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The **22nd edition of the International Scientific Conference "Innovative Solutions for Sustainable Development of Textiles and Leather Industry"** is a prestigious international event in the field of textiles, leather, and related industries. It is organized by the **Department of Textiles, Leather and Industrial Management** of the **University of Oradea, Romania**, and will be held on **May 29th–30th, 2025**, in Oradea.

With a well-established tradition, this conference brings together scientists, researchers, students, and industry professionals from around the world. It serves as a dynamic platform for sharing theoretical and applied knowledge, exchanging scientific ideas, enhancing international cooperation, and fostering new partnerships in the textile and leather sectors.

Building on the success of previous editions, the 22nd conference continues to uphold high academic and scientific standards. Through a rigorous peer-review process and consistent inclusion of conference proceedings in recognized international databases, it aims to inspire future research directions and encourage collaboration among universities, companies, and public institutions in addressing key economic and societal challenges.

All accepted papers will be published in the **Annals of the University of Oradea, Fascicle of Textiles-Leatherwork (ISSN 1843-813X)**. This journal is indexed in international databases such as **EBSCO, Index Copernicus, DOAJ** and others, ensuring broad visibility and academic recognition for contributors.

The format of issue involves a printed book of extended abstracts and electronic version of the full papers.

Topics of interest for submission include, but are not limited to:

1. **Textiles**

Smart Textiles

Technical Textiles

Textile Design & Fashion design

Fibres, Yarns & Fabrics

Technology, Machinery & Equipment

Innovation of Industry Chain of Textile and Apparel

Testing & Quality Control

Composite Materials

Surface Treatment of Fibers and Fabrics

Computational Modelling and Simulation

Dyeing, Finishing & Printing

Energy Saving and Emission Reduction

2. Leather and Leather substitutes

Machinery& Equipment

Systems and Technologies

Footwear design

Materials

Biomaterials

Environment

Clean Innovative Technologies in Leather Making

3. Management and Marketing

Innovative process management for SMEs in the fashion industries

Cost monitoring and other economical intelligence tools

Labour risk: equipment, infrastructures, awareness Clustering and international cooperation

Political, industrial and commercial competitiveness studies and measures

Mass Customisation

Marketing policies and methodologies

E-Commerce and B2B strategies

Monitoring methods in fashion trends

Please note that the editors take no responsibility of the results, opinions and conclusion expressed in the published papers.

Organizing committee
Oradea, 2025

MANAGEMENT AND MARKETING

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"Innovative solutions for sustainable development of textiles and leather industry"

SUSTAINABILITY AND INNOVATION TRANSFORMING FASHION OPERATIONS MANAGEMENT

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Key words: *Sustainable Practices, Circular Economy, Supply Chain Innovation, Ethical Production, Digital Transformation, Economic Priorities, Ecosilence.*

1. ABSTRACT

The fashion industry is currently in a state of flux, driven by growing consumer awareness and increasing regulatory pressure for sustainability and, above all, transparency. This paper examines the intersection of operations management, innovation, and socio-environmental responsibility within the fashion and apparel sector. Using qualitative methods, including an in-depth literature review and semi-structured interviews with leaders of responsible fashion companies, the study identifies key practices, tools and challenges related to the transition to sustainable operations. Findings emphasize the integration of advanced technologies, such as ERP systems and supply chain digitization, to optimize resource utilization and improve traceability. The adoption of circular economy principles, including material recycling and small-scale localized production, appears to be a promising but complex strategy. Persistent obstacles, such as high implementation costs, systemic opacity and technical constraints, remain particularly significant for small and medium-sized enterprises. To address these challenges, the paper recommends systemic collaboration, policy incentives, and investment in education to empower both businesses and consumers. This preliminary study provides actionable insights for practitioners and policymakers, while also identifying opportunities for future research to support the sustainable transformation of the fashion industry.

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TEXTILES

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MODIFICATION OF COTTON FABRICS WITH CHITOSAN FOR IMPROVED DYEABILITY WITH ACID ORANGE 7

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Keywords: *textile; dyeing; mordant; eco-friendly; cotton modification.*

1. ABSTRACT

Cationized cotton fibres, achieved through chemical modification with cationic compounds, have been explored to improve dye uptake while also addressing the concerns about the environmental impact of low exhaustion rates and the use of salts. Chitosan, a green biopolymer, is a potential eco-friendly textile chemical due to its nontoxic, biodegradable, and cost-effective nature. This study investigated the effects of chitosan modification, with and without citric acid crosslinking, on washing and dyeing using an anionic dye, Acid Orange 7. The experimental analysis included fabric preparation, chitosan solution formulation, padding application, curing, washing, and dyeing. Dye exhaustion percentages and colour measurements were analysed. The results demonstrated enhanced dye exhaustion in chitosan-modified cotton fabrics, with optimal results observed at 120°C curing. Chitosan modification led to darker and deeper shades in dyed fabrics. However, adding citric acid for crosslinking did not significantly improve dye exhaustion. In conclusion, chitosan modification improved dye exhaustion and colour intensity, showcasing its potential as an eco-friendly alternative for enhancing dye uptake in cotton fabrics. Further investigations could optimise solution preparation and application methods for optimal results. This study contributes to sustainable practices in the textile industry by highlighting the potential of chitosan as a dyeing enhancer.

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TREATMENTS APPLIED TO THE MATERIALS IN THE COMPOSITION OF MATTRESS COVERS

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Key words: *chemical treatments, fibers, hotel regimen, household use.*

1. ABSTRACT

The chemical treatments applied to the materials used in the manufacture of mattress covers can significantly influence their quality, strength and durability. The present work has demonstrated that these treatments are important for achieving the desired performance, adapting to the different uses of the covers, whether it is for domestic use or for use in the hotel sector. Addressing consumer education on the use of chemicals in textiles is key to promoting informed choices and a healthy and sustainable lifestyle. The comparative analysis of the finishing treatments of natural materials used in mattress covers highlights the fact that each treatment has a specific applicability depending on the field of use. Manufacturers must consider balancing the needs of comfort, durability and aesthetics, without compromising sustainability. Thus, consumers can benefit from quality products, adapted to their specific requirements. In the present work, a detailed analysis of the materials used for the manufacture of two types of mattress covers was carried out: one intended for domestic use and the other oriented to the hotel regime. The aim of this research was to obtain essential information about the chemical treatment process of the fibres in the new covers and to assess the impact of these

treatments on the performance and safety of the product. Future studies should focus on examining these covers and the chemical compounds they contain.

