploratory research will be approached to carry out a comparative analysis on the forms of labor flexibility most used at the European level, emphasizing those whose use during the crisis was successfully embraced at the company level, therefore being considered as examples of good practices.

***Keywords:*** Covid-19 pandemic, hybrid work, labor flexibility, telework.



## CONNECTED FACTORY: DIGITAL SOLUTIONS FOR SMART PRODUCTION. CASE STUDY - BRAICONF 4.0

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### *Abstract.*

Romania has a rich tradition of textile production dating back centuries, the country being known for its skilled workforce in the textile and apparel industry. Like many other countries, the Romanian textile industry faces challenges such as competition from low-cost manufacturing centers, changing consumer preferences, and the need to adopt sustainable practices, this becoming an increasingly important aspect with a growing focus on environmentally friendly practices and materials. Connected factories are progressively making their mark in the textile industry, reshaping traditional manufacturing processes into smart, data-driven production systems. Digital solutions play a pivotal role in smart textile production by revolutionizing traditional methods, while optimizing manufacturing processes, enhancing quality control, enabling customization, and supporting sustainability efforts. The present research paper analyzes the complete integrated solutions identified for optimizing the production at Braiconf S.A. and is based on an internal evaluation conducted between January and March 2019 and contributes to the development and enhancement of the retail activity, the increase of the MTM activity, the attraction of customers with higher quality level and the increase of the productivity of the production lines. The 2019 assessment was considered in the research, given the reference year for the peak of textile industrial production, while the pandemic and post-Covid period represents the decline of the textile industry. The latter period is complemented by reviewing the scientific literature to the present, reiterating the importance and impact of digital solutions in smart manufacturing. Analyzing the efficiency of the departments and using the specific risk management methodology, we aimed to establish solutions adapted to the reality of production in order to improve the products and to optimize the processes, thus increasing the competitiveness and productivity of the company.

**Keywords:** *management, textile industry, connected factories, entrepreneurship, smart production*



## EVALUATION OF STUDENTS' ATTITUDE TOWARDS SLOW FASHION AND FAST FASHION IN THE CONTEXT OF ENVIRONMENTAL SUSTAINABILITY

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### ***Abstract.***

Sustainability is an approach approached by more and more private and public organizations. Universities are starting to get actively involved in the implementation of sustainability practices and principles. The steps taken in public organizations are fewer, but they are starting to intensify. Environmental sustainability should start with the education of students and the updating of educational plans. For this purpose, the present research evaluates the attitude of students towards the considerable consumption of clothes. This research analyzes university students' knowledge and attitude towards clothes in terms of environmental sustainability and slow fashion. Students are prone to purchase many articles of clothing and become part of the slow fashion flow. The research presents the results obtained following the quantitative evaluation of the data obtained following the involvement of students in market research carried out in the Polytechnic University of Timisoara. The main results show that students do not have solid knowledge about slow fashion and the importance of this concept for environmental sustainability. It has been established that the courses followed are tangential to sustainability and represent an important step in improving the level of knowledge.

***Keywords:*** *Sustainability, slow fashion, fast fashion, awareness, university, resources, consumption.*



## STATISTICAL RESEARCH IN HUMAN RESOURCE MANAGEMENT IN PUBLIC INSTITUTIONS

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### ***Abstract.***

Municipalities represent local public institutions in Romania and are responsible for the administration and management of affairs at the level of administrative-territorial units. The current research conducts a statistical analysis of human resources at the level of municipalities to quantitatively assess the human resource management process within an organization to achieve its objectives and ensure an efficient, motivated, and engaged workforce. The research methodology encompasses all stages of a well-founded quantitative and qualitative evaluation, including data collection, analysis of the normality of value series, formulation of working hypotheses, application of statistical tests consistent with the results obtained in the normality analysis to validate or invalidate hypotheses, correlational and inferential analyses applied to primary value series, formulation of conclusions and proposals for improving activities in these public institutions. The areas of Human Resources addressed in the research include performance evaluation at the municipality level, employee motivation and engagement, labour relations, and the impact of technology introduction in public institutions. The originality of the research stems from identifying, defining, and analyzing the variables that influence organizational activity in municipalities, from the consistent and comparative application of a statistical methodology on primary data series, and from formulating statistically validated conclusions to improve human resource organizational activities.

***Keywords:*** *human resource, public institutions, statistical hypotheses, statistical analyses*



## THE IMPACT OF THE STRUCTURE AND DYNAMICS OF RESOURCES ON FINANCIAL PERFORMANCE

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### ***Abstract.***

One of the challenges facing companies is the efficient use of their resources. The few research on this topic has provided mixed results, which requires further analysis to shed light on the interdependencies between resource use and business performance. The aim of this study was to perform a comparative analysis to answer the following research question: how can performance be improved? In order to perform the analyses, secondary data were collected for the period 2010-2022, for a sample of companies from four different fields of activity (information technology consultancy; trade with clothing; trade with construction materials; trade with cars). Based on the econometric analyses that used panel data, the aim was to assess the extent to which the volume and dynamics of human, material and financial resources influence the size and dynamics of performance, measured based on return on assets (ROA) and return on equity (ROE). The performance analysis measured by ROA and ROE indicated that the volume of advanced resources in economic activity is very important for companies engaged in textile, car and construction materials trade. A special situation presents the companies that provide consulting in information technology. For these companies, the variation in resource volume explains only 56% of the ROA variation. The analysis at the level of resource types indicated the following: a) the increase in the volume of fixed assets negatively influences the performance (measured by ROA and ROE); b) the increase in the volume of current assets and human resources has a positive impact only on the performance of companies engaged in car trading; c) the use of own financial resources has a mixed impact on ROA and ROE; d) the intensification of the use of financial resources procured through indebtedness has negative effects on performance; e) the positive impact of resource use efficiency was significant only for one of the two analysed indicators (labour productivity); f) analyses at the level of resource dynamics confirmed the negative impact of indebtedness on financial performance measured by ROA and ROE. The results of this study are theoretically useful (because they provide additional evidence on the interdependence between resources and performance), but also practically (because they provide support for managers to adopt investment policies that are favourable to increasing financial performance).

***Keywords:*** *financial performance, types of resources, the efficiency of resource use, commerce, information technology consultancy.*