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BOOK OF ABSTRACTS

REFRAMING FASHION EDUCATION: HOW HIGHER EDUCATION CAN ACCELERATE THE FASHION INDUSTRY TOWARDS SUSTAINABLE PRACTICES AND DIGITAL TRANSFORMATION

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Fashion stands at a critical juncture, confronting urgent sustainability challenges alongside rapid digital transformation across its value chain. Yet, the industry has been slow to adopt digital technologies, hindered by a range of factors including high implementation costs, fragmented infrastructure, and a shortage of talent with essential digital skills. This research explores how higher education institutions (HEIs) can accelerate this transformation by digitalising curricula, equipping future professionals with both technological competencies and a sustainability mindset.

Digital tools such as 3D prototyping, artificial intelligence etc offer significant potential to reduce waste, streamline production, and lower environmental impact. HEIs play a vital role in embedding these tools into education, ensuring graduates are prepared for the evolving demands of the industry.

Using a qualitative methodology grounded in constructivist grounded theory and institutional ethnography, the research draws on interviews, focus groups, and fieldnotes to gather insights from educators and industry perspectives.

The findings reveal both opportunities and barriers to digitalising fashion curricula, including the need for stronger infrastructure, industry-aligned learning, and interdisciplinary collaboration. This research highlights the critical need for HEIs to form symbiotic relationships with industry and technology developers. It offers insight into a groundbreaking model involving Manchester Metropolitan University, Style3D, and leading fashion brands working collaboratively to drive sustainable practice through digitalisation.

AI-DRIVEN CLOTHING RECOMMENDATION SYSTEM

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Clothing products are among the most frequently purchased items in e-commerce. However, high return rates in online fashion retail remain a major issue, leading to increased operational costs, extended product cycles, higher carbon emissions from logistics, and environmental degradation. Returns in fashion e-commerce are mainly caused by poor fit or unmet expectations.

This study presents the development of a personalized clothing recommendation system utilizing an innovative learning method, Self-Operational Neural Networks (Self-ONNs). The system extracts relevant features from user-selected clothing images through using Self-ONNs, which allows for the capture of intricate details in clothing aesthetics and user preferences. By leveraging a geometric distance-based method, the system identifies the most suitable clothing combinations that align with both body shape classifications and individual style choices. A labelled dataset of 5,000 real-life clothing images was prepared to train predictive models, ensuring robust feature representation.

Designed for integration within existing brand websites or deployment as an independent platform, the solution facilitates enhanced aesthetic alignment between garments and diverse body types. This alignment contributes to improved customer satisfaction.

The research highlights the distinctive importance of how AI-driven styling tools can simultaneously improve user experience, lower environmental impact, and strengthen brand perception.

CRAFTING CIRCULARITY: A SUSTAINABLE ARTISAN-DRIVEN MODEL FOR UPCYCLED FOOTWEAR WITH ETHICAL AND TRACEABLE SUPPLY CHAINS

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The global textile industry generates over 92 million tonnes of waste annually, with post-consumer and post-industrial textiles contributing significantly to landfill pollution and resource depletion. While circular economy frameworks offer transformative potential, systemic gaps persist in integrating ethical labour practices, technological innovation, and cross-cultural collaboration. This research proposes a novel artisan-driven circular model that upcycles textile waste into commercially viable consciously self-designed footwear, using enhanced textile enabled traceability, low-impact material processing, and South Asian artisan empowerment to address environmental and socio-economic challenges.

Central to this model is a closed-loop supply chain designed to recover, regenerate, and redistribute textile waste. Post-consumer garments and industrial off-cuts from the UK and EU are collected through partnerships with municipalities and brands. The uniqueness of the model is that there is no additional sorting involved since the product to be developed is compatible with fibre of any kind (natural, machine-made, regenerated cellulosic). Pre-processing involves just mechanical shredding and enzymatic treatments to remove contaminants, yielding hybrid fabrics blended shreds as a base one raw material. These materials are transported to artisan cooperatives in South Asia, where skilled craftspeople predominantly women from marginalized communities are trained in zero-waste pattern cutting, natural dyeing (using plant-based extracts), and modular footwear assembly. Keeping design for disassembly as a foundation for this model, the design templates will be fused with traditional motifs to enable culturally resonance and market-ready products. The construction would involve use of recyclable components like bio-based glues and soles which can also be repurposed into insulation materials, achieving considerable landfill diversion.

A key part of this model is its hyper-transparent supply chain. Existing Blockchain traceable technology will be implied to track materials from waste source to final product, with QR-linked NFC tags embedded in each footwear. Consumers access a digital dashboard detailing the product's lifecycle, carbon savings and most importantly artisan profiles to establish a deeper connect. This transparency fosters trust and aligns with growing demand for ethical fashion.

The business model study also aims to quantify the impact and amount of textile waste that can be upcycled. Along with this to also quantify a key metric of elevation in artisan wage through fair business and trade practice. The potential scalability challenges would be logistic emissions from intercontinental material transport, and uneven artisan skill levels.

This research contributes a scalable blueprint for circularity that combines technology, tradition, and ethics. By transforming waste into wearable art while empowering global artisan communities, the model redefines value chains across the textile lifecycle.

A CASE STUDY ON THE EMERGING TEXTILE RECYCLING INDUSTRY IN BANGLADESH

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As global interest in sustainable fashion grows, industrial-scale textile recycling is gaining momentum worldwide, with hubs emerging in regions such as Panipat (India), Wenzhou (China), and Usak (Turkey). Bangladesh, the world's second-largest apparel exporter, has recently entered this space, though the sector remains nascent with only a few large-scale recycling plants currently in operation. This study investigates the early development of industrial textile recycling in Bangladesh, with a focus on circularity, technological practices, and competitive positioning.

Using a qualitative case study approach, data were collected from six recycling factories located outside Dhaka. Findings indicate the adoption of closed-loop recycling models, where waste fabric from knitwear production is processed into recycled yarn for new textile manufacturing. While the scale of intra-brand or intra-company recycling remains unclear, these factories report supplying recycled yarn to major global brands such as H&M, Zara, Primark, Ralph Lauren, Puma, and others.

This presentation will share insights into the technological processes employed, the challenges and opportunities in implementing circular models, and the competitive landscape for Bangladesh's emerging textile recycling industry.

EVALUATING BACTERIAL CELLULOSE LAYERS FOR MICROFIBER POLLUTION MITIGATION AND SUSTAINABLE WATER IMPACT

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Environmental pollution by microfibers is a global concern that has been considered. It has been estimated that millions of tons of microfibers accumulate in the ocean worldwide, increasing every year.

Microfibers released in the textile process from spinning to garment production include natural, synthetic and semi-synthetic fibres. Recently, much research has been conducted on the absorption of synthetic microfibers such as polyester, which are called microplastics. While there is a need to address the microfibers released by natural and semi-synthetic polymers. Due to their inherent properties of absorbing more substances than synthetic fibres, natural fibres can absorb pollutants and move in different environments, which will have a negative environmental impact.

This research will explore the behaviours of different types of bacterial cellulose layers as biopolymers, aiming to identify the most suitable type not only as a sustainable material for manufacturing but also for its impact on water, in alignment with SDG 6 and 14.

GARMENT CARE AND ENVIRONMENTAL IMPACT: ALIGNING CONSUMER AND INDUSTRY PRACTICES

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Garment care practices, traditionally associated with quality and durability, are increasingly being considered from an environmental perspective, acknowledging the impact created during the consumer use phase. This shift however relies on the ability to quantify the environmental impact created through the use and maintenance of garments, with current measures utilised not capturing this data. Current metrics and methods of impact evaluation, such as lifecycle analysis (LCA) operates cradle-to-gate, opposed to cradle-to-cradle meaning that the consumer use, disposal and any reuse mechanisms enabling second life and beyond, remain unmeasured.

This paper explores the relationship between environmental impact and garment care practices through the investigation of garment ownership, use behaviours and motivations driving these actions. Additionally, working with a range of fashion brands, the research explores care and communication strategies of recommended maintenance principles with their customers. Adopting a 3-stage methodology, a large-scale consumer survey (1,200+ participants), consumer workshops and brand focus groups have enabled the aims of the research to be addressed.

Findings highlighted disparities between industry's influence of responsible wardrobe management and actual consumer behaviour, demonstrating a misalignment between theory and practice. Furthermore, a methodology to enable the quantification of environmental impact of consumer use was developed, highlighting the need for further research and validation.

PREPARATION OF TEXTILE WASTE TO RECYCLING: ANALYSIS AND REMOVAL OF TEXTILE FINISHING TREATMENTS

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The EU generates 12.6 million tonnes of textile waste each year. Clothing and footwear alone account for 5.2 million tonnes of waste, yet only 22% of post-consumer textile waste is currently collected separately for re-use or recycling. In recent years, several solutions have been developed to recycle textile waste, including optimising recycling by separating blends, but little is known about the influence of finishing treatments on different types of recycling processes.

For these reasons, this work has dealt with the analysis and removal of different finishing treatments (silicone finish, water repellent, optical brightener) applied to different fibres in blends (polyester, cotton and modacrylic) to prepare textile waste for mechanical recycling. Different analytical methods were tested to detect the treatments (to aid sorting) and different methods for their removal were evaluated. The results of this research may also be useful for other types of recycling (e.g. thermo-mechanical, chemical).

