Gheorghe Asachi
Technical University of Iaşi

Faculty of Industrial Design
and Business Management

BOOK OF ABSTRACTS

The 7th International Symposium

Technical Textiles - Present and Future

Iaşi, Romania
12th November 2021

„Technical Textiles-Present and Future" International Symposium

online on November 12th, 2021

BOOK OF ABSTRACTS

Organized by

Gheorghe Asachi Technical University of Iasi, Romania

Faculty of Industrial Design and Business Management

Department of Engineering and Design of Textile Products

With the support of

Alumni Association of the Faculty of Textile – Leather

About the TTPF2021 International Symposium

The „Technical Textiles-Present and Future" International Symposium is a scientific event that has become traditional in the field of textiles, since 2009, being organized by the Department of Engineering and Design of Textile Products within the Faculty of Industrial Design and Business Management from Gheorghe Asachi Technical University of Iași, Romania.

Over the years and from one edition to another, the International Symposium TTPF brought together leading researchers, textile experts from the industry, teachers from academia and vocational education, PhD students, and relevant stakeholders from the national and international scientific area to share their knowledge and the good practices regarding the technical textiles.

Reaching the seventh edition now, the International Symposium "Technical Textiles-Present and Future" has become a scientific forum in the field of technical textiles, supporting the cross-disciplinary research fields, providing the participants a real opportunity for ideas exchanging, to present the latest achievements, and to discuss perspectives.

With the focus on the latest scientific and technical advances in technical textiles but also on the companies' needs for innovative solutions, a new topic concerning environmental and sustainability issues for the technical textiles field was introduced for TTPF 2021, a topic which we hope will stir the interest of all participants.

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BRIEF PROGRAM

7th edition of the „Technical Textiles-Present and Future" International Symposium, TTPF 2021

November 12, Friday

Eastern European Time (EET)

10:00 - 10:30	**OPENING SESSION** - Welcome	
	1st Link	
	Rodica HARPA	*Chair of TTPF 2021 Organizing Committee*
	Carmen-Maria LOGHIN	*Vice-Rector Scientific Research, Development and Innovation, Gheorghe Asachi Technical University of Iasi, ROMANIA*
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	Mirela BLAGA	*AUTEX President, Gheorghe Asachi Technical University of Iasi, ROMANIA*
	Ioan CIOARĂ	*Honorary Symposium Chair, Founder*
10:30 - 11:30	**PLENARY SESSION I -** Keynote Lectures Chair: **Rodica HARPA**	
	1st Link	
10:30 - 11:00	**Andreja RUDOLF**	*University of Maribor, SLOVENIA* REVIEW OF SMART CLOTHING WITH EMPHASIS ON EDUCATION AND TRAINING
11:00- 11:30	**Alison GAULT**	*Ulster University, NORTHERN IRELAND* DELIVERING TEXTILE INNOVATION BY ENGAGING WITH SME'S AND SOCIAL ENTERPRISES FOR SUSTAINABLE SOLUTIONS
11:30- 11:45	COFFEE BREAK	

11:45 - 14:00	SESSION 1	SESSION 2	SESSION 3
	1st Link	2nd Link	3rd Link
11:45 - 12:45	SESSION 1.1. 1st Link **Functional and Smart Textiles for Medtech, Protech and Sportech Applications**	SESSION 2.1. 2nd Link **Technical Textiles for Indutech and Mobiltech Applications ; Functional and Smart Textiles for Medtech, Protech and Sportech Applications**	SESSION 3.1. 3rd Link **Technical Textiles and Sustainability**
	Chair: **Andreja RUDOLF** University of Maribor, SLOVENIA	Chair: **Daiva MIKUČIONIENĖ** Kaunas University of Technology, LITHUANIA	Chair: **Luminița CIOBANU** Gheorghe Asachi Technical University of Iasi, ROMANIA

12:45-13:00	COFFEE BREAK		
13:00 - 14:00	SESSION 1.2. 1st Link **Functional and Smart Textiles for Medtech, Protech and Sportech Applications** Chair: **Antonela CURTEZA** Gheorghe Asachi Technical University of Iasi, ROMANIA	SESSION 2.2. 2nd Link **Technical Textiles for Clothtech and Hometech Applications** Chair: **Pavla TĚŠINOVÁ** Technical University of Liberec, CZECH REPUBLIC	SESSION 3.2. 3rd Link **Technical Textiles and Sustainability** Chair: **Savvas VASSILIADIS** University of West Attica, Athens, GREECE
14:00-14:30	LUNCH		
14:30 - 15:30	**PLENARY SESSION II** -Keynote Lectures Chair: **Mirela BLAGA** 1st Link		
14:30 - 15:00	**Yordan KYOSEV** *Dresden University of Technology, GERMANY* HIGH SPEED (4D) SCANNING OF CLOTHED HUMANS – ADVANTAGES AND CHALLENGES		
15:00-15:30	**Cosmin GRAPINI** *Pasmatex S.A. Timișoara, ROMANIA* TECH-TREATMENT FOR THE YARNS OR FOR THE WEAVED PIECE? THAT IS THE QUESTION!		
15:30-15:45	COFFEE BREAK		
15:45 - 18:00	SESSION 4 1st Link	SESSION 5 2nd Link	SESSION 6 3rd Link
15:45 - 16:45	SESSION 4.1. 1st Link **Technical Textiles and Sustainability** Chair: **Cristina PIROI** Gheorghe Asachi Technical University of Iasi, ROMANIA	SESSION 5.1. 2nd Link **Textile Education and Training for the Technical Textiles Field** Chair: **Mariana URSACHE** Gheorghe Asachi Technical University of Iasi, ROMANIA	SESSION 6.1. 3rd Link **Management and Entrepreneurship** Chair: **Manuela Lăcrămioara AVĂDANEI** Gheorghe Asachi Technical University of Iasi, ROMANIA
16:45-17:00	COFFEE BREAK		
17:00-18:00	SESSION 4.2. 1st Link **Technical Textiles and Sustainability** Chair: **Irina CRISTIAN** Gheorghe Asachi Technical University of Iasi, ROMANIA	SESSION 5.2. 2nd Link **Textile Education and Training for the Technical Textiles Field** Chair: **Adrian BUHU** Gheorghe Asachi Technical University of Iasi, ROMANIA	SESSION 6.2. 3rd Link **Management and Entrepreneurship** Chair: **Marius PÎSLARU** Gheorghe Asachi Technical University of Iasi, ROMANIA
18:00	***TTPF 2021 CLOSING SESSION*** 1st Link		

CONTENT

SESSION 1.

SESSION 1.1.

Functional and Smart Textiles for Medtech, Protech and Sportech Applications

Chair:

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

SELF-POWERED POLY(3,4-ETHYLENE DIOXYTHIOPHENE)-POLY(STYRENE SULFONATE)/ POLYDIMETHYLSILOXANE-PRINTED TEXTILE WOVEN FABRIC FOR MOISTURE SENSING

Hasan Riaz TAHIR*, Granch Berhe TSEGHAI, Benny MALENGIER and Lieva VAN LANGENHOVE

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Abstract.

Self-sufficient power sensors that can covert the mechanical stimulus to electrical signals is an emerging market. In this work, a poly(3,4-ethylene dioxythiophene) polystyrene sulfonate/polydimethylsiloxane-b-polyethylene oxide (PEDOT:PSS/PDMS)-printed conductive cotton fabric was used to construct a self-powered moisture sensor. The screen printing method was used to transfer a very thin 0.011 g/cm^2 add-on onto the fabric. Using a two probe resistance measurement method, the electrical resistance of the fabric was found to be 11.36 kΩ/cm. The sensor functions by detecting the change of energy harvested from electrostatic charges developed on the semi-conductive fabric at different moisture contents. A mechanical agitation at the 2-hertz frequency with 250 ms contact time, 200 ms dwell time, and 50 ms uptime, with a tapping device, was performed to investigate the effect of moisture on the output peak voltage. Increasing the amount of moisture from 0 to 50% within the PEDOT:PSS/PDMS-printed semi-conductive cotton fabric caused a considerable increase in the electrostatic output peak voltage from 34V to 93V. This is because water molecules attached to the printed fabric change the electrostatic behavior of the PEDOT:PSS/PDMS-printed cotton fabric substrate and resistivity of the PEDOT:PSS. The results revealed that the use of a self-powered PEDOT:PSS/PDMS-printed textile fabric moisture sensor for wearable smart electronics is promising.

Keywords: *(electrostatic charge; tapping device; printed fabric; smart textile; moisture).*

DEVELOPEMENT OF CONDUCTIVE FLEXIBILE FABRICS USING CONDUCTIVE YARNS AND POLYPYRROLE COATING

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Abstract.