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ADVANCES IN TEXTILE MANUFACTURING WITH 3D PRINTING TECHNOLOGY

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Key words: *Additive Manufacturing, Fused Deposition Modeling, PLA, flexibility*

1. ABSTRACT

This paper explores the most used technologies and materials in 3D printing for textiles. It presents an overview of additive manufacturing techniques such as Fused Deposition Modeling (FDM), Stereolithography (SLA), and Selective Laser Sintering (SLS), highlighting their applications in textile manufacturing. Various materials, including PLA, ABS, PETG, TPU, and specialized resins, are examined for their mechanical properties, flexibility, and suitability for textile integration. The study also reviews recent advancements in 3D-printed textiles, emphasizing innovations in material composition, structural designs, and process optimization. Research findings on chain structures, auxetic materials, and bio-compatible resins demonstrate the potential of 3D printing in producing functional, wearable textiles with enhanced comfort and durability. Furthermore, the integration of smart materials, such as shape memory polymers, elastic liquid crystals, and hydrogels, opens the way for 4D printed intelligent textiles that adapt to environmental stimuli like temperature, humidity, and mechanical stress. Sustainability and customization are key drivers in the adoption of 3D printing in the fashion industry, as the technology reduces material waste, enables ondemand production, and offers new possibilities for personalized garments. Despite significant progress, challenges remain in scalability, material limitations, and adherence to traditional textile properties. Future research will focus on enhancing material performance, refining printing techniques, and exploring hybrid manufacturing approaches.

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ANALYTICAL AND CONTROL METHODS FOR ASSESSING QUALITY AND NON-QUALITY PARAMETERS. A CASE STUDY PART I

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Key words: *Graphical methods, tabular methods, webbing, defects, quality*

1. ABSTRACT

In this study, a case analysis was conducted to evaluate the application of graphical and tabular methods in monitoring and controlling both quality and non-quality parameters of webbings manufactured using a webbing loom. The analysis and control of product and process quality can be achieved through various methods, including graphical, tabular, and matrix-based approaches. To address most quality-related issues, graphical methods known as the Seven Basic Quality Tools can be employed. These include the cause-and-effect diagram (also known as the fishbone diagram or Ishikawa diagram), the histogram, the Pareto chart, the scatter diagram, the stratification diagram (also referred to as the process diagram or data sequence diagram), the check sheet, the control chart and tabular methods. Information presented through charts and tables is structured in a way that enhances clarity, making it easier to comprehend and retain.

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ANALYTICAL AND CONTROL METHODS FOR ASSESSING QUALITY AND NON-QUALITY PARAMETERS. A CASE STUDY PART II

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Charts are two-dimensional visual representations that facilitate easy and quick understanding of the situation and the analyzed data, allowing for the rapid identification of trends, relationships, and variations in the characteristics being examined. They can be used to highlight patterns within a dataset, compare information, and support decision-making. Tables are structured in a matrix format and are used to present data in a clear and systematic manner. Unlike charts, which

provide a quick visualization of trends, tables allow for a detailed and precise presentation of information. They are particularly useful when accurate comparison of values is required or when access to specific individual data points is necessary.

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ANNALS OF THE UNIVERSITY OF ORADEA
FASCICLE OF TEXTILES-LEATHERWORK

VALIDATION OF EDUCATIONAL STRATEGIES FOR FORMING SOCIOCULTURAL VALUES IN STUDENTS OF ENGINEERING STUDY PROGRAMS

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Key words: *strategies, educational process, values, culture, heritage, variables*

1. ABSTRACT

The, study of the specialized literature on the dimension of educational strategies in promoting sociocultural values has highlighted the interest of some researchers in various aspects such as educational strategies, widely reflected in national historiography. A special place belongs to research in the field of sociocultural values, cultural heritage, education through and for heritage, current at the beginning of the 21st century. The human need to face social challenges, directed us towards choosing the research topic regarding the formation of sociocultural values in engineering students through the use of educational strategies.

In this context, recent studies highlight the importance of integrating sociocultural values into the educational curriculum, not only for the formation of strong character and cultural identities, but also for the development of intercultural competences that meet the demands of a globalized environment. Research also suggests that education, when oriented towards the understanding and appreciation of cultural heritage, contributes significantly to the formation of a responsible and conscious attitude towards the social and cultural past and present.

The application of educational strategies in the field of engineering, a field often considered technical and objective, may seem less related to the promotion of sociocultural values, but there is a growing interest in their integration into professional training. In this regard, innovative educational approaches, which

include interactive and participatory methods, such as project-based learning, case studies and discovery learning, have been recognized as essential for facilitating the understanding and application of sociocultural values in the daily lives of students.

Therefore, the research is oriented not only towards identifying the most effective educational strategies, but also towards exploring their impact on the formation of sociocultural values in young people in the field of engineering, thus contributing to the consolidation of a society that values cultural diversity and social responsibility.

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INTERNATIONAL SCIENTIFIC CONFERENCE
"Innovative solutions for sustainable development of textiles and leather industry"

ECO-TEXTILES – FOR A SUSTAINABLE FUTURE

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Key words: *uppers for sports shoes, fashion industry, design program STOLL M1+.*

1. ABSTRACT

The adoption of eco-friendly textiles plays an important role in transforming the fashion industry into a more sustainable sector. Despite the challenges faced, such as higher upfront costs and underdeveloped recycling infrastructure, it is essential to recognise the long-term benefits that can appeal not only to the well-being of the environment, but also to the health of consumers and the economic viability of producers. Recycled polyester yarn used in the textile industry, especially in the knitting process of a sports shoe, is a significant innovation that brings multiple environmental benefits. Sports shoe uppers made of such materials are not only an environmentally friendly choice, but also a viable option in terms of performance, providing comfort, durability and aesthetics. In addition, the use of recycled polyester contributes to the creation of a circular economy, in which products have a longer lifespan and are re-entered into the economic circuit. This not only fosters innovation in footwear design and production, but also improves the image of brands that adopt such sustainable solutions. In this context, consumers become more aware of the impact of their choices and can opt for products that reflect their ecological values.

In conclusion, the recycled polyester yarn used to make sports shoe uppers is not only a sustainable alternative, but also an opportunity to redefine industry standards and promote more responsible practices that protect the environment and contribute to the development of a more sustainable society.

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FROM THEORY TO PRACTICE: THE EUROPEAN UNION'S LEGISLATION ON WASTE MANAGEMENT AND THE CURRENT SITUATION OF TEXTILE RECYCLING IN ROMANIA

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Key words: *EU's Directive, waste, recycle, sustainability, circular economy.*

1. ABSTRACT

Waste, regardless of its nature and origin, has a serious impact on several areas of life, causing a multitude of negative effects on both human health and the environment, climate and, last but not least, the economy. The amount of clothes produced globally has experienced a significant increase with the emergence of the concept of fast fashion. A direct consequence of this is the increase in textile waste. In order to reduce the negative impact on the environment, the European Union has implemented various regulatory acts which aimed at reducing textile waste and increasing the life cycle and recycling of textiles, like the Directive 2008/98/EC of the European Parliament and of the Council, amended by the Directive (EU) 2018/851 of the European Parliament and of the Council. In Romania, nowadays, the Government Emergency Ordinance no. 92 of August, 19, 2021 is in force. One of the most important provisions that can be found in the above-mentioned Emergency Ordinance is that by January 1, 2025, the national authorities must introduce separate collection of textiles. This measure of separate collection of textiles represents an important step towards sustainable resource management and reducing environmental impact. This paper will show which are the refererences to textiles made in the European Union's

Directive, as well as the situation in our country regarding the transposition of the European regulatory acts. At the same time, it will also present the stage in which textile waste collections is in Romania.