ECO-FRIENDLY COTTON DYEING PROCESS USING EUTECTIC SOLVENTS AND CURCUMIN

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The textile industry is a significant contributor to global water pollution, primarily due to the discharge of synthetic dyes and hazardous chemicals on water sources. This study proposes an eco-friendly cotton dyeing process utilizing eutectic solvents (ES) and curcumin, offering a sustainable alternative to traditional methods. ES are gaining attention for their low vapor pressure, non-volatility, non-flammability, and high thermal and chemical stability. Three ES systems—cholinium chloride/glycerol (ChCl/Gly), cholinium chloride/urea (ChCl/U), and glycerol/urea (Gly/U)—were evaluated for their dyeing performance and colorimetric properties. Among these, Gly/U (1:1 molar ratio with 20% water) was identified as the most efficient and cost-effective system. The optimized process achieved 30% curcumin exhaustion and a color difference (ΔE) of 24.0 over five consecutive dyeing cycles. Additionally, the process enhanced colourfastness properties compared to conventional dye baths. This approach significantly reduces reliance on harmful chemicals, energy-intensive processes, and wastewater production, making it a viable solution for sustainable textile processing. The study highlights the potential of ES-based dyeing systems to revolutionize the industry by combining environmental and economic benefits.

CiCLO® Technology: an Innovative Solution to Synthetic Fiber Fragment Pollution

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CiCLO® technology is a textile innovation that enables virgin or recycled polyester to remain durable during its useful life, biodegrade if it pollutes the environment, and maintain recyclability at end-of-life.

Polyester accounts for 57% of textile fibers, amounting to over 71 million tonnes in 2023. Volumes are expected to grow and eventually, a significant portion will be made from the abundant supply of textile waste. While circular textiles are environmentally beneficial, polyester is a non-biodegradable plastic and can persist in the environment indefinitely as pollution, regardless of whether it is made from virgin or recycled raw materials.

Considering the widespread use of polyester and its non-biodegradable nature, it clearly correlates that fiber fragmentation from synthetic textiles ("microfiber pollution") is the most prevalent form of microplastic pollution accumulating worldwide. These small fiber fragments unavoidably leak into the environment through many pathways, where they cannot feasibly be recaptured. Their persistence negatively impacts biodiversity, human and animal health, and climate change.

This paper discusses a case study on CiCLO® technology, an innovative solution designed to mitigate microfiber pollution caused by synthetic textiles by enabling polyester to naturally biodegrade while maintaining durability and recyclability.

CLOTHING FOR A MORE SUSTAINABLE WAY – A REVIEW

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We dress to shape our appearance and build an identity. Textiles and clothing are essential to humans, are deeply rooted in everyday life, and allow to express individuality. However the speed with which they are consumed and then discarded is astonishing. There is an urgent need for a transition to more sustainable fashion, a change in behaviour on the part of both the industry and the consumer. The challenge for sustainability in the fashion industry is to redesign methods and procedures, reshape the consumptive behaviour of the fashion, including consumers. This article is based on a literature review to identify the possibilities in the textile industry for a positive shift towards the circular economy model. It's a demanding process that requires a new awareness, a lot of information and a broad collaboration between various parties. It must be a gradual change, one that allows a return to balance for the Earth and for human beings. The fashion industry will have to slow down and prioritize communication in order to achieve sustainability.

A HOLISTIC APPROACH TO INVESTMENT MECHANISMS TO INFORM FASHION & TEXTILE INTERVENTIONS

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This research unpacks learning from the Fashion Demonstrator project, which developed several areas of research and produced a series of commissioned reports for AHRC and DCMS. UK government will use these reports to inform future areas for investment for the UK Fashion and Textile industry. We view the triple helix innovation model through a theory of change lens to provide insights into the development of future intervention mechanisms for the sector.

Creative industries generally have been under resourced, to address this challenge AHRC leveraged ISCF to develop the Creative Industries Cluster Programme (CICP) which delivered 2018-2024; the Fashion Demonstrator was an extension of this research. Fashion and textiles, whilst certainly part of the creative economy, are uniquely placed at the intersection of art and design, advanced manufacturing and disruptive digital innovation, which has resulted in specific challenges for the sector. UKRI recognised this with its £15M circular fashion and textiles investment, demonstrating support for the sector through the trilateral agreement between Innovate UK, AHRC and NERC. Building on insights from Fashion Demonstrator research, this paper develops sector-specific learning, exploring ways to define successful interventions in terms of multi-faceted impact indicators throughout supply chains and stages of business development and growth.

EXPLORING SUSTAINABLE PRODUCT DEVELOPMENT IN THE VALUE FASHION MARKET

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The fashion industry has immense potential to drive sustainability, yet the reality of carbon emissions, water wastage, ethical malpractice, and supply chain inefficiencies presents a more complex picture. This study explores sustainability through the lens of fashion product developers working within the value fashion market, examining how digitalisation and technology can support sustainable product development. With the rise of blockchain and Digital Product Passport (DPP) for supply chain traceability, AI-driven inventory management, and digital product lifecycle tracking, there is an opportunity to bridge the gap between sustainability as a strategic goal and its practical implementation. Additionally, digital design technologies such as 3D prototyping, virtual sampling, and AI-driven trend forecasting play an important role in reducing waste, optimising resource use, and streamlining the product development process.

Using a qualitative research approach, this study captures insights from upper management, managerial, and non-managerial personnel, highlighting varying interpretations of sustainability across organisational levels, including the understanding of Tripe Bottom line (TBL). While upper management integrates sustainability into long-term business strategies, operational teams often focus on material selection and cost-effective, eco-friendly solutions. However, a clear gap remains in adopting digital tools that could streamline sustainability efforts, improve traceability, and enhance efficiency within product development.

This research highlights the need for a digital-driven transition in sustainable product development, ensuring that sustainability is embedded not just in strategy but in everyday decision-making and operational practices. By addressing these challenges, the fashion industry can move towards a more integrated, transparent, and responsible industry, balancing environmental goals with business efficiency. The findings offer valuable insights for policymakers, industry leaders, and businesses looking to implement sustainability into actionable, technology-supported frameworks within the product development process.

EFFECT OF YARN FRICTION ON THE MECHANICAL PROPERTIES OF PLAIN WEAVES: A NUMERICAL STUDY

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In this presentation, a numerical analysis method using the homogenization method by FEM is introduced to investigate the effect of friction behaviour at the intersection of warp and weft yarns on the stiffness of plain weave. The warp and weft yarns are considered as a monofilament to simplify the procedure of numerical analysis, and the interpretation of analytical results is set to investigate the shear behaviour of the plain weave. As for defining the mechanical properties of the yarns, a basic elastic body is adopted to focus on the analysis of the effect of the weaving structure. Numerical simulations have been computed to evaluate the product characteristics of plain weave under the conditions of these structural modelling and mechanical properties. As a conclusion, the difference in the elastic properties of the yarns has a high linearity to the macroscopic properties of the plain weave, where the friction at the intersection of warp and weft yarns affected the stress distribution within the yarns, but had little effect on the macroscopic properties of the plain weave. In summary, the comparison of the above numerical results with experiments revealed that the actual product of the basic plain weave exhibits extremely complex behaviour.

Exploring the Transition Towards Circular Business Innovation Among Pakistan's Textile Producing Enterprises

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Over-exploitation of resources and the burden on natural systems have provoked worldwide concerns about the potential resource and supply risks in the future. Conversely, contextual empirical research on the Circular Economy (CE) in the emerging economy of Pakistan, is still in its infancy. Of particular interest in this regard is the textile industry that contributes to 61% of country's total exports. But the relevant stakeholders have so far only explored the CE potential to a marginal extent. This knowledge gap has constituted the main motivation for the present study to explore the diffusion of Circular Business Innovations (CBI) among textile-producing enterprises. The research aims to explore the dominant categories of CBI among the sample. The study employed qualitative analysis and descriptive statistics to support a multi-case study approach through key informant interviews to get an insight into 26 large textile-producing industries. Findings reveal that i) 66% out of a total CBI cases indicate open innovations, while the remaining are closed innovations, and ii) only 33% of current innovations pertain to product innovation, while others refer to process innovation and recycling. However, the present landscape provides an opportunity to value network stakeholders for devising actionable collaborations for scalability and longevity of these initiatives.

EVALUATING THE QUALITY AND COMPOSITION OF END-OF-LIFE GARMENTS IN GREATER MANCHESTER

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This study addresses the growing problem of textile waste management. The UK end-of-life garment sorting sector is at the point of collapse, similar to Europe, due to the erosion of the global re-wearable market which has increased the proportion of sorted garments that are only fit for recycling. Manual sorting of non-reusable textiles (NRT) makes a loss, which will worsen if efforts to divert more textiles from residual household waste results in poorer quality garments reaching sorters.

To understand these dynamics, we evaluated the quality of garments in residual household waste and the material composition of NRT to determine the most effective recycling routes. Working with Greater Manchester Combined Authority, Salford City Council, SWD, Textile Recycling International, SUEZ, and the Textile Recycling Association, we used near infra-red (NRI) scanning technology to assess garments collected from a kerbside collection pilot and household waste recycling centres.

Findings suggest that the proportion of NRT that are only fit for recycling could be as much as double that which is currently entering UK sorting operations. Material composition analysis reveals that about half of NRT may be suitable as feedstock for downstream recycling options, which could increase the value extracted from this fraction by sorters.

DIGITAL TEXTILE PRINTING: OPPORTUNITIES AND CHALLENGES FOR SUSTAINABLE LOCALISED PRODUCTION

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Mass-produced, low-cost textile production, driven by fast fashion, obscures culpability and creates risks in complex supply chains. Consumers struggle to make sustainable choices as it remains unclear where, how, and by whom clothes are made. Overproduction leads to surplus, often destroyed or landfilled, while garment usage declines. New approaches to production are essential for sustainable change.