This paper presents the production of conductive heating fabric using the polypyrrole coating process on two types of textile surfaces. The fabrics used are viscose and polyester fabrics. The method used for the polymerization of polypyrrole is oxidative polymerization in aqueous solution. In order to distribute the dissipated power over the entire surface of the polypyrrole-coated fabric, a circuit model was made, by sewing conductive yarns to the viscose fabric and printing with conductive ink to the polyester fabric. The conductive yarns used are rubber core yarns wrapped in a copper filament and rubber core yarns wrapped in a copper filament filmed with a layer of silver. Conductive ink is composed of silver particles as a conductive material. These conductive textile materials obtained were evaluated from the electrical point of view by surface resistivity measurements, obtaining values between 1.76 - 33 kΩ for the viscose fabric, at electrical voltages applied between 25 ÷ 35 and 0.23 - 2 kΩ at voltages applied between 10 ÷ 30 V, for polyester fabric. The conductive textiles were also subjected to SEM study, for the homogeneity analysis of the surface morphology. The images obtained with the help of SEM analysis revealed that in the case of both viscose and polyester fabrics, the deposition of the polypyrrole polymer is quite uniform, which is important because the polymerization defects can cause variations in the electrical conductivity of the film.

Keywords: *conductive fabrics, polypyrrole, conductive yarns, surface resistivity*

USERS' PERCEPTIONS ON COMFORT LEVEL OF CYCLING CLOTHING

Yetanawork TEYEME[1, 2*], Benny MALENGIER[1], Tamrat TESFAYE[2], Simona VASILE[3], Maria-Cristina CIOCCI[4], and L. Van LANGENHOVE[1]

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Abstract.

In this study the performance of existing cycling garments which influence the wearer comfort has been investigated based on a user survey in relation to ergonomic wear comfort, thermal comfort, garment design, construction and buying preference. For the purpose of this study, a total of 94 both recreational and professional male cyclists were recruited. An online questionnaire was developed to address various key aspects such as tactile sensation; garment fit with reference to size (freedom of body movement, closeness of garment); garment assembly (seam and stitch types, seam position); garment aesthetics (style, shape); and overall satisfaction (relating to design of the garment and style). To deduce whether the parameters were significant or not, statistical analyses were used including descriptive methods and Chi-squared test (x2). The level of statistical significance for Chi-squared test (x2) analyses was set at P = 0.05. The result indicates cyclists are not very satisfied with the comfort level of current outfit. About 94 % of respondents (88 male in total) experienced different discomfort sensations. The most frequent causes of discomfort were fabric characteristics, design and size fit of the outfit. Based on a Chi Square analysis, the size fit of the garments was statistically significant (P = 0.000). Therefore, it can be concluded that the garment that have good ventilation or breathability and a very good fit values were preferred by cyclists. Indeed, from the manual measurements taken, great differences between garments of the same specified size M were observed between the selected four commercial brands A-D. Hence, from the results found, we conclude that an improvement of the existing products and prioritize better design and new features are needed.

Keywords: *Subjective assessment, user comfort, cycling clothing, garment fit*

INFLUENCE OF TREATMENT ON THE BENDING BEHAVIOUR OF ANTISTATIC TEXTILES

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Abstract.

Mechanical properties of the knitted fabrics are very important when using them for different applications, such as the following: clothing, technical textiles, composites, e-textiles, etc. In this research, the bending behaviour of 1x1 rib and half-Milano knitted fabrics developed applying the eight cotton / antistatic polyester blends ratios such as 90 % cotton / 10 % antistatic polyester, 80 % cotton / 20 % antistatic polyester, 70 % cotton / 30 % antistatic polyester, and 65 % cotton / 35 % antistatic polyester was investigated. An M-100 (MATSUYA, Japan, 2016) automatic flat knitting machine with 14E gauge was used applying constant machine settings for the development of investigated fabrics samples. The effect of fabrics dying, softening with AQUASOFT®SI hydrophilic softener, and Polygiene VO-600 antibacterial finish on the bending stiffness of the investigated knitted fabrics was evaluated along both courses and wales directions for both technical face and back sides. The method of free fold loop suggested by Raymond H Plaut was applied to test the bending stiffness of the knitted fabrics. The results of the bending stiffness testing revealed that the bending stiffness increased after the dying, softening and treatment with antibacterial finish compared to the untreated (raw) fabrics samples. The samples cut in the wale fabrics direction were stiffer than in the course direction. Bending stiffness for the fabric technical face and technical back was found similar in the case of 1x1 rib knitted fabrics due to their well-balanced structure for both technical sides. However, small differences in respect to technical sides were determined for the investigated half-Milano rib fabrics.

Keywords: *bending stiffness; 1x1 rib; half-Milano rib; antistatic polyester; knitted fabric*.

SESSION 1.2.

Functional and Smart Textiles for Medtech, Protech and Sportech Applications

Chair:

Antonela CURTEZA, ***Gheorghe Asachi Technical University of Iasi, ROMANIA***

A REVIEW OF KNITTED STRUCTURAL EFFECT ON MECHANICAL PROPERTIES OF FABRICS

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Abstract.

In the modern knitting world, the customer focuses more on the performance characteristics of the fabrics. Normally, the fabric structures are developed for the use in winter or summer season depending upon the structure properties with reference to materials. Previously, the work has been done in developing fabrics with single structures and studying their properties. To achieve the optimum properties between the summer and winter wears, multiple combination of structures has been developed by changing the arrangement of cams as well as needles. The hybrid structures have been made, in which each fabric is having combination of two different structures in its construction including Single Jersey Plain, Single Jersey – Single Pique, Single Jersey – Double Pique, Single Jersey – Single Lacoste, Single Jersey – Honey Comb, Single Pique – Double Pique, Single Pique – Single Lacoste, Single Pique – Honey Comb, Double Pique – Single Lacoste, Double Pique – Honey Comb, Honey Comb – Single Lacoste. The effects of these combinations have been studied on the mechanical properties of the fabrics. It is concluded that by developing structures this way, the appearance, as well as mechanical properties of the fabric have been improved as compared to the conventional single structured fabrics.

Keywords: *Knitting, Knitting designs, Single Jersey, Hybrid Knitted Structures, Mechanical properties*

DEVELOPMENT OF A COLLECTION OF MODELS OF POST-OPERATIVE TEXTILE PRODUCTS INTENDED FOR POST-MASTECTOMY WOMEN

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Abstract.

The paper presents a collection of models of post-mastectomy textile products, a collection developed based on the results of the in-depth study of the assortment of post-mastectomy functional-adaptive textile products available to women who have undergone a mammary gland amputation. The timeliness of the topic is determined by the sudden decrease in the quality of life of patients who have undergone a surgery to amputate the mammary gland. The work aims to develop a collection of models of post-operative textile products intended for post-mastectomy women by creating innovative models. In the Republic of Moldova post-mastectomy women are forced to face new needs in terms of clothing products by adapting the wardrobe until the intervention or having several models of bra-type products available, which do not always correspond to the preferences and needs of the wearer. It is absolutely necessary to create functionally, structurally and aesthetically improved textile products. For this purpose, a model system was created, formed by the alternative search method, using websites of international brands specialized in the creation of functional underwear, descriptions of those types of products. The system includes 12 models of bra-type products intended for post-mastectomy women. The models of the system differ in terms of constructive solutions: bra type, cup, positioning and closure type, pocket for external breast prosthesis. Evaluation of the models of the system is carried out by interviewing the opinions of medical and textile specialists. Based on the models of the system, innovative textile product models are developed for post-mastectomy women.

Keywords: *model system, functional-adaptive textile products, post-mastectomy textile products.*

THE INTERDEPENDENCE BETWEEN THE QUALITY OF THE PRODUCTS' POSITIONING ON THE HUMAN BODY AND THE CONSTRUCTIVE PARAMETERS OF THE BASIC PATTERN OF THE MEN'S TROUSERS

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Abstract.

The paper deals with the issue of ensuring the correspondence of men's clothing products with the size and shape of the wearer's body. Research on the constructive parameters of pattern constructions has shown that they act directly on the positioning of products with waist support on the human body. In order to establish how to optimize the construction methods to the basic patterns of the products with waist support, a comparative analysis of the methods of elaboration of the product patterns for men's trousers was performed. During the experiments, the patterns of men's trousers with a semi-fit silhouette were performed throughout four design methods from various European countries. The methods used in the design process are currently used at the industrial scale or, as own methods of some authors. The comparative analysis of the construction methods of the basic patterns for the men's trousers product concerned the following aspects: the initial data necessary for the construction, the particularities of the calculation relations of the constructive segments, the sequence of construction of the patterns by arranging the segments and drawing the contour lines, the values and the variation of the constructive parameters characteristic for the support sectors. Research was also conducted to establish the correct positioning of the product made by 3D simulation on the body of the avatar using various body postures. The identification, measurement and statistical-mathematical processing of a series of constructive parameters, allowed us to conclude that the correct positioning of the product on the body is determined to a large extent by the equilibrium parameters of the product. Their value shall be established with high accuracy by using type 1-calculation relationships, which use the anthropometric dimensions of the carrier necessities.