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TEXTILE WASTE MANAGEMENT IN ROMANIA IN THE CONTEXT OF THE CIRCULAR ECONOMY

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Key words: *TIR, TMW, reuse, repair, recycling.*

1. ABSTRACT

The circular economy in Romania's textile industry represents a sustainable resource management model that aims to reduce waste and maximize the value of materials throughout their entire life cycle [1]. This concept promotes the reuse, repair, and recycling of textile products, in contrast to the traditional linear economic model based on "take, make, and dispose."

In Romania, the textile industry has a long-standing tradition, but in recent years it has faced challenges related to managing textile waste [2]. Selective textile recycling is essential to prevent pollution and conserve natural resources. This involves the separate collection of textile waste from consumers and sorting it based on the type of material and the degree of wear. The materials can then be reintroduced into the economic cycle in the form of recycled fibres, new products, or even fuel for energy production [3].

This article explores the potential and challenges of implementing a circular economy in Romania's textile sector, focusing on sustainable resource management and waste reduction [4]. The study highlights the limitations of the current linear economic model, which heavily relies on the consumption of non-renewable resources and generates a significant amount of textile waste. It emphasizes the need for a transition to circular practices, including reuse, repair, and recycling, to improve sustainability.

The study highlights the urgent need to improve the selective recycling system in Romania, where the textile waste recycling rate remains alarmingly low, ranging between 6% and 10%.

The fiber composition of textiles, mainly fiber blends and woven structures, complicates the recycling process, requiring specific treatments and complex processing technologies for each type of waste.

The analysis of clothing wear also revealed the negative impact of fast fashion, which promotes short product lifespans and leads to increased waste volumes. This trend is further exacerbated by the preference for multicolored items, which hinder efficient recycling compared to single-color garments made from a single type of fiber, offering greater reuse potential.

Implementing a circular economy in Romania's textile sector is not only essential for environmental protection but also a strategic opportunity to develop new markets and create jobs, thereby contributing to sustainable economic growth. This transition requires a strong commitment from all involved institutions to ensure the efficient and responsible management of textile resources in the future.

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FUNCTIONALISATION OF TEXTILE MATERIALS WITH VOLATILE COMPOUNDS

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Keywords*: volatile oils, chromatography, mass spectrometry, chemical compounds*

1. ABSTRACT

This research work aimed to determine the components of textile materials with volatile oils treated with essential oils extracted from Eucalyptus globulus and Pine. Two types of textile materials (Variant 1 - 80% cotton / 20% Elastane and Variant 2 - 45% cotton / 55% Polyester) were prepared and treated with the solutions of essential oils in the concentration of 0,002%. After completion of the treatment, the samples were dried freely at room temperature for 24 hours [1]. The Gas Chromatography-Mass Spectrometry (GC-MS) method was applied to obtain the chromatograms of the essential oils and the constituent chemical compounds [2]. The following compounds were identified in eucalyptus essential oil: Caryophyllene oxide, m-cymene, Eucalyptol, Spathulenol, and in pine essential oil: 1R-alpha-Pinene, Aromadendrene oxide-(2), Caryophyllene. In the textile samples treated with eucalyptus/pine essential oil, the compound 17-Pentatriacontene, belonging to the terpenoid class, recognized for its antibacterial properties, was identified [3].

GC-MS analysis of the volatile oils identified several phyto-compounds, including mono- and sesquiterpenoids such as 17-pentatriacontene, tridecene, hexadecene, heptacosane, eicosene, and pentatriacontanol, based on the NIST mass spectra library [4]. In all four samples treated with eucalyptus or pine essential oil, the terpenoid compound 17-pentatriacontene was detected. This compound is known as a decomposition radical resulting from ionization, a characteristic feature of the GC-MS analytical method, and is frequently reported in chromatographic analyses of essential oils, as documented in the literature. Textile structures subjected to exhaustion treatment with pine and eucalyptus essential oils at a concentration of 0.002%, combined with 1% gum Arabic, exhibited a satisfactory antibacterial effect

against *Escherichia coli* and *Staphylococcus aureus*, whereas untreated samples demonstrated an unsatisfactory antibacterial performance.
Chemical compounds were identified for eucalyptus essential oil and pine essential oil. The following compounds were identified in eucalyptus essential oil: Caryophyllene oxide, m-cymene, Eucalyptol, and Spathulenol.

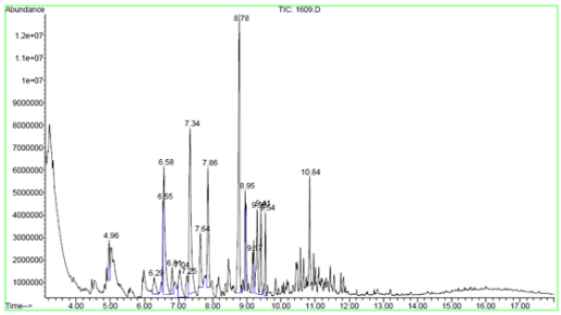

Fig. 1: *Chromatogram of pine essential oil*

Fig. 1 presents the GS-MS chromatogram for pine essential oil. The following compounds were identified in pine essential oil: 1R-alpha-Pinene, Aromadendrene oxide-(2), and Caryophyllene.

The antibacterial activity was evaluated based on SR EN ISO 20645/2005 Textile fabrics - Agar diffusion plate test. The tests were performed using the bacteria Staphylococcus aureus ATCC 6538 (gram-positive) and Escherichia coli ATCC10536 (gram-negative) for untreated textiles treated with essential oils of pine, and eucalyptus. The textile structures treated by exhaustion with pine and eucalyptus oil in a concentration of 0.002% and gum Arabic (1%) showed an antibacterial effect on Escherichia coli and Staphylococcus aureus of satisfactory level compared to untreated samples (unsatisfactory).

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DIGITAL FASHION – A SUSTAINABLE ALTERNATIVE FOR THE FUTURE

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Key words: *Digital fashion, sustainability, 3D design, virtual prototyping, CAD systems*.

1. ABSTRACT

Digital fashion is becoming a viable and sustainable solution to the ecological challenges faced by the clothing industry. This article explores how 3D technologies can serve as a sustainable means of design and production, helping to reduce environmental impact through the lowering of carbon emissions, water consumption, and textile waste. By replacing physical prototypes with virtual simulations, digital fashion enables an efficient, flexible, and waste-free creative process. The article presents arguments supporting the transition from traditional to virtual fashion: optimizing production costs, shortening the development time of collections, enabling design personalization, and increasing brand competitiveness in the digital market. Moreover, this transition allows for rapid adaptation to market demands and encourages responsible consumption. Special attention is given to the evolution of digital fashion in the Republic of Moldova, highlighting its integration into university curricula, particularly at the Faculty of Design of the Technical University of Moldova, as well as the first local industry initiatives in this direction. Concrete examples are provided regarding the use of CLO 3D, Style3D and CAD solutions, which contribute to developing students' digital skills and improving production efficiency. Although the digital transition faces challenges related to technological access and professional training, the article

argues tha, through strategic investment and educational innovation, digital fashion can become a key pillar of sustainability in the fashion field.