This presentation explores how digital textile printing (DTP) could drive small-scale change while complementing broader system shifts through combining of creative technology and design innovation; on-demand production models using microfactory setups (print bureaus, makespaces, and embedded repair hubs) integrated with advancements in software and automation, could enable mass customisation at scale. This empowers designers to create personalised, made-to-order garments, transforming our relationship with clothing, extending wear, reducing overproduction, and localising manufacturing.

Through a narrative review and case studies of UK-based SMEs, this study assesses DTP's readiness to support sustainable, on-demand production. It highlights creative opportunities and evaluates its environmental benefits, and identifies areas for improvement, such as resource consumption, laundering-related pollution, and the sustainability of digital colourants. By examining both the opportunities and limitations of DTP, this study contributes to the conversation on digital manufacturing's potential to create a more ethical, sustainable fashion industry.

APPLICATION OF ADDITIVE MANUFACTURING ON TEXTILES

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3D printing is increasingly being explored in textile manufacturing, not only to produce yarns and fabrics but also to enhance their properties through direct printing on fabric. This technique offers the potential to create metamaterials that combine conventional textiles with functional, structural, or protective elements tailored for specific applications. This study aims to define and optimise the printing parameters of Poly-Lactic-Acid (PLA) and Thermoplastic-Polyurethane (TPU) filaments on Tulle and Calico fabrics. Key parameters such as filament temperature, layer height, and initial print speed were systematically varied to assess their influence on the adhesion properties of specified fabrics. Initial testing has provided suitable ranges for these properties, but further testing is required to optimise the setting for each fabric-material combination.

There is no guidance for printing on fabric or a standard for testing the adhesion, these results could be used to create a database that would provide optimised 3D printing parameters for printing on fabrics. The findings from this study would provide information to textile manufacturers and designers interested in 3D printing on fabric to enhance its properties. Further work would involve the printing of metamaterials to try and tailor certain properties of the fabric to improve and adapt its functionality.

OPTIMIZED PRE-TREATMENTS AND RECYCLING STRATEGIES FOR TEXTILE WASTE

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The increasing demand for sustainable solutions in textile recycling has driven the development of advanced pre-treatment and chemical recycling technologies. Efficient textile waste sorting is crucial for successful recycling and determines fibre quality and recyclability. However, the complexity of fabrics, dyes, and functional treatments presents challenges, with residual contaminants persisting after sorting. These impurities can disrupt recycling processes, especially chemical methods, where additives interfere with depolymerization and material recovery. To mitigate these issues, a pre-treatment step is essential. Pre-treatment processes, such as enzymatic hydrolysis, alkaline decolorization, and selective dissolution, enable the dyes, contaminants, and synthetic fibres removal, improving recyclability.

"Be@t – bioeconomy at textiles" is a project belonging to the PRR Plan with 56 entities aiming to contribute to achieve and consolidate a truly innovative, sustainable and circular national Textile and Clothing Industry. Circularity pillar of the project aims to enhance natural fibre reuse by optimizing recycling methods and it reintroduction in the cycle. This work examines pre-treatments of different textile blends for the chemical recycling of textile waste.

Financial support from integrated project be@t (TC-C12-i01, Sustainable Bioeconomy No. 02/C12-i01.01/2022), promoted by the Recovery and Resilience Plan (RRP), Next Generation EU, for the period 2021 – 2026.

FORECASTING RECYCLED TEXTILES: EXPLORING COLOUR, STRUCTURE AND COMPOSITION DATA TO FORECAST THE SORTING AND DESIGN OF RECYCLED YARNS

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This paper explores the required data for companies to understand the value of their textile wastes for the sorting/design of recycled fibres. Sustainable fashion forecasting is a relatively new field which has mainly focused on how better forecasting can avoid the generation of waste. However, this research focuses on forecasting the waste itself for sorters/designers developing recycled yarns.

The paper unfolds a case study of the laundry company: Elis (as part of Decouple project in the Trace Partnership). Using mixed methods, comprising data analysis and practice-based design prototyping, data from Elis' current circulating workwear was combined with physical examples of Elis' waste textiles from their recycling partner to create a recycled forecast. This was achieved by narrowing the data to suitable garments for recycling and collecting their colour, structure and composition details to understand the feedstock potential. This data was used to sort the textile waste examples, and after shredding, design various combinations into prototypes (non-woven swatches) to visualise the possible recycled coloured fibres and create a roadmap of how this waste could be best sorted/recycled. The paper concludes that colour, structure and composition data points are vital in providing forecasting value for companies, sorters, recyclers and designers in the transition towards circular textiles.

TEXT2FABRIC: CONTROLLABLE FABRIC IMAGE SYNTHESIS VIA FINE TUNED DIFFUSION MODELS

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For textile designers, the creation of new fabric textures is a highly complex and time consuming task that requires both creativity and technical expertise. Recent advancements in Artificial Intelligence (AI) have shown great potential in accelerating and enhancing the design process. In this work, we explore how generative models can support textile design by fine tuning Stable Diffusion on our proprietary dataset, which consists of human assigned fabric descriptions paired with their corresponding images. This approach enables the generation of high quality, realistic fabric textures directly from textual descriptions, thereby reducing design effort, improving efficiency, and opening new possibilities for innovation in textile design workflows.

RECYCLED POLYESTER FABRICS FROM BALTEX – LOOKING FOR CIRCULARITY

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BALTEX, Technical Textile specialists based in Ilkeston, UK is pleased to introduce the RECOMESH TM concept.

Having gained approval to ISO 14001 Baltex has set up a system to track material for recycling through it's customer supply chain. At the same time the company is establishing a route for textile to textile recycling. Recomesh TM is the trademark registered by Baltex to cover its family of sustainable development fabrics. Our objective is to improve the technical textiles industry and make it more sustainable.

Baltex is aiming for greater circularity with RECOMESH – but how many times can we recycle? We do not know and have embarked on this research to find out. By using applications with long life cycles we hope to take Polyester out of the supply chain and replace foam which in itself has environmental benefits.

MATERIAL PROGRAMMING

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This paper reports on the Material Programming Research Project, a collaboration between textile design researchers at Chelsea College of Arts, University of Arts London (UAL) and specialist technical researchers at the Creative Computing Institute, UAL.

Skills in repair and machine maintenance have long been considered an essential part of knit education, but this does not extend to knitting software, which is rarely written by knitters and is largely not open-source. Due to the increased availability of both industrial and domestic digital knitting machines, and the demand for compatible digital workflows, knit is undergoing a growth in interest analogous to that of 3D printing a decade ago. We have been mapping the landscape of novel, open-source knitting software developed alongside this hardware expansion, that seeks to give knitters the agency to develop their own software tools adjacent to the use of hardware. We will outline our approach, of running a cross-disciplinary reading group, organising a crowdsourced and collaborative index, and setting up student projects to test and characterise the tools. We will present our iterative evaluation based on usability and creativity metrics, including the USE questionnaire for usability assessment and creativity support evaluation frameworks.

EMBEDDING DIGITAL TECHNOLOGIES WITHIN THE DESIGN PROCESS TO ENABLE CIRCULAR FASHION & TEXTILE SYSTEMS

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As the Fashion and Textile Industry (FTI) develops approaches to address sustainability challenges, designers and the design process are increasingly positioned as a key stage in enabling transitions to sustainable and or circular fashion and textiles. However, many designers aren't equipped with the technical knowledge required to ensure products are designed; (i) with reduced environmental impact, (ii) to enter circular systems.

Through an empirical study, research presented explores the role & capability of digital technologies in enabling designers to design fashion and textile products with full integration into sustainable and circular systems. Opportunities and challenges for digital technologies to work alongside designers by filling technical knowledge gaps within the design process are considered from a creative, technical and operational perspective.

Insights are used to outline the knowledge requirements and process for digital technologies to be embedded within the design process. Enabling designers to make considerations for sustainable materials and processes at initial manufacture stage as well as collection, sorting, re-use, recycling at end of use.

DYEING AND PROCESSING BREAKTHROUGHS - FIBERS – FABRIC SUBSTRATES

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Processing problems stem from the resultant dielectric field in the dye bath for any of the substrates; fibers, yarns or fabrics for either the natural fibers or man-made fibers as well as in combinatorial permutations across the spectrum of textile manufacturing. The processing industry seldom measures the strength of the dielectric field on real time owing to lack of credible measuring instruments and also failing to recognize this as the cause for losses in dye affinity, rate of exhaustion onto the substrates and the reproducibility of the color coordinates irrespective of near identical dyeing conditions of temperature, dye bath fluid pressure, steady state changing liquor ratios as functionally defined by the exhaustion dynamics and finally the properties of abrasion, flexural rigidity and piling post – processing after “n” washes as also the affinity to exposure to sunlight.

Extensive research methodologies on configuration of the zeta potential of various dyestuffs for reducing the dielectric field with ionic neutralization mechanisms was conducted whilst comparing the shade depth, tonal quality and the resultant color coordinates. Downstream processing was studied for outcomes for the various quality and processing parameters to evolve the acceptable range of standard operating procedures.

CARD ENGINEERING FOR REAL TIME PARAMETRIC CORRECTIONS TO DRIVE OUTCOMES OF QUALITY AND PRODUCT ECONOMY IN THE FABRIC VALUE CHAIN

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Problem statement:

Card engineering has several complex nodes that are not well comprehended by design and process engineers alike. Consequently, the course corrections in the process and initiatives to control the process are often found disruptive yielding severe inconsistencies in yarn products that in turn influence the manifestation of substantial problems in dyeing and processing of fabrics as well as cause visible objectionable defects in the fabric surfaces. Barre in the fabric after bleaching or dyeing is another important pitfall arising out of poor controls in the card engineering protocols.