Keywords: *men's trousers, construction parameters, design methods, 3D simulation*

STUDY OF CHARACTERIZATION INDICES OF WORSTED WOOL FABRICS USING AS A STATISTICAL TOOL CORRELATION METHOD

Liliana HRISTIAN, Ionuț DULGHERIU, Daniela NEGRU

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Abstract

The paper proposes an indicator for analyzing the fabrics structure and a manner of calculation thereof, reflecting the warp and weft yarns volume in a weave repeat, being useful in designing fabrics and filling some information about the characteristics and fabric properties, including also their behaviour at their various demands. This indicator was called volumetric filling factor as it reflects the real state of the internal structure of the fabric, according to the type of bonding. The elements that characterize the internal structure of the fabrics are defined by the basic structural parameters, fineness, density of yarns and the weave, that determines the mutual position of the yarns of those two systems, yarns positional stability, distribution of the yarns on the parts of the fabric, the dominant of the bundle points binding regarding warp or weft effect. In this study for analysis of volumetric filling coefficient that characterizes the worsted fabrics type, it was used the correlation method / graphic method. Correlation curve allows determining both bond existence, shape, direction, intensity, and the absence of link between variables. The ultimate goal of the analysis of these indices for characterizing the fabrics is to establish the influence of structure parameters on the surface characteristics so that it can be correctly defined the most appreciated item from the studied range, ensuring an excellent performance both in technological processes, and the use processes, in accordance with destination.

Keywords: *volumetric filling coefficient; correlation method; fabrics; density of yarns.*

SESSION 2.

SESSION 2.1.

Technical Textiles for Indutech and Mobiltech Applications, Functional and Smart Textiles for Medtech, Protech and Sportech Applications

Chair:

Daiva MIKUČIONIENĖ, ***Kaunas University of Technology, LITHUANIA***

EFFECT OF SOLVENT AND DISTANCE TIP-COLLECTOR ON PEO FIBERS ELECTROSPINNING

Iuliana G. LUPU[1], Oana CRAMARIUC[2],[3], Ana L. LEON[1], Liliana HRISTIAN[1], Razvan ZVONARU[1] and Anatolie LUPU[1]

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Abstract.

In this study, polyethylene oxide (PEO) fibers were produced through the versatile electrospinning technique. In electrospinning, a polymer solution is dispensed from a needle tip of a syringe where an intense electric field attracts the solution to a collector while drawing the polymer into a very thin fiber. High resolution scanning electron microscopy SEM was used to assess the influence of solvent as well as distance from tip to collector at a constant applied voltage on fiber morphology and diameter. Polyethylene oxide powder with average molecular weight of 900 kD was dissolved in a solvent mixture constituting deionized, distilled water and ethanol in different weight ratio (1:5, 3:2 and 5:1). The 4% (w/v) polymer solutions were electrospun at tip-collector distance which was varied between 15 and 25 cm. The effect of solvent mixture and tip-collector distance on the fiber diameter was investigated by using statistical analysis. This revealed a liniar dependency between solution, process parameters and fiber diameter. Once the tip to collector distance was increased, the fiber diameter decreased and bead-free fibers were obtained. Also, it was found from the results that nanofibers with an average diameter of 216 nm were obtained at a ratio 3:2 in solvent mixture.

Keywords: *electrospinning; poly(ethylene oxide); fiber diameter; statistical analysis*

NATURAL DYES USED IN TEXTILES: A REVIEW

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Abstract.

For thousands of years, man has been trying to copy the colors from nature and to transpose them on different supports. Although the use of natural dyes has several limitations (the difficulty of controlling the dyeing process, the low reproducibility of the dyes) they are still used due to their eco-friendly and biodegradable properties. On the other hand, in the last years, there has been a tendency for consumers to be unique or different from others, and from this point of view, dyeing with natural dyes can be seen as an opportunity. Dyeing with natural dyes is not completely free from environmental harm due to mordants used in the dyeing process, that are not environmentally friendly chemicals. For this reason, replacing classic mordants with alternative natural mordants (biomordants) present an ecological approach. Natural dyes obtained from plant parts (flowers, leaves, roots, stem, fruit, and bark) and waste material (distillation residues from strong liquor production, peels from vegetable processing, etc.) contain a variety of compounds with functional properties such as antimicrobial, UV protection, deodorizing, anti-moth, and mosquito repellent. This review presents the results of research on the evolution of natural dyes, the types of natural dyes and their functional properties, and the mordants used in textile dyeing with natural dyes.

Keywords: *natural dyes, biomordant, waste material, dyeing, eco-friendly.*

TECHWEAR – SINERGY BETWEEN TECHNOLOGY AND SPECIALIZED GARMENTS FOR OUTDOOR CLIMBING ACTIVITIES

Diana-Roxana VIZITEU, Antonela CURTEZA and Manuela-Lacramioara AVADANEI

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Abstract.

This article aims to make a brief overview of techwear and outdoor sportech products. Due to growing interest and involvement in the alpine sports and leisure activities, such as hillwalking, hiking, bouldering, alpinism, and ice climbing, the consumption of sports articles and equipment with associated technical textiles has shown a steady increase. Protection equipment for mountaineering encompasses a wide range of products. Applications of functional and smart textiles for mountaineering sports and leisure are very diverse, ranging from sports foot-wear to harnesses, rescue system integrated in gear and even sleeping bags and tents fabrics. Technical garments worn by mountaineers should be considered a safety net that offers enough protection, while still allowing improved mobility and comfort. For example, a jacket wetting out, either from water infiltration or moisture accumulation due to lack of breathability, could often prove fatal under extreme conditions. The research directions related to comfort, performance and protection apparel, and mountain equipment have highlighted a series of the materials worn by athletes and design solutions for these significant characteristics. The present paper deals with the principles of functional design, highlighting some of the commonly known and distinguished products designed for mountaineering, also including an interesting cross-point merging technology, engineering, electronics and textile, in a virtual environment, for faster product life cycles at less cost.

Keywords: *techwear; outdoor apparel; mountaineering; technical materials; virtual environment; functional design.*

COTTON FUNCTIONALIZATION BY CROSSLINKING CELLULOSE WITH COMPOUNDS TYPE CHLORHYDRINE

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Abstract.

The objective of this paper is to achieve the functionalization of cotton in order to increase the non-siphonablility and water sorption. Functionalization was achieved with eco-friendly compounds and consisted of repeated grafting treatments based on pad-dry-cure technologies: 1) with chitosan; 2) with a chlorohydrin as 2-chloroethanol (ETC) or epichlorohydrin (EPC). From the interaction of ETC and EPC with the chitosan grafted on cellulose, hydroxyethyl chitosan and hydroxypropyl chitosan were obtained directly on the cotton fabric. The functionalization generated by the crosslinking of cellulose influences not only the non-siphonablility but also the crystallinity, the durability to wash, the yellowing and the capacity of the cotton to absorb water. The methods used to prove how cellulose interacts with the treatment agents consisted of spectroscopic evaluation, Fourier Transform Infrared (FT-IR) and determination of an index/crystallinity ratio (Cr. R). The values of the take-up degrees, the wrinkle recovery angles (WRA), the durability to repeated washings and the water absorption capacity demonstrate the achievement of the study' s objective. The best crosslinking/ functionalizing effect was obtained when using chitosan and EPC.

Keywords: *Functionalization, crosslinking, chitosan, chlorohydrin, grafting.*

SESSION 2.2.

Technical Textiles for Clothtech and Hometech Applications

Chair:

Pavla TĚŠINOVÁ, ***Technical University of Liberec, CZECH REPUBLIC***

STUDY ON THE INFLUENCE OF PROCESSING TECHNOLOGY ON PHYSICAL-MECHANICAL CHARACTERISTICS OF 100% WOOL YARNS USING THE ANCOVA MODEL

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Abstract.

The paper aimed to highlight the existence of significant differences between the variation of the breaking force of lots of yarns with fineness Nm28 made of 100% wool processed on different technologies, using the mathematical model ANCOVA. The yarn lots in this study were obtained on the technological flow with combing machine (WW – worsted wool) and on the technological flow without combing machine (NWW – non-worsted wool). The model included: the dependent variable (Y) - the variation of the breaking force P (cN); nominal independent variable - processing technology (WW worsted wool and NWW non-worsted wool) and quantitative independent variables - USTER® unevenness (CV%) and yarn imperfections (thin, thick and neps). From the results obtained, through Tests of Between-Subjects Effects, it is observed that the effect of the nominal independent variable "processing technology" is significant, F (1.18) = 54.605, Sig. = 0.000, $p < 0.05$. Interpreting the value of Sig < 0.05, it can be concluded that between the variation of the breaking force there are significant differences depending on the processing technology of the studied yarn lots and USTER® unevenness (alternative hypothesis H1 is accepted). The analysis of the covariance method was used as a means of controlling the inputs when studying the differential impact of the processing technology on the variation of the breaking force of the studied yarn lots. This technique can be used later to model the physical-mechanical properties of the yarns and to select the most appropriate ones to meet the requirements of a certain field of use.

Keywords: *ANCOVA model; breaking force; yarn irregularity; processing technology.*

TENSILE PROPERTIES OF TWISTED THREAD MADE OF COMBINED METALLOPLASTIC YARNS

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Abstract.