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THE CLOTHING-PERSON RELATIONSHIP: COMPARATIVE ANALYSIS OF A STANDARD T-SHIRT ON A HEALTHY BODY AND ONE AFFECTED BY A NEURO-IMMUNE CONDITION WITH CLO3D

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Key words: *Enclothed cognition, functional clothes, inclusivity, ergonomic design, comfort, Clo3D.*

1. ABSTRACT

Clothing is more than a basic necessity; it plays a crucial role in self-perception, emotional well-being, and social interaction. This study explores the significance of functional clothing and digital garment simulation to highlight the essential role of functional clothing for individuals with neuro-immune conditions. Based on the concept of enclothed cognition, the research emphasizes how clothing influences psychological well-being, confidence, and social interaction. The main focus of this research paper is individuals with disabilities resulting from autoimmune neurological conditions, for whom clothing must not only be accessible and functional but also aesthetically empowering. Using CLO 3D simulation software as a central methodological tool, this research visualizes and compares the fit and comfort of garments on both healthy and minimally affected body types. By modifying the avatar to realistic postures, the authors were able to analyse garment behaviour under two physical conditions. The main tool used was the stress and tension mapping in CLO 3D, which revealed significant areas of discomfort—particularly around the neck and shoulders—in the affected body, underscoring the need for design adaptations. The findings reinforce the value of integrating user-specific needs into product development to improve autonomy, comfort, and emotional well-being through functional and inclusive fashion solutions to improve the quality of life for individuals with

disabilities, ensuring that fashion is both functional and empowering.not merely a necessity but a transformative tool that enhances autonomy, self-esteem, and overall well-being. By fostering innovation and inclusivity, the fashion industry can develop adaptive clothing solutions that significantly improve the quality of life for individuals with disabilities, ensuring that fashion is both functional and empowering.

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PERSONALIZED PATTERNS FOR PEOPLE WITH DISABILITIES USING 3D MODELING

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Key words: *Personalized clothing, 3d body modeling, disability fashion, virtual prototyping, functional garments, adaptive fashion*

1. ABSTRACT

The garment industry is faced with challenges related to achieving a proper fit for diverse body types, especially for individuals with physical disabilities. Standardized sizing often fails to accommodate variations such as asymmetries, differing limb lengths, and other anatomical differences. This issue is particularly significant for people with neurological body modifications, such as those caused by Multiple Sclerosis, Parkinson's disease, spinal cord injuries, or stroke. The lack of well-fitting, functional clothing options for these individuals has led to an increasing demand for personalized and functional garments.

This study explores the potential of digital fashion technologies, such as 3D body scanning and virtual prototyping, to create customized clothing solutions. Using the CLO3D simulation system, two virtual body models were created to represent an adult woman with specific body measurements. One model represented a standard body, while the second model incorporated modifications focused on the upper torso area. The study investigates the development of functional garment patterns, highlighting differences between standard and modified body shapes, particularly in the shoulder and neck regions. By comparing these patterns and overlapping the two designs, the research aims to explore how digital tools can contribute to the development of more inclusive, comfortable, and well-fitting clothing for individuals with disabilities.

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SOFTWARE APPLICATIONS FOR MILITARY EMERGENCY RESCUE EQUIPMENT

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Key words: *conductive fabrics, electronic circuit, hemostasis, pneumatic tourniquet, combatant, 3D simulation*

1. ABSTRACT

The smart textiles market is experiencing significant growth, particularly within the Military and Defense sectors, due to the unique ability of these materials to monitor both the wearer and their environment. This allows them to respond to external stimuli, providing crucial support in dynamic and high-risk situations [1], [2]. Conductive textiles, a key category of smart textiles, are projected to triple its market value since 2032 [3], with a pivotal advancement in the military and defense sectors, espacially Personal Protective Equipment, offering real-time body monitoring, environmental sensing and improving safety for personnel, all crucial for modern military operations [4], [5], [6]. One of the most significant challenges in the design of military protective equipment is ensuring effective auto-hemostasis for individuals wounded on the battlefield. The current paper addresses this issue by proposing three advanced technological solutions aimed at integrating an innovative, autonomous primary hemostasis system within military equipment. The proposed system automatically activates a pneumatic tourniquet upon detection of bleeding in the limbs, thus inducing hemostasis and preserving lives of the combatants. This system not only focuses on functionality, specifically the automatic response to bleeding- but also takes into account the comfort and mobility of the combatant, which is essential during intense military operations. To visualize the components of the protective combat suit, 3D modeling and simulation technologies were employed using the OptiTex software suite [7].

These simulations provided an effective technique of assessing the design and functionality of the suit's integrated hemostasis system. Additionally, the undergarment fabric was antibacterially treated, enhancing hygiene and preventing infections, while the combat suit was designed with infrared camouflage through screen-printing technique, ensuring both tactical advantage and protection in diverse combat environments. The paper outlines the promising potential of these technological innovations in improving the safety and survival of soldiers in battlefield conditions.

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VIRTUAL REALITY FOR SUSTAINABLE FASHION EDUCATION: THE FASHION.ED PROJECT EXPERIENCE

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Key words: *Fashion.ED, Erasmus+ project, Virtual Reality, education*

1. ABSTRACT

Virtual Reality (VR) is transforming education by creating immersive and interactive learning environments that enhance student engagement, motivation, and knowledge retention. In higher education, VR offers new possibilities for experiential learning, allowing students to explore complex concepts, develop practical skills, and apply theoretical knowledge in simulated real-world contexts. Through realistic simulations and hands-on virtual activities, learners can engage with content in ways that traditional methods cannot provide, promoting critical thinking, creativity, and problem-solving. As digitalization becomes increasingly important in education, VR stands out as a powerful tool to support innovation, flexibility, and personalized learning experiences across various disciplines.

This article presents the results of the Erasmus+ project Supporting Entrepreneurship in Eco Design–FASHION.ED (2023-1-ES01-KA220-HED-

000157440). The main outcomes include the development of the e-learning course Eco-Design in Fashion, the creation of a Virtual Reality (VR) laboratory offering interactive 3D eco-design experiments, and the organization of an international competition focused on eco-design entrepreneurship for fashion and textiles students. These activities demonstrate the potential of combining digital innovation with sustainability education.

The project results underline the importance of integrating VR technologies in higher education to create immersive learning experiences, enhance practical skills, foster creativity, and better prepare students for the challenges of the modern labor market.

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THE INTEGRATION OF 3D DESIGN AND BIOCOLORING IN SUSTAINABLE FASHION DESIGN

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Key words: *sustainability, 3D design, biocoloring, fashion design*

1. ABSTRACT

The contemporary fashion industry is undergoing a transition toward sustainable practices due to the negative environmental impact of conventional textiles.

This article explores the integration of sustainability in fashion design through the use of 3D design and natural biocoloring, highlighting the benefits of these technologies in reducing waste and utilizing eco-friendly resources. 3D design is revolutionizing the creative process by eliminating the need for multiple physical prototypes, thereby reducing material and energy consumption. Digital technologies enable the optimization of models and design testing before final production, significantly minimizing textile waste. Biocoloring, as an alternative to conventional dyeing methods, uses natural pigments extracted from renewable sources, offering a non-toxic and environmentally friendly process. This technique promotes the aesthetic uniqueness of fabrics and enhances product durability. Studies on bio-dyes demonstrate color stability and a reduced impact on ecosystems. The combination of 3D design and natural biocoloring provides an innovative solution for the development of sustainable collections, contributing to pollution reduction and the advancement of a more responsible fashion industry. This article analyzes the potential for integrating these technologies and their impact on the future of fashion design.