Solutions:

Line of shear is a critical parameter in cad engineering that needs to be controlled through a host of measures at the blow room and the card. Monitoring of the states in the real time profiling of the line of shear is essentially online, thereby giving forth powerful insights on the process and enabling a corrective action to be initiated well in time prior to actual occurrence of incidents and events.

Observations and the effectiveness of the course corrections are portrayed in the real time online values of classimat data scatter.

Impact of the research:

1. Consistencies in quality, throughput, yield and OEE

2. Benchmarked procedures for detecting process outliers and initiating course corrections prior to the onset of incidents and events.

3. Significant improvements in the costs of conversion and consequently on the capacities to absorb distress pricing regimes whilst maintaining higher thresholds of quality

PROCESS AUTOMATION WITH EXPERT DECISIONING SYSTEMS THROUGH ML-AI APPLICATIONS IN YARN MANUFACTURING

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Problem statement:

Yarn manufacturing is decidedly complex for the entire range of raw materials in the realm of natural fibers as well as for the man-made fibers. The complexity blurs the pathways to capture the essence of outstanding engineering principles in the management of the equipment and the processing parameters inclusive of AHUs (air handling units) for plant air conditioning systems thereby raising an exponentially large number of anomalies and process related pitfalls that can severely alter quality and throughput outcomes within the ambit of yarn manufacturing.

Consistencies in process engineering and established universal SOPs – standard operating procedures are generally missing in the management systems thereby undermining the credibility of the controls and essentially living by the sales contracts rather than having generic excellence in the plant.

Research driven solutions:

The research process has been exhaustive in bringing forth the clusters of influences in heuristic reference frames with ML-AI grid to drive home consistencies in OEE – overall equipment efficiencies that encompass speed losses, plant utilization losses and the quality determinants of yield losses in universal standards of operations to benchmark processes.

Impact of the research initiatives

1. Consistencies in quality, throughput, yield and OEE

2. Benchmarked procedures for detecting process outliers and initiating course corrections prior to the onset of incidents and events.

3. Significant improvements in the costs of conversion and consequently on the capacities to absorb distress pricing regimes whilst maintaining higher thresholds of quality.

THE DIGITAL PASSPORT: A SUSTAINABILITY JOURNEY IN ETHICAL FASHION

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Recent government legislation on Extended Producer Responsibility (EPR) aims to enhance garment businesses' awareness of unethical manufacturing practices and promote circular principles within supply chains. This includes designing for circularity, increasing education on textile selection for biodegradability, and reducing microplastics. EPR initiatives also focus on eliminating waste at the product disposal stage and promoting sustainability through communication channels with consumers. Innovative digital technologies, such as RFID tracking and Digital Garment Passports, offer solutions for transparency, carbon calculation (Scope 1&2), and consumer trust. Blockchain technology further enhances transparency in the circular economy, particularly in rental and resale industry practices.

This presentation showcases a case study of an industry partnership between ACS Clothing and Fashion at the University of Salford. Here we employ a constructivist philosophy using Value–Belief–Norm (VBN) theory to underpin sustainable practices. The collaboration involves research into sustainable business models, textile innovation, digitalisation and consumer behaviours. Technological applications include RFID tracking, AI in garment sorting, and automation in sustainable logistics. By integrating these strategies, we bridge the gap between academia and industry practice, fostering sustainable transformation. VBN Theory helps analyse how consumer attitudes, industry practices, and policy frameworks drive sustainability, guiding behaviour change and industry-wide commitments.

ENHANCING CLIMATE RESILIENCE AND WORKPLACE SAFETY IN THE SRI LANKAN APPAREL SECTOR

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This study investigates the implications of climate change on occupational health and safety within Small and Medium-Scale Apparel Manufacturing Companies (SMAMCs) in Sri Lanka. Specifically, it examines the operational and workforce vulnerabilities arising from the escalating frequency and severity of climate-related hazards namely heatwaves, air pollution, and extreme weather events. These hazards pose critical risks to the continuity, safety, and well-being of workers in the apparel manufacturing sector.

Adopting a mixed-methods research design, the study integrates quantitative data from surveys with qualitative insights drawn from focus group discussions and content analysis of organisational safety manuals. This approach enables a comprehensive assessment of existing health and safety frameworks, climate risk mitigation strategies, and worker perceptions, offering a multidimensional understanding of the sector's resilience capacity.

The findings reveal significant deficiencies in current occupational safety protocols, underscoring the sector's limited preparedness to address emerging climate-induced risks. In response, the study proposes the Unified Climate Resilient Approach, operationalised through the Health, Safety, and Climate Resilience Assessment Tool (HSCR). The HSCR tool comprises 19 strategic sections and 203 evaluation points across four critical domains: legal compliance, occupational health and safety, climate resilience factors, and environmental compliance. This instrument offers a structured mechanism to evaluate and strengthen climate resilience across SMAMCs.

The study's implications call for urgent policy reform and the mainstreaming of climate risk assessments into national and sectoral workplace safety and sustainability strategies. Aligning existing protocols with international standards and cultivating a proactive safety and sustainability culture will be pivotal in safeguarding workforce health and operational integrity amidst escalating climate challenges.

SUSTAINABLE TEXTILE DYEING: EXPANDING THE CHROMATIC PALETTE THROUGH NATURAL DYES OF PRIMARY COLOURS

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The increasing demand for environmentally responsible products has induced the textile and fashion industries to reconsider conventional dyeing methods and explore sustainable alternatives that guarantee aesthetic and functional standards. Natural dyes have emerged as a promising substitute for synthetic dyes, offering ecological and health-related benefits. However, their wider application is challenged by a limited colour palette and colour fastness. This study explores the development of an expanded chromatic range through the strategic combination of natural dyes (indigo for blue, madder for red and weld for yellow), and auxiliary agents, applied via a systematic exhaust dyeing process using industrial equipment. Critical dyeing variables, including dye concentration, bath temperature, process sequencing, and use of auxiliaries, were optimised to improve performance. The dyed samples were analysed for their colorimetric coordinates and wash fastness. Results demonstrate that a diverse range of shades can be produced from a limited number of natural dyes. Furthermore, dyeing parameters and material combinations used significantly influence visual results and fastness properties. This work emphasises the importance of process optimisation in the effectiveness of natural dyes for sustainable textile production. Moreover, it provides valuable contributions to the textile and fashion industry by expanding achievable colour options through environmentally responsible processes.

REYA: REUSE YARN

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Processes in knitwear colouration focus on specificity, accurate colour production and repeatability. The specificity of colour choice restricts the use of stock colours and results in overproduction due to minimum orders, it is exacerbated by minor changes in key colours to encourage seasonal purchasing, resulting in deadstock yarn. This paper proposes that minor colour inconsistencies are unimportant to consumers, particularly in online sales. Additionally, it suggests a commercial route for deadstock yarn from the conventional knitwear supply chain.

Working with a variety of deadstock yarns from John Smedley and Shima Seiki, UK, 10 garments were manufactured with subtle colour variations. Multi-yarn blends were knitted as three-colour birds-eye jacquards. Replacing single yarns within a blend minimises colour and count differences. A nuanced, qualitative and quantitative evaluation of garment colour and consumer feedback, collected in five UK focus groups, provides a detailed study of behaviour that evidences accurate consumer tolerances to colour inconsistency.

Findings suggest that differences in component colours have a minimal impact on overall garment aesthetics and consumers are tolerant of these minor colour inconsistencies. This evidence will allow designers to utilise emerging sustainable colouration methods with commercial confidence and contribute to positive colouration policy change in the fashion industry.

HYBRID TEXTILE MATERIALS WITH IMPROVED ABRASION RESISTANCE INTENDED FOR PROTECTIVE GLOVES

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One of the aims of the personal protective equipment development is to increase the safety of employees exposed to mechanical factors during manual work. Protective gloves consist of multi-layers, where the coating is the outer layer, most important in terms of mechanical protection. The modification of coating is one of the possibilities to improve performance properties without adding extra layers into protective gloves, which could deteriorate ergonomic properties. The high abrasion resistance is one of the requirements for protective gloves according to EN 388:2016+A1:2018. In our research we proposed polyurethane coating modification intended for protective properties by incorporating additional particles, including glass balls, aluminium oxide (Al_2O_3) and silicon carbide (SiC). The abrasion resistance of aramide textile, which did not achieve the 1st performance level, increased to the 1st performance level after coating application and coating with glass balls. On the other hand, incorporation of Al_2O_3 as well as SiC particles contributed to achieving a higher number of rubs (600 and 800) and the obtained materials were characterized by the 2nd performance level according to EN 388:2016+A1:2018. However, to date, research and development work in this area has primarily been focused on the design of hybrid textile materials for protective gloves.

FIXING FASHION- A SUSTAINABLE FUTURE

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The fashion industry faces significant challenges in reducing its environmental and social impacts. Despite improvements in brand commitments over the past decade, the complexity of the issue requires new perspectives. Generation Alpha are deeply aware of climate change and poised to drive change through pro-environmental behaviours rooted in strong personal, social, and environmental beliefs. Therefore, understanding value belief theory is crucial for shaping the circular economy and guiding industry-wide sustainability commitments.

A UK-based case study on sustainable fashion education highlights innovative pedagogical approaches. By developing active blended learning strategies using multi-modal assessments, student engagement has increased. The curriculum begins with an introduction to environmental and social issues in global fashion production. Students analyse global production and consumption, examining the effects of mass production, resource depletion, and fast fashion through exploring ethical dilemmas and alternative production lifestyles.

Students use advanced digital techniques to create sustainable zines, reflecting trends in ethical consumerism, second-hand fashion, rental models, and repair services. They are challenged to balance profit with ethical responsibility, underpinned by theories such as Social Practice Theory and Value-Belief-Norm. By analysing real-world examples, we provide a sustainable roadmap for fixing fashion, offering valuable insights for industry stakeholders, policymakers, academics, and future designers.