Metalloplastic threads can be used in the embroidery textile industry, as well as in various technical applications. In the process of embroidery, to form the seams, the needle with thread pierces the tensioned fabric in the frame, so that the thread will be subjected to mechanical stress. Experiments were performed in order to determine the physical-mechanical characteristics of a twisted thread obtained from three combined yarns, processed from a polyester filament yarn and a silver metalloplastic yarn. It was found that the metalloplastic narrow flat strip has a very low specific strength, but by twisting it around the polyester filaments results a combined yarn that has a higher specific strength. The processing of three combined yarns will result in a twisted thread with a specific strength 2.7 times higher than that of the metalloplastic strip, a yarn that will withstand the tensile stresses during processing and subsequently during the use of the final product. The structural changes of the twisted thread and its components as a result of the tensile stresses were studied by analyzing the load-extension curves. With the help of these diagrams the following specific features have been established: the limit of proportionality, the tensile yield stress and the breaking limit. The experimental data were analyzed and the maximum stresses that the twisted thread and its components can withstand, without permanent deformations, were established.

Keywords*: metalloplastic strip; combined yarns; specific strength; load-extension curves.*

REGARDING THE QUALITY PROFILE OF AN ASSORTMENT OF SEWING THREADS

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Abstract.

The influence of sewing threads on the quality of the seams and therefore on the overall quality of the garments is an important aspect, that garment manufacturers must consider when choosing the sewing thread for a specific product. This important decision is often based on the sewing threads supplier's recommendations. However, to prevent the occurrence of any seam quality problems, the final decision should be made based on the results of the objective evaluation of sewing threads' performance. The paper presents the results of a study intended to evaluate the quality profile of a sewing thread assortment from the Coats Epic range and to assess the compliance with the producer's specification for a selection of sewing threads. Four types of 3-ply polyester core-spun sewing thread were individually tested in the laboratory, following specific standards, in terms of two important characteristics that influence the seam quality and the sewing thread's sewabiliy, namely the tensile properties and the friction features. The results of this study provided useful information that may underpin a simple methodology the garment manufacturers can apply to identify possible causes of sewing defects, avoiding loss of time and money.

Keywords: *sewing thread; quality profile; tensile properties; friction features; seam quality.*

ARCHITECTURE OF A FOOTWEAR COLLECTION FOR OVERWEIGHT TEENAGERS

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Abstract.

Nowadays, one of the most important health problems among young people is obesity. This research paper aims to highlight the importance of movement and physical exercises using the appropriated footwear products. Because teenagers are very selective in the way they are choosing their clothes, and they usually wear trainers or sports shoes, the authors propose an architecture of a footwear collection for overweight and obese teenagers. New models can be distinguished from others by the upper's components, by the bottom assembly, or both. Within a family of models, the performance of functions, by each model, is ensured by setting certain features/design parameters. Starting from a certain type of last there can be quickly achieved a complete model of footwear, which can be produced in any combination of colors or textures. The benefits include rapid development of a model, operating directly on it the changes that we desire, deleting or adding new components, view the model from different angles by interactively rotating the last. Using a proper questionnaire, it can be identified the consumer's needs and preferences regarding the collection's models. With these results, the producer has a better understanding of the market's needs and for the new models, the success rate is much higher.

Keywords: *obesity; teenagers; design; footwear; 3D modeling; product development.*

SESSION 3.

SESSION 3.1.

Technical Textiles and Sustainability

Chair:

Luminița CIOBANU, Gheorghe Asachi Technical University of Iasi, ROMANIA

STATISTICAL FIBER-LEVEL GEOMETRICAL MODEL OF THIN NON-WOVEN STRUCTURES

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Abstract:

Non-woven fabrics are widely used in technical applications and functional clothing. The geometrical model of non-woven structures for special clothing is the significant start point for simulating their properties. This paper demonstrates the application of the statistical fiber-based geometrical method, which can be used to build the non-woven microstructure with high accuracy. The method consists of three steps. The first step is the detection and analysis of the fiber orientation and coordinates. The coordinates of each analysed fiber are recorded using image processing software (IMAGE J) from the scanning electron microscope pictures of the non-woven structures. The second step is the development of a mathematical model which describes the coordinates the orientation of the fiber line and the deviation of its distance between the line. For the last step - 3D representation – these coordinates are extended with the third space coordinate using python script and finally visualized using 3D view software (TexMind Textile Viewer). Generated non-woven modules were satisfactory compared qualitatively as well as quantitatively against the accurate scanning electronic microscope pictures of the non-woven fabrics and can be used as starting point for advanced mechanical, thermal, electric, and other simulations.

Keywords: *non-woven module; 3D geometrical; Python programming; image analysis; optical porosity*

HOLLOW 3D-WOVEN FABRIC FILLED WITH TEXTILE WASTE FOR THERMAL INSULATION OF BUILDINGS

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Abstract.

Acknowledging the ever-growing demand for more efficient construction materials and taking into consideration the issues that the environment is facing due to waste generated by the textile/fashion industry, a performant thermal insulation woven fabric is proposed as solution to both above mentioned concerns. The paper describes the design and manufacturing process of a 3D-woven fabric with hollow structure, which constitutes the skeleton of a thermal insulating panel. The structure consists of a multilayer woven fabric with rows of overlapping open spaces (pockets) woven on an ARM Selectron Patronic loom equipped with 24 shafts, using jute and cotton yarns. The hollow pockets are filled with polyester woven ribbons, a common industrial waste resulting from the weaving process when using certain types of weaving machines (that require dummy selvage). The manufactured textile panel was tested for thermal conductivity. The results showed comparable thermal insulation properties for the textile panel compared with common products on the market. Sustainability and minimising environmental impact are becoming more important in all domains. Using this proposed textile panelling for thermal insulation would create an opportunity for repurposing of material that is currently industrial waste. This product would act as a direct alternative to different thermal insulating materials, which requires an energy intensive manufacturing process, pollutes the soil after disposal and can affect the human respiratory system when being handled on construction sites and during manufacturing.

Keywords: *sustainable building material, textile insulating panel; hollow 3D-woven fabric.*

SYNERGISTIC EFFECT OF SCREEN-PRINTED AL(OH)$_3$/SWCNT NANOPARTICLES AND PHOSPHORYLATED-CNF ON THERMAL AND THERMOPHYSIOLOGICAL COMFORT PROPERTIES OF FR-FABRIC

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Abstract.

Thermal protection and thermophysiological comfort are two of the most important properties regarding fire-retardant (FR) clothing, where first offers protection against combustion and high temperatures and second prevents the accumulation of moisture. For that reason, FR fabric was additionally coated by two different FRs: aluminium trihydroxide nanoparticles (AL(OH)$_3$), ATH NPs,) were used as ecologically acceptable alternative FRs with endothermal decomposition and compared to single wall carbon nanotubes (SWCNTs), which act by a formation of protective char layer. Additionally, phosphorylated cellulose nanofibrils (PCNF) were used as wear-related safe moisture management coating. Coating was conducted by screen-printing method, where PCNF and/or hydrophobic polyacrylate (AP) was printed as one or two-layers on fabric's one (back) or both (front and back) sides, without and with addition of NPs. The results show that one-sided printing (PCNF/AP) resulted in a higher effect of fabric' asymmetric wettability (front side hydrophilic, back side hydrophobic), as well as an increase water-vapour (13%) and heat (12%) transfer. The latter was further increased to about 16.5% and 20-25% by addition of 6.7 wt% of ATH NPs and 0.4 wt% of SWCNTs, respectively, while differently reducing air permeability (58%/ATH and 32% /SWCNTs). Such treatments also increase fabric' thermal stability up to 14°C-18°C, and lowere mechanical properties in case of ATH NPs compared to SWCNTs.

Keywords: *Al(OH)$_3$ nanoparticles; Single wall carbon nanotubes; Phosphorylated cellulose nanofibrils; Screen-printing; Fire-retardant textile; Thermophysiological comfort.*

THE EFFECT OF A BIOCOMPATIBLE HAND BUILDER ON CELLULOSIC FABRICS FOR MODIFICATION OF THEIR FLEXIBILITY

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Abstract.

Through new technologies and digitalisation, industrial manufacturing is in continuous evolution. The concept 'Industry 4.0' has forced the textile industry to be involved in this technological innovation era, to achieve full automation even where nowadays manual handling is still required. It is known that a common plant-based textile fabric is coming out from the production flow as non-rigid material. The flexibility of the textile structure is currently a barrier to the complete automation of the sewing operation because it prevents the material from being handled correctly. This research is focused on a new concept regarding the finishing process of textiles to obtain modified textile fabrics compatible with the requirements of robots automation. In particular, a wet process concept for finishing cellulosic materials, which offers a temporary finishing effect, was studied to bring stiffness to the fabrics without changing their initial characteristics. Using a natural hand builder in different concentrations, two types of fabrics were subjected to a certain degree of rigidity. Starting from the basic design parameters of the fabrics, all the geometrical parameters have been defined. As the first evaluation method, the process control of fullness was monitored through the percentage weight increase of the fabric after the finishing process. SEM analyses were performed to observe the morphological changes obtained from the finishing step. Air permeability analyses were performed to understand how the thermal treatment affected the physical properties of the fabrics. An optical microscope was used to capture images of the treated and untreated fabrics and carry out image analysis to have information about the degree of yarn coverage distribution on the total surface area.

Keywords: *Industry 4.0; automation and robotics; textile industry; finishing process; image analysis*

SESSION 3.2.