The integration of 3D design and biocoloring in the fashion industry brings significant benefits, both ecologically and technologically. Thus, 3D design and biocoloring not only optimize the creative process, but also set a new standard in the fashion industry. The adoption of these technologies represents an essential step toward sustainable, efficient, and innovative fashion production.

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AVAILABILITY AND AWARENESS OF BANANA FIBER AS A SUSTAINABLE MATERIAL: A CASE STUDY OF KENYAN BANANA FIBER PRODUCTION

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Key words: *awareness; banana fiber; material; pseudo stem; sustainability*

1. ABSTRACT

Banana is a one of the important foods and cash crops in Kenya, yet its post-harvest byproduct, which includes the pseudo stem is largely underutilized. The limited utilization of banana pseudo stem poses a missed opportunity in promoting circular economy practices and reducing agricultural waste. This study sought to evaluate the availability of banana fiber in Kenya and assess stakeholder awareness and readiness for its sustainable use. A mixed-method approach was used, involving structured questionnaires, focus group discussions, and secondary data from agricultural agencies. Descriptive statistics were used to analyze production volumes and estimates of the potential for banana fiber extraction based on global standards undertaken. Based on 2023 data, findings indicated that Kenya has the potential to produce 2,800 metric tons of banana fiber annually. Awareness of banana fiber as a sustainable material was high (81%), with respondents recognizing its potential in eco-friendly products and agricultural waste reduction. However, significant gaps exist in hands-on training, policy support, and financial

access for fiber-related enterprises. The study concludes that Kenya has untapped potential to scale up banana fiber production as a sustainable material. Bridging training gaps, enhancing supportive policy frameworks, and promoting circular economy initiatives are critical for unlocking this opportunity.

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ANTIMICROBIAL BEHAVIOR OF GREEN SILVER NANOPARTICLES DEPOSITED ON KNITTED TEXTILE SUPPORT

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Key words: *silver nanoparticles, antimicrobial activity, knitted textile*

1. ABSTRACT

Since the synthesis of nanoparticles by green methods is still an emerging trend in nanotechnology, many research projects aim to contribute with additional data to the existing knowledge related to nanotechnology applications for materials functionalization [1]. Green synthesis of nanoparticles involves the use of metallic salts and different biological agents, such as enzymes, microorganisms, oligo- or polysaccharides, yeasts, fungi, or different parts of plants (root, leaf, petals, etc.) [2,3]. However, the most common green reduction agent remains the plant extracts, due to the ease of production, at low cost and lack of toxicity, without compromising the efficiency [4,5]. The data presented in this work follow the application of green synthesised silver nanoparticles (AgNPs) on colored knitted textile fabric. The padding method was used for the fixation of the treatment. The antimicrobial evaluation was performed by the agar diffusion method. Thus, the treated knitted fabrics were incubated with Escherichia coli and Staphylococcus aureus bacteria strains and the size of the inhibation zone was measured. The physico-chemical characteristics of the resulted fabric were analysed, in terms of mass per unit area, knit density, permeability to air, and hydrophilicity. Nevertheless, the structure, morphology and integrity of the textile fibres were studied using the scanning electron microsope technique (SEM).

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SMART CHROMIC DRESSING FOR NON-INVASIVE GLUCOSE MONITORING: A THEORETICAL DESIGN

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Keywords: *biosensor, colourimetric, diabetes, disease, smart textile.*

1. ABSTRACT

Diabetes is one of the most prevalent non-communicable diseases worldwide, with a rapidly increasing incidence that poses a serious public health challenge and economic burden. Current glucose monitoring systems, such as finger-prick glucometers and continuous glucose monitors (CGM), are often invasive, costly, and uncomfortable for patients, especially for long-term use. These methods also generate considerable medical waste, contributing to environmental concerns.

This paper presents the theoretical design of a smart textile dressing for non-invasive glucose monitoring. The concept is based on a colourimetric response that indicates glucose concentration in sweat through a visible colour change. The dressing incorporates silk fibroin as the enzyme immobilisation substrate, glucose oxidase (GOx) as the active agent, and gold nanoparticles to enhance signal visibility. A cellulose acetate transparent film allows external colour assessment via the naked eye or a handheld colourimeter.

The proposed system offers multiple advantages over conventional glucose monitoring devices, including lower cost, greater comfort, and increased environmental sustainability. It also avoids skin puncture, improving usability for patients with diabetes who require continuous monitoring. This preliminary study sets the foundation for further research and prototyping of a low-cost, wearable

biosensor that aligns with current trends in smart textiles and personalised healthcare.

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INVESTIGATION INTO IMPROVING LOOP LENGTH PREDICTION IN WEFT-KNITTED FABRICS USING EXPERIMENTAL AND GEOMETRICAL APPROACHES

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Keywords: *geometrical modelling, yarn diameter, image analysis, loop length prediction, quality control, product design*

1. ABSTRACT

Geometrical models of weft-knitted fabrics aim to capture the spatial geometry of yarn loops by utilising structural and material parameters. This study investigates the accuracy of various geometrical models in predicting loop length (LL) using theoretical and experimentally-adjusted yarn diameters. The geometrical models proposed by Chamberlain, Pierce, Leaf and Glaskin, Munden, and Kawabata were investigated. These models use course and wale spacing and yarn diameter as predictors. The yarn diameter, initially calculated using yarn linear density, was experimentally validated through microscopy-based image analysis. An adjustment factor was introduced by comparing measured yarn diameters to theoretical values to refine model predictions. Results revealed that predictions using adjusted yarn diameters significantly outperformed those using theoretical diameters, with Pierce's model demonstrating the highest accuracy among the tested models. Experimental validations were conducted on diverse fabric samples, incorporating wale and course spacing, yarn count, and other structural parameters. Comparisons between theoretical and experimental loop lengths illustrate the efficacy of the adjustment factor in enhancing prediction

reliability. Additionally, this study establishes a foundation for future work in automated loop length determination using image analysis of fabric structure, enabling more efficient and accurate predictions in textile engineering. The findings contribute to improved geometrical modeling of weft-knitted fabrics and offer practical applications for the textile industry, particularly in quality control and product design optimisation. Further studies are recommended to expand the scope to other fabric types and modeling techniques.