DEVELOPMENT OF MILITARY DEFENCE PRODUCTS: AN INNOVATIVE AND SUSTAINABLE DESIGN APPROACH

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Contemporary military defence equipment must present enhanced performance taking advantage of digital innovation and sustainable principles. Soldiers today face diverse, challenging environments that demand body armour which not only safeguards but also remains lightweight, flexible, and ergonomically adaptable to various body types. Additive Manufacturing (AM), recognised by the European Commission as a key enabling technology, is central to this endeavour. Fused Deposition Modelling (FDM) builds components layer by layer from melted thermoplastic polymers, enabling a production process that is both rapid and decentralised. Incorporating sustainable materials such as Polylactic Acid (PLA) achieves an environmentally friendly manufacturing method that minimises waste and improves efficiency.

This study places digitalisation at the heart of prototyping hard ballistic plates - essential elements of modern body armour. A user-centric approach, supported by comprehensive surveys and digital anthropometric studies, has been adopted to capture prevalent body types and guide ergonomic design. An iterative process, utilising Computer-Aided Design (CAD) and optimised through FDM, produced 3D models that significantly streamline the traditional manufacturing cycle.

The convergence of digital and advanced technologies with sustainable practices offers a promising route to develop adaptable, high-performance military gear that fulfils both operational demands and ecological responsibilities.

INCREASING RECYCLED CONTENT IN CIRCULAR KNITTED FABRICS WITH CORIZON TECHNOLOGY

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Incorporating mechanically recycled fibres into new knitted fabrics is challenging due to the short length of fibres after the tearing process, which makes it difficult to spin them into high-quality yarns, such as compact yarns. Open-End (OE) spinning results in yarns that are hard, grainy, and unsuitable for clothing that requires a soft touch.

This research explores the Corizon process, developed by Terrot, which combines yarn spinning and knitting. This modified circular knitting machine feeds the intermediate yarn product directly into the knitting machine, producing yarn immediately before the meshing process. This method allows for a higher recycled content in circular knitted fabrics while maintaining a softer, more refined feel compared to traditional methods.

The first test series, featuring 25%, 50%, and 75% post-consumer cotton, demonstrates successful feasibility. Subjective and mechanical property tests of T-shirts made from these fabrics confirm their pleasant feel, wearability, and durability. However, a new aesthetic has emerged that necessitates a redefinition of quality in the context of new eco-design standards.

THE ROLE OF TEXTILES IN PROVIDING SUSTAINABLE HEALTHCARE

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Textiles can account for a third of waste generated in an operating theatre and the contribution of PPE such as reusable gowns and drapes has generated some attention, mostly just by clinicians, despite attention being drawn internationally to the carbon footprint of the health sector, its impact upon climate change and promises to reduce carbon emissions.

Despite paucity of evidence from the clinical workplace, several initiatives have attempted to improve the way textiles are used in healthcare. This paper provides details about related health policy at a national and international level alongside current issues that surgeons face in the operating theatre and attempts to improve existing practices. Proposals need to be developed to guide not only policy makers but also those responsible for procurement. Collaboration between textile companies and practitioners is the preferred way of ensuring that textile items are manufactured using sustainable initiatives.

THE UNSEEN THREAT BEHIND RECYCLED MATERIALS: A FOCUS ON BPA CONTAMINATION IN TEXTILES AND TEXTILE WASTEWATER

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According to the US EPA, bisphenol A (BPA) are one of the most widely produced chemicals worldwide. This chemical compound has been observed to trigger genotoxic and epigenetic responses.

Several studies have been conducted on bisphenol A in daily clothes. Bisphenol A was found in end products made from different compositions, mostly recycled products. However, no detailed study was carried out on whether the main source of this problem was the production processes, the yarns, or the chemicals. The purpose of the present work was to identify the origin of bisphenol A in textile products.

In the scope of the study, the presence of BPA was analysed in 24 yarns, 20 fabrics, 25 dyes, 30 chemicals and 28 different pre-treatment, dyeing or washing baths by using LC-MS/MS. Test results show that the main source of BPA is recycled yarns. BPA levels of recycled yarns are between 35 - 2500 ppb. The level of BPA in fabric gradually decreases after the production processes. However, this also increases the presence of BPA in the process wastewater. The study also shows that BPA levels in products significantly increase when left in sunlight.

MANUFACTURING OF CONDUCTIVE COMPOSITE THREADS BY THE TWISTING PROCESS AND EVALUATING OF ITS DURABILITY

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E-textiles as a shape of threads has been developed and used long as electrodes, sensors, and circuits in smart textile products. Conductive yarns, especially manufactured by coating method, has been designed to have the electrical properties, but there is a disadvantage that the conductive materials on the surface easily fall off due to abrasion by external stresses, thereby reducing performance. Smartwear such as EMS suit needs durable conductive threads during manufacturing processes such as sewing, embroidery, and knitting, but not available until now in the market.

In this study, the conductive composite threads were manufactured through a twisting to solve the matter of durability. The commercial PET and Ag-coated polyamide filaments(AP) were selected to manufacture 3-types by the twisting conditions. Afterwards, 4-types of textile electrodes including AP sample for collecting electromyography(EMG) signals were manufactured by the embroidery technique. Since the electrodes for collecting bio-signals are located in close contact with the skin, the tactile comfort was also a key issues and was been studied. To confirm durability by the external stresses, electrical properties and EMG performance were investigated before/after an abrasion test.

By deriving the optimal conditions for conductive composite thread that can improve durability, it is expected that will serve as basic data for the development of a conductive thread that can be applied for smartwear.

SUSTAINABILITY IN THE CASHMERE SUPPLY CHAIN

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The cashmere supply chain is complex, with many sustainability challenges: rangeland degradation, threatened pastoral livelihoods, hazardous chemicals, poor traceability and inequitable trade. Additionally, actors are very varied: nomadic herders, traders, textile processing companies in Asia and Europe and luxury fashion houses. As a relatively small and niche market, however, it has proved possible to make a significant sustainability impact in a short period of time.

Since 2015 the Sustainable Fibre Alliance has been working to improve the whole cashmere supply chain and to safeguard the health of people, animals and the environment (a "One Health" approach). The strategy has been based on engaging and connecting market actors, using market leverage and drawing on a deep knowledge of rangeland systems to drive change. Subject experts and academics have contributed significantly through standard development and innovative research projects. The SFA has developed and published a robust international standard addressing the most pressing issues in the cashmere supply chain. This has wide market acceptance and pending ISEAL approval.

This presentation will outline the challenges, the strategy, the actions and the outcomes of the SFA's work, highlighting some of the key learnings and the future strategies, including their applicability to other supply chains.

HIGH-PERFORMANCE CONDUCTIVE NANOFIBER: A SUSTAINABLE SOLUTION FOR NEXT-GEN WEARABLES IN HEALTHCARE MONITORING

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The conductive nanofibers offer a flexible, biocompatible, and highly sensitive solution replacing the conventional bulky, rigid, and adhesive electrodes that are used to monitor the human physiological signals. Their seamless integration into wearable products advances real-time physiological signal tracking, enabling continuous monitoring of vital parameters for early diagnosis with a comfortable healthcare monitoring solution. This research focuses on developing conductive nanofiber electrodes for monitoring human vital parameters such as heart rate, pulse rate, and respiratory rate from electrocardiogram (ECG) signals by integrating the electrodes as a wearable harness. The conducting nanofiber is developed through an electrospinning process with bio-derived polyurethane (PU) which is a non-isocyanate and bio-degradable material. Polyacrylonitrile (PAN) polymer has been doped with PU for nanofiber formation. Further, the obtained nanofiber is sputtered coated with copper nanoparticles to increase the conductivity. The morphology study reveals the formation of nanofiber with a diameter of 600 nm. The conductivity of nanofibers is 1.27×10^{-2} S/cm. The Cu sputtered nanofiber is then developed as an electrode of size 1.5x2 cm and integrated in the chest harness as a wearable for signal acquisition. Using three electrode system the ECG signal has been recorded and the obtained value of heart rate and pulse rate is 86 BPM, and the respiratory rate is 16bpm. The result obtained reveals that the nanofiber sensor is capable of efficient, real-time, physiological signal monitoring.

CO-DESIGN LED CROSS-DISCIPLINARY INTEGRATION OF HIGH AND LOW-TECH EXPERTISE IN CREATING A REGIONAL SUPPLY CHAIN

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This on-going investigation aims to encourage cross-disciplinary collaboration in the use of biobased materials in design-led Natural Fibre Composites (NFC) applications. Designer pull for the sourcing of materials from closer to 'home' will help to promote the creation of a transparent regional supply chain, with the merging of high-tech / low-tech expertise and processing, from fibre cultivation through to niche value-added product development. NFC as a truly multi-disciplinary domain, presents a challenge in covering in depth all the related areas in the merging of two totally different and complex worlds of natural fibres and polymers. The creation of value-added products, that must both work and look good in addressing end-user needs, demands a collaborative design-led approach. The adoption of Co-Design methodology enables the development of shared language between disparate cultures in making novel materials, processes and terminologies accessible for all stakeholders. Northern Ireland's textile and engineering heritage may be revived with the potential for innovative applications for natural fibres (e.g flax, hemp, wool) in NFCs through engaging with disciplines that include architecture, interior, furniture and product design. Overall the aim is to inspire creative practitioners with the confidence to select more sustainable alternative materials and processes within their product development.