Technical Textiles and Sustainability

Chair:

Savvas VASSILIADIS, *University of West Attica, Athens, GREECE*

KEY ELEMENTS OF SUSTAINABILITY IN THE FIELD OF TECHNICAL TEXTILES

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Abstract.

Textiles is one of the global industries with the highest environmental, economic and social impact. With the increased awareness of preserving the world for future generations, environmental sustainability has become a major concern for the textile industry. Players from all market segments understood the need for change and strive to meet the sustainability demands along the whole value chain, from raw materials through manufacturing to the post-consumer stage. Besides clothing, technical textiles rank amongst the most important driving forces of growth in the textile market. Technical textiles is a high value-added products industry that plays an important role in almost every sphere of social and economic activities, ranging from healthcare or buildings to automotive, protective equipment, sports and leisure etc. The main components of textiles sustainability apply to technical textiles as well: raw materials from renewable sources, innovative eco-friendly production processes in the dyeing and finishing stages, durability, waste recovery and recycling. Particular issues related to technical textiles regard: replacement of high-performance engineered fibers with natural fibers and taking advantage of their biodegradability where possible, higher durability, need for care and maintenance during the service life, need for specialized recycling technologies that facilitate disassembly and separation, ease of removal of incorporated chemicals and additives. Raw materials and processing technologies must demonstrate minimal environmental impact without compromising technical performance of the final product. One other particularity comes from the potential influence of technical textiles upon the environmental impact of certain application areas, like agriculture or packaging. This paper aims to shortly review necessary actions required to minimize the environmental impact of technical textiles, and to investigate their possible influence upon the sustainability of the end-use industries they serve.

Keywords: *sustainable textiles, technical fibers, renewable resources, clean technologies, textile recycling.*

ANALYSIS OF THE MECHANICAL BEHAVIOUR OF TEXTILE-RUBBER COMPOSITE MATERIALS USING RECYCLED RUBBER AND TEXTILES

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Abstract.

This paper presents the mechanical behavior of composite materials obtained using recycled rubber from End-of-Life car tires and recycled textile. The materials used for the composite are rubber particles resulted after End-of-Life tire shredding processes and recycled cotton woven fabric. The rubber powder used had a higher content of natural rubber, from a motorcycle tire. The composite was realized applying a mixture of recycled tires rubber powder into a solution of acrylate rubber (AR), (NipolR AR 51) in acetone/ethyl acetate on a 100% cotton woven fabric. During the experiments, recycled textile 100% cotton specimens were used. The variation of the mechanical properties of the coated material versus the textile specimen was evaluated. The evaluation of the behavior of the rubber-textile composite under mechanical stress, compared with the original textile sample will set path for studying future applications, with the scope to provide industrial use. Circular economy tendencies over the globe are taken in consideration, using as much recycled products used as prime materials as possible. It will follow that the quality of the obtained products from recycled materials origins to be comparable with the ones made out of non-recycled materials.

Keywords: *Recycled rubber and textiles; circular economy; composite materials*

ECOLOGICAL SOLUTION THAT INTEGRATES LOW-QUALITY WOOL INTO A VALUABLE NATURAL INSULATION MATERIAL FOR SUSTAINABLE CONSTRUCTIONS

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Abstract.

In the current world situation, it is particularly important to implement the principles of sustainable development and the circular economy. Wool is a renewable resource that is currently underutilized. This paper presents indisputable evidence of the possibility of using these natural fibers of animal origin in the field of thermal insulation of buildings. A group of nonwovens produced by an aerodynamic process from renewable or recycled raw materials and their main technical characteristics were analyzed in terms of thermal insulation performance in relation to the production price. The results indicate good performances, with the best price-performance ratio in the range of apparent density of the product in the limits of 25-35 kg/m^3.

Keywords*: technical textiles; innovation; nonwovens; thermal insulation; wool.*

THE PRINCIPLES OF DECONSTRUCTION/RECONSTRUCTION FOR THE DESIGN OF SUSTAINABLE GARMENTS

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Abstract.

In the consumer market, clothing products have a short life cycle to meet fashion trends and customer demands. The collections that come to market follow each other rapidly and are based on the models presented on the catwalk. The desire to satisfy consumer needs with a variety of products was the basis for the emergence of the concept of "fast fashion". With this strategy, clothing collections are built on the latest fashion trends seen at the spring and fall fashion shows in New York, Paris, and Milan, offering consumers luxurious styles at an affordable price. Products that no longer meet consumer needs because they are no longer used become waste over time.

The way people get rid of clothes they are unlikely to wear again is to “throw them away”, turning them into waste. One solution to reducing this amount of waste that is toxic to the environment and every living thing (human, bird or animal) is recycling.

The principle of clothing recycling is still relatively new to many countries, brands, fashion houses or consumers. Recycling is the process of collecting, sorting and processing (discarded) materials and turning them into other raw materials or products. In this case, textile recycling means collecting, sorting and processing textile waste, both industrial and consumer, to convert it back into other raw materials, materials or products. One recycling principle that can be applied to clothing products is deconstruction/reconstruction (upcycling). Based on this principle, the authors of this paper develop a collection of avant-garde models for women’s clothing products

Keywords: *recycling; deconstruction/reconstruction; sustainable garments.*

SESSION 4.

SESSION 4.1.

Technical Textiles and Sustainability

Chair:

Cristina PIROI, *Gheorghe Asachi Technical University of Iasi, ROMANIA*

INVESTIGATIONS ON THE RECYCLING OF POLYPROPYLENE MATRIX COMPOSITES REINFORCED WITH HEMP FIBRES

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Abstract.

Polypropylene-based composite materials reinforced with natural fibres are developed at S.C. TAPARO S.A. Company for upholstered furniture applications. The replacement of wooden furniture parts with thermoplastic composite materials based on natural fibres reduces pressure on forest resources and contributes to the prevention of global warming. The increasing use of thermoplastic composite materials in various applications leads to increasing amount of waste that generates environmental pollution. Due to the new environmental regulations and to the shift from linear economy to circular economy, the recycling of materials becomes more and more important.

The aim of this paper was to investigate the effect of recycling on the mechanical properties of polypropylene composites reinforced with hemp fibres. For this purpose, composite material waste was prepared for thermoforming by two different methods: shredding and grinding. The tensile and flexural properties of recycled composite materials decreased after first cycle of recycling. Also, the results revealed that waste preparation by grinding led to better mechanical properties of recycled composite materials than waste preparation by shredding. The recycled composite material obtained from ground waste has been subjected to a second cycle of recycling. After a new cycle of recycling, both the bending strength and tensile strength slightly decreased.

Keywords: *Recycling; composite materials; polypropylene matrix; reinforcing hemp.*

CHEMICAL MODIFICATION OF CAROÁ FIBER (NEOGLAZIOVIA VARIEGATA) FOR APPLICATION IN ADVANCED FABRICS AND AS COMPOSITES MATERIAL REINFORCEMENT

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Abstract.

Vegetable fibers are an important group of materials from renewable sources, due to their large possibilities of applications in different areas of technology. Since textiles for clothes to fibers used as reinforcement in advanced composite material, these fibers have evolved along with other human developments. Despite this evolution, some characteristics may be increased or optimized by the use of technological methods. Thus, this analysis was carried out in order to investigate the influence of chemical treatment on the thermal, chemical and morphological properties of fibers from caroá (Neoglaziovia variegata), which remains still unexplored for advanced applications. Caroá is a native plant from semiarid region of Brazil and has been used for manufacturing of ropes, due to its natural mechanical property of tensile strength. Samples were submitted to chemical treatment of mercerization and bleaching, and characterized by chemical analysis, X-ray diffraction (XRD), Scanning Electronic Microscopy (SEM) and Thermogravimetric Analysis (TGA). The contents of cellulose and lignin were determined in each step of the treatment, and it was seen that, as mercerization and bleaching treatments were applied, the relative percentage of cellulose in the sample increase and the content of lignin decrease, thus indicating purification of fiber, as demonstrated also by changing in XRD patterns and confirmed by morphological analysis. In addition, thermal behaviour has been also changed, indicating an elevation of Onset temperature of the fiber, which is of high interest for further uses, as it gives them more thermal stability for high temperature applications. Therefore, the results of this study were essential to elucidate the chemical process that might be applied to obtain desirable properties of caroá fiber, in a effort to open up new possibilities for applications as advanced fabrics, yarns or non-woven materials.

Keywords: *Caroá; Chemical treatment; Thermal properties; Brazilian semiarid development*

SUSTAINABLE SOLUTIONS IN THE FIELD OF TEXTILES

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Abstract.

One of the most important ambitions of the clothing and textile markets is the transition to a completely sustainable value chain. This would mean that there is no negative impact on humans, animals and the environment during the life cycle of textiles. Such a huge change requires great adaptation on the part of buyers and producers, but also promises consistent social, environmental and economic benefits. This study will help companies and business support organizations understand what a sustainable transition is and how they can meet and exceed tomorrow's requirements. Most experts in transition theory agree that transitions occur when technical or social innovations are slowly adopted in existing systems in industry, culture, politics, science, consumer preference, and technology.