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EXPRESSIVE, AESTHETIC, AND FUNCTIONAL SPORTWEAR PREFERENCES AND SATISFACTION OF KENYAN FEMALE SITTING VOLLEYBALL ATHLETES WITH PHYSICAL DISABILITIES

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Key words: *Sitting volleyball, functional, expressive, and aesthetic attributes, athletes' satisfaction*

1. ABSTRACT

Sitting volleyball is one of the most inclusive and empowering sports among athletes with physical disabilities, particularly those with amputations, spinal cord injuries, and limb weakness. Despite its popularity, sportswear needs of sitting volleyball athletes with physical disabilities has received less attention in research, particularly in Sub-Saharan Africa. This study explored the functional, expressive and aesthetic sportswear preferences and satisfaction of female sitting volleyball athletes with physical disabilities in Kenya. Structured questionnaires were used to collect data from 67 female sitting volleyball players, aged 20–65 years, and actively playing sitting volleyball. Descriptive statistics was used to summarize the level of satisfaction with the sportswear attributes. Inferential statistics were used to examine the significant differences in sportswear preferences and athletes' satisfaction, as well as assessing the associations among various sportswear attributes. Findings reveal that while the sitting volleyball athletes are

more satisfied with the aesthetic (M=3.85) and expressive (M=3.31) sportswear attributes than functional attributes (M=3.31). The study concludes that although satisfaction with the functional attributes was lower compared to other attributes, it has a significant relationship with both expressive and aesthetic satisfaction. This indicates that functional aspects should be more emphasized in the design of sitting volleyball uniforms to enhance satisfaction.

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GEOPOLYMERS – SUSTAINABLE MATERIALS FOR ADVANCED TEXTILES, A SHORT REVIEW

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Key words: *coatings, adhesion strength, fiber reinforcement, thermal stability, mechanical performance*

1. ABSTRACT

Geopolymers are inorganic polymers synthesized from alumino-silicate materials, presenting unique advantages such as high thermal stability, fire resistance, and low environmental impact. These properties make geopolymers highly suitable for applications in textiles, particularly in enhancing fabric performance while addressing sustainability challenges. This work investigates the potential of geopolymers as a coating or additive to textile fibers. It explores their role in providing textiles with improved fire resistance, durability, and moisture management. The incorporation of geopolymers into textiles could reduce the need for toxic and unsustainable chemical treatments traditionally used in the textile industry. The sustainability of geopolymers, coupled with their functional properties, offers significant potential for eco-friendly textile solutions. Furthermore, this paper discusses the challenges involved in the incorporation of geopolymers into textiles, such as issues with processing techniques, scalability, and compatibility with existing textile manufacturing processes. The paper also highlights emerging innovations and the ongoing research aimed at improving the properties of geopolymers, making them more adaptable to various textile applications. Additionally, the economic and environmental benefits of incorporating geopolymers in textile production are explored, offering insights into their long-term impact. The application of geopolymers in textiles is a promising

area of research that could revolutionize the industry by providing environmentally friendly alternatives and improving fabric performance.

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CONDUCTIVE TEXTILE TRANSMISSION LINES FOR MICROWAVE FREQUENCY FILTERS

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Key words: *silver, smart textiles, reflection factor S11, simulation, measurement*

1. ABSTRACT

Smart textiles require transmission of the vital signs towards a central unit, via embedded antennas. Impedance matching is required in order to maximize the power transmitted by the antenna. This paper presents the design and manufacturing of a coplanar waveguide low pass filter, manufactured by screen printing on a flexible textile substrate. Silver paste was used for deposition by screen printing on a Polyamide-imide textile substrate. The relative permittivity and the losses tangent delta of the textile substrate were experimentally determined. The morphology of the Silver trace was analysed via SEM, while the condition of a lower trace thickness than the skin depth was proved. A coplanar waveguide low-pass filter was designed with an inductor in series and a capacitor in parallel. The coplanar waveguide filter was simulated in Sonnet Lite 18 software and optimized for the best S11 reflection factor in the frequency range 5-2000 MHz. The geometric parameters of the coplanar waveguide filter were established and then the filter was manufactured by screen printing on the textile substrate. The manufactured filter was afterwards measured via a network analyser. The S11 reflection measurement results show a good relation to the simulated values.

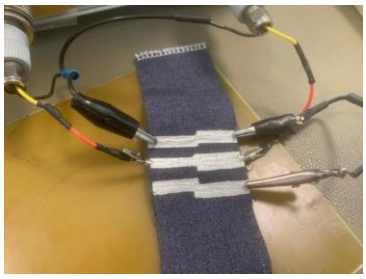

Fig. 1: *The network analyser measurement of the filter*

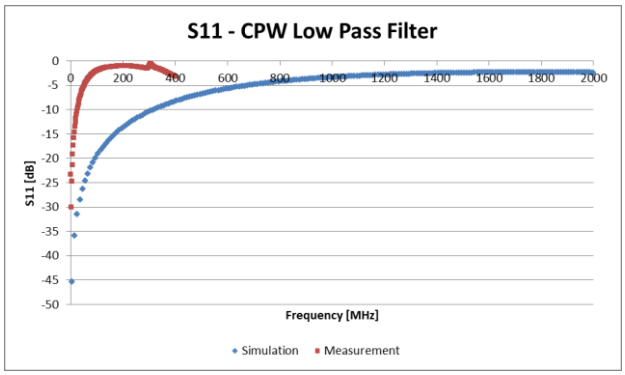

Fig. 2: *S11 reflection factor of the coplanar waveguide low-pass filter – simulated and measured*

The bending of the flexible substrate showed insignificant modification of the S11 reflection loss, making the developed coplanar waveguide filter a promising candidate for wearable applications.

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THE INVOLVEMENT OF ARTIFICIAL INTELLIGENCE IN THE PATTERN-MAKING AND DESIGN PROCESS

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Key words: *ChatGPT, Illustrator, Adobe Firefly, design, AI in fashion*

1. ABSTRACT

In this paper, the authors propose a brief presentation of the effect of involving artificial intelligence in the process of collection development, design and fashion design. Artificial intelligence (AI) is a generic term that comprises a wider area of branches and systems, such as: machine learning, deep learning and generative artificial intelligence. Most of fashion software have included artificial intelligence, especially generative artificial intelligence, in the pattern-making and design process, making the design process shorter and easier. Artificial Intelligence (AI) plays an increasingly important role in the fashion industry, bringing significant changes in the way clothing is designed and produced. Whether it is used to generate a print or to generate a more complex model, as presented in this paper, the result is obtained based on a text description entered by the user. Platforms that use (AI) to generate designs are often equipped with user-friendly interfaces that allow users to enter textual descriptions effortlessly. This new feature in the design process, is making it accessible even to users without fashion experience. AI not only accelerates the design process, but also expands the horizons of creativity, offering new opportunities for innovation in the fashion industry.

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LARGE-SCALE OPERATIONS CARGO PARACHUTE SYSTEM

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Key words: *LCADS, Cargo Parachute, Airdrop, Polypropylene Fabric, Recycling*

1. ABSTRACT

The article describes the design process for a low-cost aerial delivery system (LCADS) that is a one-time use, disposable, airdrop system consisting of cargo parachute and container. The parachute systems is developed for military resupply missions and for humanitarian relief efforts in areas where ground supply and/or recovery of airdrop equipment is difficult or not feasible [1].

The LCADS consists primarily of three types of cargo parachutes capable of supporting and delivering in a wide range of weights, from 70kg up to 1000kg. During the product development three types of delivery topologies will be targeted each with its own type of low-cost parachute: 'Low Velocity' delivery where the cargo is slowed down considerably by the parachute down to 5-7m/s for fragile and sensitive equipment using a cross type parachute made of fabric bands; 'High Velocity' delivery where the cargo is only stabilized during descent and only marginally slowed down by the parachute for non-fragile equipment using a smaller parachute; 'High Altitude Precision Delivery', where the cargo is driven to a specific target using a self-steering a ram-air parachute.