AI-Powered Sustainability: Digitizing Certification Through Machine Learning and Natural Language Processing

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Sustainability labels like GOTS have long been essential for ensuring ecological and social standards in the textile industry. However, these traditional certification systems are increasingly challenged by the complexity of modern supply chains and growing consumer demand for transparency. Issues such as manual, time-consuming processes, limited data traceability, and concerns around greenwashing emphasize the need for innovative solutions.

Artificial Intelligence (AI) presents a significant opportunity to address these challenges. AI enables the development of digital, dynamic sustainability certifications that update in real time, offering more flexibility and efficiency. This article explores how AI can transform sustainability certifications by automating audit processes, verifying production data through machine learning, and using Natural Language Processing (NLP) to detect greenwashing.

Blockchain technology plays a crucial role as well, ensuring secure, tamper-proof validation of supplier data and promoting transparency across the supply chain. AI-driven real-time data analysis can provide dynamic sustainability assessments, going beyond static certification labels.

Through industry case studies, the article demonstrates how companies are utilizing AI to streamline operations, enhance trust, and improve sustainability tracking. It also highlights the use of NLP tools for real-time verification of sustainability claims.

Ultimately, the article explores the future of sustainability certification systems, driven by AI, offering more adaptive and responsive solutions for a transparent textile industry.

DIGITAL PRODUCT PASSPORTS: A ROADMAP FOR TEXTILE CIRCULARITY AND COMPLIANCE

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The textile industry faces growing pressure to improve supply chain transparency, traceability, and circularity. This pressure is being intensified by the recent EU Ecodesign for Sustainable Products Regulations and associated Digital Product Passport (DPP) requirements (due 2027), which aim to support sustainable consumer choices.

This research, funded by an Innovate UK AKT Circular Fashion grant, is a collaboration between the University of Liverpool Management School and A.W. Hainsworth. Using an action research methodology, it explores the feasibility of integrating novel tracer and track-and-trace technologies with decentralised digital records to enhance product authentication, combat counterfeiting, and ensure DPP regulatory compliance. Beyond compliance, DPPs may offer strategic advantages by enhancing market differentiation, strengthening consumer trust, and serving as a powerful marketing tool for engagement and sustainability awareness.

As regulations tighten and market opportunities expand, diverse solutions have emerged, from novel tracer technologies to third-party DPP providers. This study evaluates their feasibility for the woollen textile supply chain and the broader textile sector, assessing their ability to securely link physical products with digital records. It also takes steps toward a practical roadmap for DPP adoption, providing insights into best practices, regulatory considerations, and scalable solutions that support circular economy goals and commercial success.

CONTINUOUS RECYCLED CARBON FIBRE – PROGRESS TOWARDS A CIRCULAR COMPOSITES INDUSTRY

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In May 2022, continuous recycled carbon fibre (rCF) was successfully recovered from end-of-life composite pressure vessels and re-manufactured similarly to virgin carbon fibre (vCF). This was a significant advancement made by the National Composites Centre (UK), in collaboration with Cygnet Texkimp and B&M Longworth. Previously, rCF was recovered in a discontinuous form, typically with highly variable mechanical properties that limit its use as a substitute for virgin fibres in high-performance composites. The development of short-fibre alignment technologies for post-processing discontinuous rCF has gone some way to improving the composite performance of rCF materials, but continuous rCF has the potential to offer a higher performance, lower variability and cost-competitive virgin carbon fibre substitute to the industry.

However, the true performance potential of continuous rCF remains unclear, particularly after it is converted into a composite preform. While mechanical properties have been evaluated immediately after recovery, little is known about rCF's performance post-processing. Our research reveals that rCF can differ from vCF in surface condition, being recovered unsized and often with surface char residue. This presentation discusses how these unique surface properties affect fibre-to-preform processing alongside our work towards developing a conversion method for continuous rCF that minimizes fibre damage and maximises performance.

BIOCOMPATIBLE, DURABLE PET-G- SERICIN FIBERS WITH *IN SITU* DEPOSITED AGNPS FOR EFFECTIVE ANTIBACTERIAL ACTIVITY

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Polyethylene terephthalate (PET) fibers dominate global synthetic fiber markets yet face critical limitations in antimicrobial efficacy and surface functionality, posing risks in healthcare and public hygiene. To address these challenges, we engineered a low-temperature plasma-assisted grafting-reduction strategy to synthesize biocompatible, durable AgNPs@PET-g-SP fibers, integrating sericin peptides (SP) with in situ-deposited silver nanoparticles (AgNPs). Optimized plasma etching induced nanoscale pitting and introduced carboxyl/hydroxyl groups, enhancing PET's surface energy and enabling robust SP grafting via amide bonds. The oxygenated moieties (e.g., carboxyl, hydroxyl) on plasma-activated PET surfaces synergize with the innate oxygen and amino functionalities of SP to facilitate high-density Ag^+ coordination via chelation-driven nucleation. Meanwhile, SP's 3D structure and innate amino acids (e.g., tyrosine, aspartic acid) templated homogeneous AgNPs (15–20 nm, PDI <0.1) while inhibiting aggregation. The hybrid fibers exhibited exceptional antibacterial activity (>99.99% inhibition against E. coli and S. aureus), sustained efficacy after 30 wash cycles (>90% retention), and ultralow Ag+ leaching. Concurrently, SP imparted moisture-wicking properties (water contact angle: 32° vs. pristine PET's 118°) and skin compatibility. This plasma-biointerface synergy establishes a scalable platform for durable, eco-friendly antimicrobial textiles, bridging critical gaps in medical and wearable applications.

THE INTEGRATION OF SOFT ROBOTICS WITH APPAREL MANUFACTURING: ENHANCING AUTOMATION AND INTELLIGENCE IN THE TEXTILE INDUSTRY

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Flexible materials allow soft robots to safely interact with humans, showing great potential in intelligent apparel. This study examines advancements in soft robotics, focusing on actuation technologies such as gas, tendon, and shape memory alloy actuation. These methods are applied in textile handling, medical garments, and other areas. Gas-driven grippers manipulate textiles effectively, while combined grippers and multi-point layouts enhance automated clothing transfers. Soft robotic garments include hand rehabilitation gloves, upper limb assistance garments, and lower limb assistance garments. Rehabilitation gloves use pneumatic artificial muscles or tendon drives to strengthen hand muscles. Upper limb assistance garments improve motor performance and reduce metabolic costs with shape memory alloy fabric muscles (SFM) and unpowered exoskeletons. To address research limitations, optimizing actuation methods with smart materials and reducing sensing and control elements through micromachining can improve manufacturing efficiency and precision. Analyzing fabric characteristics enhances gripping accuracy. Intelligent garment development should prioritize a "human-centered" approach, optimizing devices via "human-in-the-loop" methods. Further exploration of smart manufacturing models incorporating soft robotics based on human needs is essential.

LIFELONG LEARNING IN TEXTILE AND CLOTHING INDUSTRY: CIRCULARITY DECK OF CARDS

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The transition to circular design requires innovative educational approaches that promote engagement and lifelong learning. Gamification enhances knowledge retention by boosting motivation, creativity, and problem-solving skills. In sustainable design education, interactive tools can effectively develop competencies, enabling learners to critically examine and operationalize circular economy principles. This article discusses the design and application of a learning resource developed within a European-funded project. The resource was designed to facilitate circular design for products and services and was implemented in multiple training sessions involving students and professionals in the textile and clothing industry. During these sessions, data collection was conducted through questionnaires to assess receptiveness, challenges, and opportunities arising from gamification in circular design education. The study thus discusses the pedagogical efficacy of this resource, the methodologies applied within it, its implementation, and its impact on lifelong learning experiences. Accordingly, an investigative approach was adopted, focusing on existing tools and methodologies associated with gamification in sustainable design education. Ultimately, gamification acts as a catalyst in training students, designers, and industry professionals to address the challenges of circularity. Beyond contributing to environmental sustainability, this research project stands out as a sector innovation driver, fostering new perspectives for circular design in professional practice.

LEAN PRACTICES IN OPERATIONS MANAGEMENT: ADVANCING EFFICIENCY AND SUSTAINABILITY IN THE TEXTILE INDUSTRY

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This study explores the role of Lean Manufacturing as a key driver of digital transformation, sustainability, and future workforce competencies within the UK textile industry. Using an action-based, collaborative methodology, the research examines how Lean principles enhance operational agility, process optimisation, and cultural adaptation in response to emerging digital and environmental challenges.

Working with five partner companies at varying levels of digital maturity, the study utilises semi-structured interviews, roundtable discussions, and observational process analyses to evaluate Lean's impact on efficiency, resource utilisation, and sustainability outcomes. Findings indicate that Lean fosters leadership commitment, workforce engagement, and supply chain integration, supporting businesses in transitioning toward digitalised, low-impact production models.

Despite barriers such as manual data dependency and scalability challenges, multi-skilling initiatives, visual management, and IoT integration have shown promise in reducing inefficiencies, improving machine uptime, and enhancing traceability. This research highlights Lean's role in bridging the gap between digital adoption, workforce development, and sustainable manufacturing, offering a structured approach to continuous improvement.

By integrating Lean with AI-driven process monitoring, real-time data analytics, and sustainable production strategies, this study provides valuable insights for practitioners and policymakers, outlining a scalable model for future-proofing textile production through efficiency, collaboration, and the development of future skills and competencies.

How Tuck Stitch Structures Can Improve the Tactility of Wool Fibres Using 'Blending Through Pattern'

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The paper explores how a novel approach to blending fibres: 'Blending Through Pattern', can enhance the tactile qualities of breed-specific British broad wools in knitted fabrics so they can be utilised for apparel. This approach is an alternative to traditional processes, such as spinning and twisting, as it utilises weft-knitted pattern structures to combine different yarn types together.