More innovations in the field of sustainable textiles will contribute to green, clean production, better waste management and the adoption of new strategies to improve working conditions. Consumption of water, energy and chemicals is a challenge for textile companies at every stage of the value chain.

Sustainable solutions for the field of clothing for industrial enterprises are described in this paper. Innovative techniques for sustainable product development are proposed.

The paper aims to highlight the most important aspects of sustainable product development without having unforeseen costs just by adapting them.

Keywords: *innovative product, industrial enterprises, adaptive clothes*

THE IMPACT OF PET FIBER ON THE TEXTILE INDUSTRY: REVIEW AND PERSPECTIVES ON SUSTAINABILITY BETWEEN 2000 AND 2020

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Abstract.

Over the decades of the 21st century, it was possible to notice the growth in the consumption of synthetic fibers in the world textile industry, with emphasis on polyester (PET) which was widely used thanks to its versatility in applications such as clothing, household utensils, packaging beverages, among others, in addition to the low production cost. However, with the increase in plastic waste in the environment, a discussion began on the environmental impacts caused by the accelerated production of these fibers, from manufacture to disposal of these wastes. Currently, being the most sought-after fiber, polyester has a composition with numerous aromatic chains, which makes it difficult to break and biodegrade, taking an average of 400 years to fully decompose in nature. In addition, the acceleration of consumption and disposal cycles for items produced with PET generates a significant increase in plastic waste in the environment. Thus, this study aims to bring the main references on the production of polyester through an overview of the impacts generated by the textile industry between the years 2000 and 2020 to point out sustainable solutions already used and prospect alternative solutions. The study of data was presented through qualitative and descriptive research, in which an analysis of the most relevant studies in the literature was demonstrated. Therefore, the results pointed to the fact that advances in the development of polyester fiber also boosted the culture of rapid disposal of products from this material. Although research on treatment methods for these residues has evolved a lot over the years, the percentage of treated residues is insufficient in relation to the polyester production speed, which only tends to grow. Through this analysis, it can be concluded that the treatment of PET fiber residues is essential for the sustainable development of the textile industry, and the constant search for new eco-compatible ways to treat the damage related to this production is essential for environmental reduction impacts already caused.

Keywords: *PET fiber; Textile industry; Sustainability; Environmental impact;*

SESSION 4.2.

Technical Textiles and Sustainability

Chair:

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

BIOMIMICKING AND TECHNICAL TEXTILES: REVIEW

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Abstract:

Biomimetics is a relatively recent scientific subject concerned with the extraction and replication of natural functioning principles and their application in engineering. It's a new name, but it's as old as humanity, and it refers to taking unique concepts and structures from nature and applying them to a new innovation that incorporates simple technology into our services. Examples of currently existent technical solutions that either parallel biology or are truly influenced by biological models highlight the impact of natural inspiration for technical fabrics. Some plants and animals in nature have some inspiring characteristics that scholars can look into. These distinguishing characteristics open up a plethora of possibilities for transferring the structure to technical textiles, allowing nature to impart wisdom. Nature gives us with amazing technologies everywhere around us, and all we have to do is calmly mentor and examine what is going on inside nature, and then impart that information so that humans can benefit from it. The most common biomimetic techniques are described and examined briefly. Inspirations for biomimetic products include a variety of structural and functional qualities found in various plants and natural environments. Developmental approaches are also addressed. Bio-copying of nature's recent achievements in the technical textiles field are briefly covered.

Keywords: *A biomimicking; bio copying; technical textiles; biological*

RECYCLING OF CHAMOIS LEATHER WASTE INTO VALUABLE PRODUCTS WITH POTENTIAL APPLICATIONS IN THE FIELD OF TECHNICAL TEXTILES

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Abstract.

The very large amounts of solid collagenous waste, resulted as by-products of the leather,slaughterhouse, fishing and aquaculture industries, lead to worrying environmental pollution, but also to a huge waste of protein resources with unique biological properties. Extraction of collagen from this waste and its conversion into products with high added-value make this biomaterial an important resource for obtaining multifunctional textiles with applications in technical fields such as: medical, pharmaceutical-cosmetics, sports etc.; moreover, a waste is brought into the circular economy paradigm.

This work aims to obtain collagen hydrolysates from chamois leather waste resulted from the buffing operation, which are able to induce some desired, permanent bio-functional properties to textile fabrics, resulted from crosslinking reactions with the functional groups of different textile fibers. Alkaline hydrolysis of the protein-based waste resulted in colloidal solutions with high polydispersity, given by the simultaneous presence of oligopeptide and polypeptide fractions, and amino acids as well. The hydrolysis yield, expressed as hydrolyzed proteins: collagenous substances in the chamois leather ratio, is around 19.04 % (wt/wt). The lyophilized collagenic form, resulted from alkaline hydrolysis, at pH=11 for 14 hours, has the following characteristics: destabilized conformation, functional activity, total dry matter content 82.97 %, total ash 4.74 %, protein content 90.96 %, and other organic matter content 4.3 %. The FTIR spectra of collagen hydrolysate demonstrates the presence of important band frequencies for assessing the hydrolysis degree, the damage extent of the conformational structure and the reactivity of the collagen form, which ensure biofunctional properties to the treated textile fibers. The collagen hydrolysate composition and hydrolysis degree are the main factors that impart new functional properties to the textile fibers: increased degree of softness and fine touch, moisture absorption and desorption properties, additionally skin rehydration as compared with clothing made of non-functional textile fibers, antistatic effect and protection against UV rays.

Keywords: *collagen; alkaline hydrolysis; oligopeptide; functional textiles*

DEVELOPMENT OF INTELLIGENT FUNCTIONAL PRODUCTS FOR CHILDREN

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Abstract.

Current trends show an integration of everything related to fashion and technology. Technology is reshaping the textile and clothing industry in a spectacular way. Smart textiles are the result of a long journey of technology.

Smart textiles have a complex of functions and properties that give more power to specialists in various fields of activity, more information in a short time. These fabrics are designed to monitor the condition of the body, to announce the detection of certain specific features of the person. Moreover, these fabrics can also function as protective clothing to protect the human body against extreme environmental hazards, such as radiation and the effects of space travel. Smart textiles can transmit information about the state of the body. This paper presents information on smart textiles with applications in the development of SMART products for children.

It is well known that children with certain health conditions need to monitor and accumulate data from medical investigations in order to follow the evolution of the treatment to which they are subjected. The products we propose for the examination of these patients are made of materials integrated with sensors. The functionality of developed clothing products is due to the injected sensors to detect the environment and respond appropriately to changes in the health of young patients. Fabrics are excellent tools for measuring the human senses. Data collection, processing, interpretation and storage are performed to monitor vital parameters such as body temperature, heart rate, respiration, pulse, etc. Therefore, smart textiles are the key to a new stage of progress.

Keywords*: Smart textile, clothes, fabrics, functionality, children.*

REVIEW ON GALLERIES AND DATABASES OF DIGITAL TEXTILE MATERIALS

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Abstract.

One of the main pillars influencing many industries is digital transformation that is increasingly changing the way companies create and deliver decision-making proposals and interact with their customers. When the goal is to implement a more cost-effective, productive, secure and sustainable way of studying materials, the answer is obvious: digitalization. Thus, to achieve the expected efficiency, it is necessary to go beyond the current definition of digital materials. The trend of constant use of digital devices in recent years has asked many questions about the most realistic possible rendering of the multitude of existing things, through a single image, so as to meet the requirements and needs of users. Digital galleries are considered to be different in their ability to store information. The field of evaluation and processing of digital images aims to transmit duplicates or more accurate reproductions of visual information for human consumption. Globally, the textile industry creates one of the most significant economic and environmental impacts. For this reason, all companies should focus attention on environmental sustainability since the product design phase by using digitalization. Digital galleries offer: streamlining of complex supply chains; financial efficiency; a larger gallery of materials; environmental sustainability. This paper reviews the existing approaches made by different companies regarding digitalization of textile materials, companies like Material Exchange, Pantone, X-Rite, Vizoo, Atacac, Swatchbook, etc. and existing digital materials databases such as CUR-et, KTH-TIPS OpenSurfaces, SynBRDF, UTIA. Findings suggest that existing research on digital libraries focuses mainly on technical issues and models of using the digital library. A much more intense approach from the client's point of view and more precisely the subjective evaluation is needed. As a result, the subjective evaluation will facilitate the process of understanding and taking into account the needs and expectations of customers in the development of digital libraries of textiles.

Keywords: *Digitization, digital textiles, digital library, sustainability.*

SESSION 5.

SESSION 5.1.

Textile Education and Training for the Technical Textiles Field

Chair:

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DESIGNING COURSES FOR TECHNICAL DISCIPLINES FOR ONLINE AND BLENDED LEARNING

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Abstract.