The parachutes are made from woven polypropylene fabric that can be made from recycled source materials [2]. These parachutes are 55% to 80% less expensive than the traditional nylon cargo parachutes due to a much lower cost of the material. An added benefit for the LCADS, which are made from woven polypropylene fabric, is that these parachutes have shown to have a lower rate of

descent than standard nylon cargo parachutes.

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EXPERIMENTS TO ASSESS POLLUTION LEVELS IN THE TEXTILE MATERIALS PROCESSING INDUSTRY

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Key words: *silica filter, quartz filter, Raman, scanning, equivalent diameter, spectra.*

1. ABSTRACT

Concerns about pollution, its extent, and its impact on the health of organisms and biodiversity have increased over the years. Managing and reducing the effects of pollution are critical issues for policymakers, industry stakeholders, the academic community, and researchers. The textile industry is a significant contributor to pollution, producing substantial amounts of wastewater, toxic dyes, and microplastics. Furthermore, it significantly contributes to greenhouse gas emissions due to the energy-intensive nature of manufacturing processes. This study presents the results of experiments conducted to assess the concentration of particulate matter in the air within a textile factory that processes synthetic polymers. Factors influencing particulate concentration levels at different times

of the day, as well as the distribution of particles based on their chemical composition, are examined. The TED-GS MS method is used to determine the chemical structure of particles collected on quartz filters, while SEM and µRaman techniques are employed for particles collected on silicon filters. The equivalent diameter of the particles is defined and calculated, with their classification based on this parameter.

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A NEW MODELING APPROACH OF THE SURFACE PROPERTIES OF POLYMERIC SUPPORTS

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Key words: *mathematical model, polymeric textiles, nanoparticles, contact angle, porosity, UV-protection*

1. ABSTRACT

The methods for protecting ultraviolet sensitive materials from photo-oxidation include physically shielding the material from light (for example, clothing shielding skin), physical blockers such as titanium dioxide that scatter light, and chemical absorbers that absorb the radiation and emit it at a longer wavelength, which translates to a lower energy [1-2]. UV absorbers, commonly used in sunscreens, are effective means of shielding against UV radiation [3-4].
This study investigates a new technique of linearization, and the proposed pseudo-power model estimates more precisely the optimal value of the formulation of 3.5% of nano-oxide (ZnO) suspension as coating for polymeric support as UV shields [5].

In fact, the present study aims both at the analyzsis of the relationships between the contact angle (wettability) and the concentration of the emulsion before and after UV exposure, and the development of a a mathematical model to analyze the data, for which the suggested model will identify two distinct values that describe how the concentration of the zinc oxide emulsion affects the coating after UV irradiation.

The contact angle and concentration of nano-oxides emulsion before and after UV irradiation were subjected to mathematical modeling using linearization by pseudo-power technique and the partial differential equations. By combining

both the linearization technique and the power law for concentration of zinc nano-oxides emulsion as the independent variable, two interesting optimal exponent-values apparently characteristic and specific for the present studied zinc nano-oxides emulsion, before and after UV irradiation. The mathematical handling was done for the two values of the concentration exponent: α = 0.59 and α = 0.75, before and after UV irradiation, respectively. Moreover, future similar investigations on other nano-oxides emulsion and comparison of their specific exponents can lead to deep interpretations of this phenomenon and some novel physical meanings.

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SUSTAINABLE DESIGN BY PRESERVING FASHION HERITAGE

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Key words: *Fashion Heritage, Historical Styles, Modern Innovation, Sustainable Design, Cultural Aesthetics, Creative Expression.*

1. ABSTRACT

INTRODUCTION. Fashion history is inextricably linked to the cultural, social and artistic processes that have developed for each individual era [1, 2]. Over different historical periods, the style of clothing reflects not only the aesthetic demands characteristic of its time, but also, on the other hand, reveals the different ideas about femininity, status and social identity [3, 4]. This article will trace the evolution and interrelationship between four key historical styles of fashion design. Namely, Empire, Romanticism, Victorian style and Art Nouveau style of clothing, through the creation and analysis of contemporary design interpretations borrowed from the esthetics of these historical eras.

The purpose of this study is to analyze how historical clothing styles can be adapted to contemporary fashion design. This is achieved through the use of new technologies both for the construction of the model construction and for the use of new materials and approaches. By juxtaposing traditional elements that are part of historical clothing and the use of contemporary design practices, this article explores the connection between the past and present development of fashion, demonstrating how traditional cultural heritage in clothing can inspire the creation of new innovative and current design solutions.

AMPERE. Modern models are proposed that interpret the Empire silhouette, inspired by the gentle elegance of women's clothing from the period 1795–1820, combined with the simple rigor of the men's vest, characteristic of this

era. The model is adapted to modern esthetics through light and breathable fabrics that convey comfort and mobility. The silhouette emphasizes femininity, but through clean lines and bold details. This model is suitable for both formal events and fashion shows and photo shoots of an artistic nature.

ROMANTICISM. The proposed models reveal a modern adaptation of the feminine and dreamy look of fashion from the Romantic period (1820 – 1850).

VICTORIAN ERA. Contemporary models are proposed. The models are made of satin, delicate lace and light voile tulle, which creates multi-layered depth and drama. The main fabric is silk satin with a silk finish, which gives smoothness and a luxurious shine. Lace inserts and translucent ruffles are used to achieve an ethereal lightness and mystery that are characteristic of the Victorian style.

ART NOUVEAU. The proposed models are a contemporary interpretation of the feminine idea of esthetics characteristic of the historical period of the Art Nouveau style of clothing (1890 – 1914), also known as the Belle Époque. This style draws its inspiration from the ornamental forms in nature, curved and curved lines, and also decorative elegance.

CONCLUSION. Based on the presented designer models analyzing the four historical clothing styles – Empire, Romanticism, Victorian and Art Nouveau clothing styles, it can be concluded that fashion heritage continues to have a significant influence on contemporary fashion design.

In this context, it can be concluded that the knowledge and understanding of historical clothing fashion will not only enrich contemporary design, but has the ability to open up new opportunities for innovation and creative expression. This transience between the tradition of historical clothing notes and modern trends is a key factor in the creation of sustainable, culturally aware and aesthetically justified clothing fashion in the present as well as future projects.

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LEATHER
AND
LEATHER SUBSTITUTES

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EXPLORING THE USE OF FOOTWEAR BUFFING DUST FOR SCULPTING IN GHANA

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Key words: *Footwear Industry, Waste as Resource, Up-cycled Art, Modelling, Casting*

1. ABSTRACT

Waste is an inevitable part of life and this is the case for the footwear industry. Despite this, very few studies have focused on understanding how footwear waste like buffing dust can be managed by harnessing its potential to serve as a resource to the benefit of society. This study experiments with footwear buffing dust for recycled art through sculpting. Through modelling and casting techniques, the study leverages experimental arts to extend the possibilities of footwear buffing dust. The study sought to find answers to questions like effective binders, ideal proportions and material properties like water resistance among others. Three artworks were executed and data collected during the production process through reflective journaling and analysed thematically. The study concludes that bonded glue is an effective binder for using footwear buffing dust in modelling. However, footwear buffing dust can be used for modelling with limitations. Additionally, the study concludes that footwear buffing dust is a suitable material for casting and resin is an effective binder. The study recommends that art professionals and art student practitioners explore the use of footwear buffing dust for their sculpture practice and evaluate clients' acceptability of the new material.