This material-led approach to textile design has the potential for wide-ranging use in the fashion industry. It positions material quality decisions later in production, offering design flexibility: fabrics can be adapted and changed depending on the market's requirements. This is important because 80% of the environmental impact in the fashion industry is determined during design and production. Thus, evaluating and improving established production processes is necessary to reduce this impact.

The research explores seven breed-specific wool fibres, investigating whether their tactility improves when combined through pattern and structure. This paper focuses on one specific pattern structure: Tucked patterns. It details the principle formations, the rationale behind their selection, and those that blend yarn types most cohesively. The structures were tested in combinations of two, three, and four yarn types, and the resulting fabrics were evaluated and compared using the' sense of hand'.

COLOUR FORECASTING AND AI; INTUITION OR IMAGE SCRAPING

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Colour trend forecasting was first recorded almost a century ago in the 1920's, and became a fundamental tool for designers, manufacturers and retailers. It has influenced generations of consumers clothing and textile purchases, and had an unprecedented impact on the success or failure of ranges with power to influence colour across a broad range of consumer products.

If baby blue is the en vogue color, chances are you're going to look for products in that color. You'll be able to buy a computer, shoes, socks, coffee mugs, pens, and even cars in that color.

Colour Marketing Group (2024)

Traditional methods of gathering and synthesising information to develop new seasonal colour trends relied on assessing and mapping a range of sources, catwalks, trade fairs, world events, social and technological trends (Raymond, 2019). The introduction of digital tools to gather and disseminate such trends evolved over the last 20 years: colour forecasting today bears very little relation to that of the last century.

AI tools revolutionize this process by analyzing extensive datasets encompassing runway images, search and sales data, and social media posts.

Global Brands (2024)

However, throughout the digital transformation there has always been a team of colour professionals selecting and creating colour stories and forecasts, who use their experience and creative intuition to develop colour stories into key trends.

This paper will discuss how AI and other digital tools are changing colour forecasting, supported by the views of trend forecasters and their response to the changing landscape of digital creation.

INTELLIGENT MANUFACTURING FOR 3D PRINTING BASED ON NATURAL SILK PROTEINS

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Currently, the application of natural hydrogels in tissue engineering is constrained by their poor printability and limited ability to mimic the in vivo microenvironment. To address these challenges, this study explores silk fibroin as a model material, investigating its modification and composite processing strategies to enhance its printability and broaden its application scope via 3D printing technology. This study addresses the poor printability and limited biomimicry of natural hydrogels in tissue engineering by exploring silk fibroin as a model material. We focus on modifying and formulating photopolymerizable silk fibroin-based hydrogel inks for high-precision 3D printing. Using minimal surface designs, we fabricate structured soft tissue scaffolds and investigate how internal architectures influence scaffold performance. Our goal is to develop customizable biomimetic scaffolds with enhanced mechanical properties and permeability through synergistic regulation of material composition and topological design. Additionally, we examine the effects of hybrid hydrogel inks on printing accuracy and propose a novel precision evaluation method using ink-responsive light recognition over long distances. By optimizing energy input through work curve measurements, we aim to achieve high-resolution (<100 μm) 3D fabrication of photopolymerized silk fibroin. Ultimately, this research advances the industrial translation of silk fibroin-based hydrogels for tissue engineering applications.

EXPLORATION OF VIRTUAL FIT SOFTWARE FOR THE ASSESSMENT OF GARMENT FIT AND PRESSURE APPLICATION OF COMPRESSION GARMENTS

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The aim of this research is to determine the accuracy of various virtual fit software for understanding fit and pressure application of compression garments. Previous studies have concluded that the technology has not been appropriate for this application however since, new technologies have emerged, and current software has been upgraded. The use of this technology is becoming increasingly popular within the fashion industry to reduce sampling and increase sustainability within the manufacturing process, but does the technology have the capabilities to deal with the complex nature of pressure garments in the same way?

Lectra Modaris 3D, Style 3D, Clo 3D and Grafis are explored within this research and evaluated to understand the accuracy of these virtual fit programs for predicting pressure application and fit of pressure garments. A solid Alvanon dress form is used as a control in this study. The dress form was scanned using a Size Stream SS20 scanner and the measurement data used to create a bespoke calf compression sleeve; the pressure applied by the sleeve was measured using a Picopress pressure measurement device. The digital avatar and garment pattern were imported into the various software, where the pressure was evaluated using inbuilt heat maps.

REDUCING FIBRE FRAGMENTATION IN TEXTILES: A MACHINE LEARNING APPROACH TO SUSTAINABLE FABRIC DESIGN

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Fibre fragment pollution from textiles is a major environmental concern, with fragments widespread in nature and potential risks to ecosystems and human health. One solution is to modify the design of textiles in the development phase to produce lower-shedding fabrics. This research explores how fabric characteristics influence fibre fragmentation, using data from The Microfibre Data Portal, which includes over 1,000 fabrics tested by 95 textile industry signatories. A machine learning approach was used to assess the impact of fabric composition, structure, yarn type, and finishing on shedding.

Finishing techniques were identified as a key factor due to their strong influence on fragmentation and their modifiability in production, despite limited prior research. However, the study highlights the importance of considering all fabric characteristics when addressing fibre fragmentation. In addition to offering insights for the textile industry, the machine learning model developed in this study has potential for predicting fibre fragmentation based on fabric specifications, complementing physical testing.

INTERFACIAL CHARACTERIZATION AND MECHANICAL PERFORMANCE OF HIGH STRENGTH CARBON FIBER UNIDIRECTIONAL COMPOSITES

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High-strength carbon fibers, characterized by tensile strengths exceeding 6.4 GPa, and carbon fiber-reinforced polymers (CFRPs) have garnered significant interest in industrial applications due to their exceptional properties, including low density, corrosion resistance, high strength, and superior elastic modulus. Despite extensive research on their mechanical performance, knowledge regarding the interphase between the fiber and resin in high-strength carbon fibers remains limited. A comprehensive understanding of this interfacial region is critical for optimizing composite performance.

In this study, the mechanical properties of 6.4 GPa strength-grade carbon fiber unidirectional composites are systematically investigated through experimental testing, with a particular focus on evaluating the interfacial shear strength (IFSS) between the carbon fibers and epoxy matrices. To further elucidate the fiber-matrix interaction, a representative volume element (RVE) simulation model is developed based on experimental data, enabling the estimation of interphase properties for unidirectional composites. The experimental results provide valuable insights into the tensile and shear behavior of their composite prepreg, while the IFSS analysis enhances the understanding of fiber-matrix adhesion mechanisms. Furthermore, RVE simulations offer a detailed result of stress distribution and interfacial behavior at the microscale. The findings of this study contribute to the experimental and numerical characterization of high-strength carbon fiber composites.

WEARABLE ELECTROMYOGRAPHIC MONITORING: A SMART SLEEVE SOLUTION

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Smart textiles enable seamless monitoring of biosignals like electromyography which is crucial for accessing muscle health, aiding in rehabilitation, and supporting care for individuals with disabilities. Conventional pre-gelled Ag/AgCl electrodes have perfect signal quality due to their low skin-electrode resistance. However, the gel causes skin irritation and dries leading to loss of conductivity. Textile-based dry electrodes are a promising alternative, as they can be integrated into everyday clothing. Nevertheless, they suffer from high skin-electrode resistance during physical contact which leads to inadequate signal quality. In this work, dry electrodes of surface area 3.75 cm² made from silver-plated polyamide yarn of 78 tex and electrical resistance 600 Ω/m were integrated into a knitted forearm sleeve to monitor EMG signals of living brachioradialis muscle. A dynamometer was used to measure the force exerted by subjects during contraction and relaxation. It was observed that during successive contractions the force exerted by the subject decreases marginally as shown by amplitude as well. Although the amplitude measured also depends on force exerted by subjects, the sleeve captured signals (4.39 - -4.54 mV) for a wide range of force (117 – 333 N) and when tested with commercial electrodes it delivered comparable signal quality. Thus the developed electrodes can be integrated into garments in place of commercial electrodes for biosignal monitoring.

DEVELOPMENT OF AN ANTIBACTERIAL PINEAPPLE LEAF FIBER (PALF) WOUND DRESSING INFUSED WITH TRADITIONAL SRI LANKAN HERBAL COMPOUNDS FOR ENHANCED WOUND HEALING

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The demand for sustainable, biocompatible materials has increased in every aspect globally. Natural fiber-based wound care materials have highlighted their potential in medicinal systems. At the same time, sustainable fibers derived from agricultural waste, plant sources, and biodegradable polymers are also being explored for applications in textiles, packaging, and biomedical devices. These materials offer a promising alternative to conventional synthetics due to their low environmental impact, renewability, and ability to integrate functional properties such as antimicrobial activity, moisture retention, and mechanical strength. This research proposed the development of a novel bioactive wound dressing using pineapple leaf fiber (PALF), an agricultural by-product in Sri Lanka, as a primary structural and healing substrate. PALF was separated manually from water-retted harvested leaves, and they were first alkali-treated to enhance softness and purity. Then, it was followed by antibacterial and wound healing functionalities with chitosan treatment. Treated fibers were knitted into a sack-like structure, which was filled with a layer of traditional medicinal pulp, rich in natural plant-based herbs to support wound healing further. Fibers were characterised using spectroscopy methods. Moisture content was also analyzed. Tensile strength was measured, and it was 196 MPa. Antibacterial activity and wound healing properties were also tested. This work combines natural fiber engineering, a sustainable healthcare approach, and traditional medicine to address modern challenges using locally available and sustainable materials.