In recent years information and communication, technologies have very dynamic changes, which have very deep mark on education. Education management systems or learning management systems (LMS) have developed rapidly, leading to the widespread adoption and use of e-learning systems. This was also reflected in the teaching and learning resources, it redefined the roles of the participants in the learning process, putting new challenges in front of the teachers. This was also reflected in the teaching and learning resources, it redefined the roles of the participants in the learning process, putting new challenges in front of the teachers. Thus, they had to carefully select new tools to achieve their educational goals, but at the same time, they had to acquire new skills. The creation and maintenance of online courses depend on the purpose of the organizations in which the teachers work, in particular to meet the requirements of students and the business environment to the fullest. The COVID-19 pandemic accelerated the use of various learning management platforms, but in many cases, teachers had to adapt quickly to tools with which they were not very familiar. This article presents an analysis of how to design a course for a technical discipline, using the facilities provided by a Moodle platform. Moodle provides a series of course format: weekly, topics, unique activity or social media. These types of formats can developed depending on the objective pursued in the course - free or conditional scrolling. The format in which better results were obtained was the weekly one with conditional completion for a technology course with laboratory activity, respectively the subject type format for a course with design activities. These course design methods will also be effective in the case of face-to-face or mixed activity.

Keywords: *e-learning; Moodle; course format; technical courses; course design.*

STATISTICAL METHOD FOR A TEXTILE PROCESS OPTIMIZATION

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Abstract.

The application of statistical techniques for the optimization of technical processes represents an actual challenge, from the point of view of the application methodology on technical process as well as of the qualitative and quantitative analysis of the results. This paper presents the steps to obtain a statistical model for a technical textile process - the influence of plasma treatment on polypropylene fibers. The plasma treatment of polypropylene fibers in variants differentiated by the working parameters of the installation led to appreciable modifications of the mechano-rheological and surface properties of fibers. Thus, the paper focus on highlighting the influence of technical parameters - active power and number of cycles, on the properties of polypropylene fibers, as well as the determination of some conditions for its optimization. The first step of statistical modeling is to obtain data from the textile process through the programmed experiment method. The significance of the regression equation coefficients and the statistical adequacy of the model were analyzed. The results obtained by the presented research are highlighted quantitatively and qualitatively throughout the experimental region and can be used in the educational and industrial field. The current research is useful didactically, by presenting the steps of statistical modeling on a textile process with a practical applicability in the technical field.

Keywords: *plasma technology; polypropylene fibers; statistical methodology; mathematical model; statistical optimization.*

DESIGN-BASED LEARNING IN KNITTING THROUGH EDUCATIONAL MODULES OF ERASMUS+ PROJECTS

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Abstract.

The usefulness of the Erasmus educational projects depends on the implementation of the proposed objectives, and on the real impact on the professional development of the trainees of a target group. The successful implementation of the Erasmus+ project "E-Learning Course for Innovative Textile Fields"/Advan2Tex enabled the consortium project to pursue sustainability and move forward to a new project, „Software Tools for Textile Creatives"/ OptimTex. Aimed at improving the knowledge and skills to develop key competencies in young textile specialists, including higher education students, the two projects had among the objectives, a common goal: providing innovative instruments for adequate training of these future professionals. This objective involved the development of new educational materials accessible through a dedicated e-learning platform and delivered as educational modules on innovative and up-to-date textile topics. Being technical disciplines, the approach of the teaching modules was based on the concept of design-based learning. Within comprehensive packages of educational modules, the Advan2Tex project included the Advanced Knitting Technologies module, and the OptimTex project included the Design and Modelling of Knitted Structures module, the latter involving an upper level of knitting knowledge provided by means of the software tools. This paper presents the two educational modules for knitting techniques and structures, completed by partner TUIASI within each project, and details of the Design and Modelling of Knitted Structures e-learning module. Four groups of knitted structures settled as examples are included in the educational module, presented in order of increasing complexity from standard level to a higher level of 3D structures as the ultimate applications of knitting design software for technical textiles. Therefore, the higher education students are helped to understand the theory by using up-to-date software applications for knitting design, approaching projects by a design case, and solving real-technological tasks to achieve a certain knitted structure.

Keywords: *Erasmus+ project; educational module; design-based learning; knitting techniques; knitted structures.*

REVIEW OF SMART CLOTHING WITH EMPHASIS ON EDUCATION AND TRAINING

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Abstract.

In recent years, we have witnessed a remarkable development of clothing with increased functionality, such as being able to detect, respond and/or adapt to stimuli from the environment, to which they are exposed, especially in the field of sports and health. They allow tracking of athletes during training to improve their performance, health and well-being or contribute to patients' health monitoring, rehabilitation and increase user safety. Today, the development of smart clothing or wearable clothing systems is even more progressive due to the development of smart or intelligent textile materials in collaboration with other sciences. The article gives an overview of smart clothing in the field of sports and health in recent years and highlights the importance of integrating new research achievements into the study process through the extracurricular project education of students in the interdisciplinary field of smart clothing through the last two projects, which were implemented and co-financed by the Republic of Slovenia and the European Union from the European Social Fund. Such projects promote flexible forms of learning and support high quality career guidance for students at all education levels. The goals of these projects are to solve practical problems in economics using an innovative, problem-based and group interdisciplinary approach to the problem, gaining practical knowledge and experience and promoting student innovation, creative thinking, entrepreneurial mindset, and subject-specific competences in the field of study and other sciences. In addition, the article presents the objectives of the Erasmus+ project OptimTex - Software tools for textile creatives, and the contents of the e-learning module Design and modelling of garments by 3D scanning software and CAD/PDS software developed by the Slovenian partners.

Keywords: *Smart Clothing; Education and Training; OptimTex Project; E+ Program.*

SESSION 5.2.

Textile Education and Training for the Technical Textiles Field

Chair:

Adrian BUHU, Gheorghe Asachi Technical University of Iasi, ROMANIA

BEST PRACTICES OF SUSTAINABLE PRODUCT DEVELOPMENT THROUGH 3D DESIGN AND VISUALISATION

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Abstract.

The research project "Sustainable Fashion Curriculum at Textile Universities in Europe, Development, Implementation and Evaluation of a Teaching Module for Educators", FashionDIET, co-funded by the Erasmus+ program of European Union, aims to create an Education for Sustainable Development (ESD) module and research-based teaching and learning materials delivered through an e-learning portal.

One of the ESD module topics is the "Best practices of sustainable product development through 3D-design and visualisation'', which is briefly presented in this paper. The need for such a topic is justified through the initiative of the European Commission, namely the European Industry Digitization Initiative, to strengthen EU competitiveness in digital technologies and ensure that every business in Europe can fully benefit from digital innovation. Action Plan for Fashion and High-End Industries Program, Horizon 2020 Program, Euratex Strategy, are initiatives that support the digitalisation of the fashion and apparel industry. In this framework, the Fashion DIET project is aligned to create new tools for lecturers, teachers, trainers, students, young textile specialists and the textile supply to improve and update their key competencies for a digital world. This module will contain an introductory part in which are explained the concepts of digital technologies for the textile and fashion industry (digitisation/digitalisation and digital transformation), sustainable solutions for 3D apparel development, and examples of best sustainable product development practices (3D product design/ 3D visualisation). By this approach, the Fashion DIET project will generate research-based teaching and learning material for higher and school education to educate educators for a digital textile and fashion industry.

Keywords: *digital transformation; sustainability; 3D product development; 3D product visualisation.*

DRIVERS OF CHANGE FOR THE ROMANIAN TEXTILE, CLOTHING, LEATHER AND FOOTWEAR SECTORS

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Abstract.

The TCLF sectors' competitiveness in Romania is affected by several factors that are not necessarily linked to the European ones, such as transportation infrastructure, regional disparities, labour mobility, capacity for innovation of the companies, legislative changes. However, concerning the external factors of influence at the macroeconomic level, and based on the interviews conducted in the framework of the Skills4Smart project in 2019 on 24 companies in the TCLF sector in Romania, the following drivers of change are analysed: A new customer, Demographic change and Environmental change, Technological change, Regulation&Governance, Economic&Globalization, Value&Identities.

Keywords: *TCLF industries, demographics, environment, technology, new consumer,*

USING DATABASES WITH SUCCESS STORIES AS AN INSTRUMENT IN ENGINEERING EDUCATION – THE CASE OF WINTEX PROJECT

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Abstract.

Engineering higher education is defined by practicality and requires teaching/learning tools adapted to its specifics. Examples of new products or technologies that are used in the textile industry or in other domains are an excellent instrument to not only show case the use of certain acquired knowledge and skills in completing engineering tasks in day-to-day life, but also in pointing out innovative approaches to developing new products and how to combine technical knowledge and entrepreneurship skills using business models applied to the European conditions of the textile and clothing sector. The paper presents the development of such a collection of success stories identified in the field of textile engineering and entrepreneurship and how it was built in order to answer the needs of the engineering training process. The collection of this database was carried out in the frame of the ERASMUS+ WINTEX project. Apart from the data regarding innovative practices from the industry, the database also takes into consideration existing projects for capacity building for textile higher education and underlines the importance of efficient cooperation models between universities and companies. The large geographical diversity of the contributors ensures relevance and an overview approach of the resulting content of the database.

Keywords: *Textile and clothing industry; Examples of Database structure; Academic tool; Textile engineering education.*

SESSION 6.

SESSION 6.1.

Management and Entrepreneurship

Chair:

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FUZZY BASED SYSTEM FOR TEXTILE COMPANY PERFORMANCE ASSESSMENT

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Abstract.