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APPLICATION OF KERMES OAK (*QUERCUS COCCIFERA*) IN LEATHER DYEING: A NATURAL AND SUSTAINABLE APPROACH

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Key words: *Leather, dyeing, kermes oak, Quercus coccifera, natural dye, coloration*

1. ABSTRACT

Leather, as an organic material, has been used and continuously developed since ancient times, maintaining its value through various dyeing and finishing techniques. Although the widespread use of synthetic dyes led to a decline in the use of natural dyes, recent concerns about environmental impact and health hazards have renewed interest in natural alternatives. This study explores the dyeing potential of kermes oak (Quercus coccifera), a species of the Fagaceae family native to the Mediterranean region of Anatolia, as a sustainable natural dye source for leather. The effects of dyeing temperature (60°C, 80°C, and 100°C) and mordant concentration (0.5%, 1%, and 1.5%) on the color and color strength (K/S) of leather were systematically investigated. The most intense and uniform coloration was achieved at 100°C with a 1.5% mordant ratio. The results highlight the effectiveness of kermes oak in producing aesthetically pleasing and environmentally friendly dyeing results. Overall, this study demonstrates the potential of natural dyes to serve as viable, eco-conscious alternatives to synthetic dyes in leather production, contributing to sustainable practices in the leather industry.

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HIGH-EFFICIENCY CHROME TANNING: REDUCING WATER INPUT IN LEATHER PROCESSING

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Key words: *Chrome tanning, chromium exhaustion, leather wastewater, sustainable leather processing, water ratio optimization*

1. ABSTRACT

The leather industry heavily relies on large volumes of water and various chemical agents to convert raw hides into finished leather through complex chemical modifications of collagen. However, this conventional production approach generates a substantial amount of highly polluted wastewater, posing significant environmental threats. Therefore, reducing the use of both water and chemicals during leather processing is vital for environmental protection, resource conservation, and the sustainability of leather manufacturing.

In response to the increasing awareness of environmental and human health concerns, stricter regulations and limitations on the use of hazardous substances in leather production have been introduced [1]. The REACH regulation is one such effort, aimed at improving chemical safety, enhancing risk management, and promoting alternative assessment methods. Despite these efforts, both the presence of hazardous residues in finished leather products and the discharge of chemical-laden wastewater remain pressing issues that hinder sustainable leather production.

A critical aspect of the tanning process is the effective penetration and fixation of the tanning agent within the collagen fiber matrix of the hide. However, studies have consistently shown that the uptake of tanning agents under conventional aqueous processing conditions remains inefficient. Significant portions of the tanning agents, particularly chromium salts, remain in the process bath, contributing to pollution loads [2]. Research indicates that exhaustion rates in conventional tanning are relatively low, resulting in high volumes of wastewater contaminated with unconsumed tanning agents.

Globally, the leather industry uses nearly 500,000 tons of chromium (III) salts annually. With a tanning efficiency of just 55–65% under current methods, nearly half of the chromium applied ends up in wastewater [3]. This inefficient use

of chrome not only results in economic loss but also contributes to chromium-related environmental concerns. Despite various studies focusing on alternative tanning agents [4], these substitutes have generally failed to match the hydrothermal stability and physical performance of chrome-tanned leather [5]. Consequently, chrome tanning continues to dominate, and approaches that retain chrome use while minimizing environmental risks may be more viable and practical for widespread industry adoption.

This study focuses on improving chrome exhaustion by optimizing water usage in the tanning process. Experimental tanning trials were conducted with reduced water ratios. Following the tanning process, chromium oxide concentration and conductivity were measured in the wastewater. Additionally, the chromium content and shrinkage temperature of the tanned leathers were analyzed to evaluate tanning efficiency and thermal stability. The results were compared to those from conventional chrome tanning processes. Findings revealed that decreasing the water ratio can significantly enhance chromium uptake, reduce environmental impact, and maintain or improve the performance of the final leather product, supporting the development of more sustainable tanning technologies.

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INNOVATIVE TECHNOLOGIES FOR OBTAINING NEW EMULSIONS, BASED ON PINE OIL AND SURFACTANTS

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Key words: *new emulsions, innovative technologies based on pine oil and surfactants, leathers processed*

1. ABSTRACT

New emulsions were obtained by innovative technologies based on pine oil and 2 surfactants: sodium dodecyl sulfate and Tween® 80 mixture: Ps- pine oil/ sodium dodecyl sulfate/water; Pt- pine oil / Tween® 80/water; Pst- pine oil/ sodium dodecyl sulfate and Tween® 80 (ratio 1:1)/water, for different concentrations of pine oil, in order to improved surface properties with applications in leather industry.

Pine oil has a strong antimicrobial and antifungal effect due to its content in: vitamins C and E, phytosterols, fatty acids, antioxidants and amino acids.

The order of introduction of the components in innovative technologies, the working conditions and especially the choice of the concentration of surfactants >CMC, is essential in the solubilization of pine oil and obtaining the new emulsions.

The emulsions were characterized by optical microscopy with pine oil at 23-60^{o}C. The changes in the aggregation process were observed for each type of emulsion, the influence of temperature and the solubilization of pine oil.

Dynamic light scattering (DLS) for the emulsions showed the stability, concentration, particle size, polydispersity, zeta potential. The antimicrobial properties were analyzed by microbiological tests. FTIR measurements highlighted the interaction mechanism of surfactants with pine oil from the new emulsions. The

leather samples were microbiologically tested and antimicrobial, antifungal effects were observed.

The new emulsions are original due to the successful inclusion of pine oil with high potential for improved surface properties with applications in leather industry.

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FOOTWEAR UNDER THE IMPACT OF DIGITAL TECHNOLOGIES: A REVIEW

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Key words: *footwear, design, production, innovation, digital technologies*

1. ABSTRACT

Digital technologies have had a major impact on the footwear industry, transforming both the design and manufacturing processes. The advanced use of 3D scanning and computer modelling allows the creation of customised footwear that is precisely tailored to the specific dimensions, shape and needs of each user. In production, vibration sensors integrated into machines and connected via IoT platforms enable real-time monitoring, enabling rapid detection of problems and predictive maintenance to minimise downtime and repair costs. In addition, analysis of the data collected helps to optimise production parameters, ensuring greater operational efficiency. IoT technologies also play a crucial role in intelligent supply chain management, facilitating real-time tracking of raw materials, inventory and deliveries, leading to reduced losses and improved logistical coordination. Throughout the use of footwear, digital technologies offer significant improvements in comfort, performance and monitoring of the user's health. Sensors integrated into the structure of footwear allow gait analysis, monitoring pressure on the sole and detecting potential postural or medical problems. In addition, digital technologies contribute to user safety by being used to develop smart shoes for people with visual impairments or to prevent accidents in the workplace. By integrating these innovations, the footwear industry is moving towards more sustainable and efficient production, offering more comfortable and safer products that are tailored to the individual needs of each user.

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