The contemporary industrial environment, subject to globalization generates continuous challenges for industrial textile companies, which must demonstrate on one hand reactivity to the external environment and, on the other hand, internal flexibility for developing and maintaining a sustainable competitive position. Recent developments in management and performance measurement are aligned and, in the meantime, seek to address these contemporary challenges of the technological and socio-economic environment. The social environment in which corporations operate is affected by their actions, but at the same time corporations experience the pressures of society. The idea that we are currently in a phase of transition from the knowledge-based economy and society to the innovative economy and society is strongly encouraged by significant representatives of academia and international business. Both knowledge and innovation are essential elements for an industrial company in achieving and maintaining a sustainable competitive position. In this context, production systems represent the interface between invention / innovation and socio-economic development, being those that translate innovation into finished products and bring them closer to the customer, thus contributing to the continuous improvement of quality of life. The paper aims to develop a fuzzy expert system, which can be implemented in textile companies to monitor performance indicators that can contribute to a sustainable competitive position.

Keywords: *performance assessment; fuzzy modelling; expert system design; decision making; competitive position.*

ORGANIZATIONAL SUSTAINABILITY MAIN COMPONENTS IDENTIFICATION USING PCA

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Abstract.

Organizational sustainability is an approach that aims to create long-term value for stakeholders by implementing a business strategy that focuses on the environmental, economic and social dimensions. Thus, sustainability represents a comprehensive issue in that it directly apply / integrate synergically this concept at business level (compared to the macro-sustainability plan), focusing in particular on long-term environmental, financial and social performance. In the literature, the issue of organizational sustainability is analyzed extensively, but with the risk of being unclear through its very practical foundation. Consequently, it's very difficult to evaluate and propose actions for organizational sustainability, given the lack of consensus on addressing this issue (indicators, associated dimensions correlations, methods, models, methodologies). The main objective of this paper is to identify the main components associated to organizational sustainability (dimensions: economic / financial, environmental and social) based on its determinants (using the main components analysis – PCA, and respectively the scores on each component). The results this research will contribute to the completion of scientific knowledge, by combining classical methods of data analysis with advanced one. Thus, starting from a series of empirical evidence and statistically validated causal links, was obtain the models in order to assess organizational sustainability - aspect in its "beginning" in the literature.

Keywords: *organizational sustainability; main components identification; PCA; statistical evaluation; econometric models.*

FAST FASHION – AN INDUSTRY AT THE INTERSECTION OF GREEN MARKETING WITH GREENWASHING

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Abstract.

The textile and apparel industry has experienced substantial growth over the last twenty years, which led to an intense analysis of its economic, environmental, and overall social impact and for good reasons, considering that it is the second world's largest industrial polluter after the oil industry. As a response, manufacturing companies began to understand that a more conscious approach towards sustainability and sustainable business models and practices is no longer an option, but a necessity, as consumers are beginning to pay more and more attention to these aspects. However, addressing sustainability in the textile and apparel industry comes with a significant set of challenges due to the production–consumption relationship, especially for fast fashion brands. Because the fast fashion model relies on frequent, trend-driven, impulse buying of low-cost mass-produced clothing, and because marketing is an essential business function that plays a critical role in communicating, delivering, and exchanging offerings for consumers and society at large, it is essential to reinvent it as well in order to manage the sustainability imperative. As a result companies began to adapt their offerings to better answer the customer's need for greener products and services and to adopt green marketing as a strategy to create sustainable competitive advantages. Because green marketing incorporates an extensive set of activities, including changes of products, production processes, packaging, and advertising. At the other end of the spectrum, companies wanting to gain a better image and position themselves as more sustainable, despite their unchanged business and manufacturing practices began to advertise their "green-ness" instead of reducing their environmental impact and social impact. The research aims to analyze the evolution and transformation of green marketing and greenwashing as business strategies and the way fast fashion companies are employing both to gain competitive advantages.

Keywords: *Green marketing; Greenwashing; Marketing strategy; Fast fashion; Textile industry.*

LIVING LABS: A FRAMEWORK OF ANALYSIS

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Abstract.

The concept of Living Labs (LL) appeared in academic discussions in the 1990s, but did not take shape until 2006, when the European Commission launched projects to advance, coordinate and promote a common European innovation system based on "living laboratories". A fashionable term, even if sometimes confusing, living labs often refers to both the methodology and the tool or agency that is created for its practice, these being driven by two main ideas: a) involving users as co-creators on the same reasons with the rest of the participants and b) experimentation in real environments. In short, living labs ensure the structure and governance of user participation in the innovation process. Thus, defined as innovation networks based on the philosophy of open innovation, where users become equivalent to other participants, living labs are largely ICT-based innovation networks. Hence the following distinction: in living laboratories, users shape innovation in their real everyday environments, while in traditional innovation networks or laboratories, users are observed and their perspectives are captured and interpreted by experts. From a methodology perspective, processes such as data transfers and methods of user involvement are highlighted. Most of the methods used are qualitative, often focusing on finding needs, participatory design and user involvement. The aim of this paper is twofold: to offer an overview of living labs, and to explore and identify the types of living labs and their use.

Keywords: *co-creators; living labs; open innovation; innovation process.*

SESSION 6.2.

Management and Entrepreneurship

Chair:

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THE CIRCULAR ECONOMY BUSINESS ECOSYSTEMS: THE EDGE OF KNOWLEDGE

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Abstract.

During the last decades there are various discussions about the development of business ecosystems versus innovation ones. One of the most promising streams was closely linked to the development of those type of ecosystems within Circular Economy framework. As this research direction is new with the respect to the business ecosystems domain, there should be discovered the anchor point which will explain and fill the gaps in circular economy business ecosystems development. One of the unexplored features is closely linked to the ecosystem model applied to the circular economy domain. Thus, this paper aims to provide an extensive exploration of the linkage between business ecosystems and circular economy framework based on literature review and critical analysis. The foreseen result of this paper is to discover how multiple stakeholders' involvement contributes to the development of circular economy ecosystems, to uncover the main transitions from organizational to ecosystems point of view and to define the main streams which can lead to this transition with the respect to business ecosystems theory. Consequently, the provided state of the art can lead to the development of new research directions, to the understanding of the main mechanisms of circular economy business ecosystems development and will contribute to further development of the concept.

Keywords: *business ecosystems, business models, circular economy, innovation, stakeholders 'engagement*

APPROXIMATE PREDICTION MODEL FOR A HETEROGENEOUS AND COMPLEX MACHINE INTERFERENCE PROBLEM

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Abstract.

The problem of system interference is a classic one in the field of operational research frequently encountered in production management. This work treats an heterogeneous and complex machine interference problem in which an operator serves different groups of machines affected by random stops. A group comprises all machines that perform similar processes. For such a complex machine interference problem, even if only one failure mode is considered, the Markov model can reach hundreds or even thousands of states. The paper presents approximate prediction results regarding the efficiency of the machines depending on the number of machines allocated to the operator, based on a reduced Markov model. To reduce the Markov chain, in a first stage, a model with machines of the same type is applied, in order to capture the interference phenomenon depending on the total number of machines allocated to the operator. In this step, an average efficiency is determined based on some average rate values related to random stops or repair operations. Then, in a second stage, the efficiency is adjusted for each group of machines based on the specific values of the stop rate and the repair rate, respectively. With this approximation, the problem boils down to the simpler case where the operator serves only machines of the same type. As for this much simpler model computational relations are known, the prediction problem of machine interference is considerably simplified**.** Nevertheless, for a high accuracy estimation in this complex prediction problem, a based simulation method is recommended. As simulation model, a formalism of stochastic Petri nets can be used, in which for a timed transition, the execution rate depends on the marking value of the input place.

Keywords: *Machine interference; Machine efficiency; Prediction models; Markov chains; Stochastic Petri nets*

STATISTICAL MODEL WITH ARTIFICIAL INTELLIGENCE COMPONENTS FOR THE DEPENDABILITY OF A TEXTILE PROCESS

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Abstract.

The complexity of the technical processes, respectively the quantitative and qualitative systemic modeling, determines the combined use of the different mathematical techniques for highlighting the connection and the causal relationships between the components of the technical systems. The application of the analytical methods to this type of problems implies, first, performing a quantitative analysis (knowledge of the technical content), identifying the causality between the technical parameters and secondly, drawing up some statistically justified conclusions about their interdependence. The paper combines the procedures of data systematization and verification of the existence of the interdependence between maintenance parameters of technical system with procedures for checking and measuring the interdependence form (regression analysis) and artificial intelligent procedures (neural network and genetic algorithm) into unitary algorithm applied to the data set measured on a textile process. Thus, we design a didactic and practical application methodology, structured gradually on a real data set, with objectives observed and conclusions justified at each stage of analysis. This paper complements and was based on scientific papers from the specialized literature in this field, for the use of working hypotheses regarding the distributions of the series of parametric values and the logical relationships of interdependence between the studied parameters. The importance of the paper derives from the theoretical and practical implementation of a unitary statistical based on artificial intelligence algorithms in the field of textile systems maintainability, which will gradually define with varied complexity the relationship between the maintenance parameters.

Keywords: *statistical method, quantitative modeling, artificial intelligence algorithms, textile process.*