CIRCULAR TEXTILE DESIGN WITH NEXT GEN MATERIALS

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Next gen materials are attracting growing interest as potential solutions to environmental issues in the textiles sector. This category includes biobased and recycled materials which are yet to reach full commercial scale and stand as low-impact alternatives to conventional resources such as virgin polyester or cotton. The scale and variety of next gen materials is expected to grow rapidly, yet there is little discourse on how they fit within a circular economy.

The New Composites project developed and tested guidelines for circular textile design with next gen materials. Instructions for compatible combination of resources without undermining recyclability respond to the current shortsightedness when blending next gen fibres with conventional ones for performance or cost. Key to the work was the production of a range of samples demonstrating the use of circular principles with five example next gen materials. Using these samples as boundary objects enables an understanding of the challenges and opportunities of the approach, both from the makers' perspectives, through a series of interviews, and from the end-of-life recycling perspective, using spectroscopic testing as a measure of the textiles' recyclability. This paper provides a speculation on the future of the circular textiles landscape which expands to innovative materials.

NEXT-GENERATION COTTON PROCESSING: SCALABLE, SUSTAINABLE, AND CAUSTIC-FREE

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Conventional cotton pretreatment remains a major contributor to water consumption, chemical discharge, and energy use in the textile supply chain—typically involving caustic soda and high-temperature processing that damages fibre quality and increases environmental impact. Fibre52 introduces a patented, bio-friendly system that replaces conventional scouring and bleaching of cellulose fibers with a low-temperature, caustic-free solution for all colors including bright whites. By preserving the cotton fibre's natural cuticle layer, the process enhances tensile strength, dye uptake, and softness while reducing chemical use, fabric weight loss, and finishing requirements. It operates under neutral pH conditions, requires less rinsing, and eliminates the need for acid neutralization, resulting in shorter cycle times and significantly lower energy and water usage. Designed as a drop-in solution, Fibre52 integrates into existing mill equipment without requiring capital expenditure or process overhaul. Mills that have adopted the Fibre52 system across South Asia and those currently trialing globally including Europe, Latin America, Asia have reported reductions of up to 30% in energy and water consumption, 10% reduction in dyes and 50% in synthetic softener use, alongside improved product yield and sustainability compliance and improvement. Fibre52's technology supports alignment with global certification frameworks such as ZDHC, OEKO-TEX® offering an accessible and commercially viable route for mills seeking to decarbonize and digitalize operations. This presentation will explore key process metrics, adoption case studies, and the broader implications of Fibre52's approach as a catalyst for circularity and sustainable innovation in cellulose textiles. It demonstrates how industrial-scale process and chemical reformulation can yield measurable environmental and operational benefits—bridging the gap between textile tradition and sustainability-driven transformation.

EMBEDDING BODY SCANNING INTO A SUSTAINABLE PRODUCT PIPELINE FOR FIT OPTIMIZATION AND WASTE REDUCTION

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The fashion industry demands ongoing production of textiles to continue to supply customers with products for as long as it is profitable to the supplier. However, manufacturers must incorporate sustainable actions into their production pipelines to address the global environmental impact and challenges we face. There is a demand for an improved circular economy where supply chains and business models must adapt with support from available technology. The current product development pipeline focuses largely on profitability, disregarding the need to manage unsold items and understanding the end-user experience of a product. The disregard for a product's worth once sold leaves unanswered questions concerning fit, use, and longevity.

The study aims to tackle overproduction, waste, and fit optimization by adopting 3D body scan technology at the earliest stages of production. An original product pipeline has been developed to support product sell-through by adding focus to the user's experience of anthropometric-engineered knitted garments. The findings indicate that 3D body scanning can aid the garment fit accuracy of fully fashioned products during production, with participants' wearer trials and feedback questionnaires expressing varying satisfaction levels around areas including ease, garment style and customer preference, factors that ultimately extend the product lifetime and usability.

SENTIRE - FABRIC HANDLE TESTER

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The assessment of fabric handle has historically relied on subjective human judgement, challenging consistency, scalability, and sustainability across global supply chains. As the industry faces the loss of seasoned specialists and rising demands for sustainable practices, a shift toward quantifiable, standardised methodologies is imperative. The Sentire offers a unique solution to this industry-wide problem by utilising four precise test methods to mimic human touch and quantifying key tactile properties. The collected data is analysed through established principles of fabric physics, delivering objective, reproducible results.

The Sentire offers far-reaching sustainability benefits: replacing the need for physical fabric exchanges in quality assurance which negates material waste and discrepancies with retailers. Additionally, the ambition is to empower consumers and allow them to make informed decisions about a fabric's handle when purchasing garments online- this will reduce rejections and therefore logistic emissions across the industry.

The system enables real-time quality monitoring in production stages, enhancing responsiveness and minimizing costly rework. Furthermore, its capacity to detect variations due to finishing, coatings, or laundering provides manufacturers with actionable insights into product performance and durability.

Sentire embodies a convergence of innovation and sustainability - preserving long-standing industry knowledge while redefining quality assurance for the modern textile supply chain.

EMPOWERING FASHION SUSTAINABILITY EDUCATION IN AFRICA THROUGH DIGITAL INNOVATION

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The overproduction and overconsumption of textiles in Africa contribute to severe environmental challenges, driven by cultural attitudes, economic policies, and limited sustainability education. This research examines key factors fuelling textile pollution, including fast fashion consumption, inadequate waste management policies, and limited circular economy practices, which continue to exacerbate environmental and socio-economic issues across the continent.

To gain deeper insights, focus groups with designers, consumers, and policymakers will explore attitudes, behaviours, and barriers to sustainable fashion adoption. Findings will inform the development of a minimum viable product (MVP) for a digital Fashion App in collaboration with a Nigerian fashion brand. The platform will serve as a sustainability education hub, offering interactive courses, policy insights, and community-driven solutions to promote circular fashion practices. By integrating AI-driven personalisation, gamification, and digital learning, the app will enhance accessibility, engagement, and knowledge-sharing, equipping users with the necessary tools to drive responsible fashion consumption.

This presentation will outline focus group findings, platform development, and industry partnerships, emphasising its role in bridging the knowledge gap between industry and education. Ultimately, it aims to redefine fashion consumption in Africa through a scalable, tech-driven solution that reduces textile waste, promotes sustainability, and fosters long-term behavioural change toward a circular fashion economy.

FROM LAND TO FABRIC: EXPLORING HISTORICAL TEXTILE PATTERNS AND NATURAL DYES

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'From Land to Fabric: Exploring Historical Textile Patterns and Natural Dyes' is a pedagogical approach to textiles, which aims to create a space for dialogue between tradition and innovation, through the recovery of textile heritage, contact with natural materials and artisanal processes.

The methodology consists of three workshops designed by the authors, run at the Wool Museum and its surrounding landscape, attended by Fashion Design undergraduates of the University of Beira Interior.

Cultural and environmental sustainability have a strong presence in the concept of this workshop and complement each other through the application of two processes: weaving fabrics with historical Covilhã patterns, and dyeing with natural dyes from plants in the same region, applying recipes from the 18th century.

A creative approach connecting the past and future was proposed, inviting participants to rethink their place in the world through the tactile experience of weaving and dyeing.

The workshop is a first step to engage fashion design students on industrial textile thinking approaches that might impact their creative process and cooperation with the textile industry.

Three works created during the workshop were selected for the 2024 Contextile Textile Art Biennale, marking the University of Beira Interior's debut at the exhibition.

CLOSED LOOP CONCEPT OF THE DIGITIZED AND ARTIFICIAL INTELLIGENT TEXTILE MILL: ADVANCED ANALYTICS AND REAL-TIME OPTIMIZATION OF TEXTILE PRODUCTION PROCESSES

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Predictive capability is the prerequisite for automatic action and self-optimization. In order to be able to anticipate events in production processes and to initiate timely countermeasures, as well as to leave important decisions to IT systems in the next step, intelligent Industry 4.0 systems will be dealt with within the lecture. First, we will illustrate which initial situation must be created in the company in order to subsequently use artificial intelligence technologies. This forms the basis for being able to create reliable predictions through a solid software and database architecture that manages all company data in only one central database. Data quality across all areas of the business, from sales to quality assurance to production planning and control, is intrinsically important to the predictive acuity of the AI application. Machine learning, digital twins, and real time optimizers, among others, are presented in the following.

Digital twins are created using special machine learning algorithms, through historical production data. They map processes close to reality and make it possible to predict target variables as a predictor. Thus, upcoming events can be anticipated even before processes have taken place in real time. As a result, time and money savings are achieved.

In order to be able to optimize a process in the Industrie 4.0 environment, genetic optimizers are used. With their goal of increasing the yield of production, these combine all limitations and barriers that arise within a process and weigh the best possible options for all manipulable variables of a process in order to achieve the best possible quality of a product. Incremental setpoint control allows production processes to be optimized with sustained high productivity, reduced costs and while maintaining quality specification limits. Thus, adjustments to production changes in the business environment can be made without loss of time.

During the presentation, a comprehensive insight will be given into which requirements have to be fulfilled in order to be able to apply such advanced Industrie 4.0 systems.

DEVELOPMENT OF NONWOVEN DRESS SHIRT USING ADVANCED METHOD OF PATTERN TECHNIQUES AND 3D BODY SCANNING, CHALLENGES AND SOLUTIONS

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This study evaluates the performance of woven and nonwoven fabrics in garment construction, focusing on the pattern-making challenges posed by nonwoven materials. Traditional pattern development methods, designed for woven fabrics, are often unsuitable for nonwoven textiles due to their distinct structural properties. These differences create construction challenges, particularly during sewing, and impact the visual and functional performance of garments.

To investigate these issues, four men's shirts were developed using nonwoven fabrics, and their cutting, stitching, and overall garment performance were analyzed. The findings indicate that specific areas, such as armholes and curved sections, require redefined pattern-making techniques to accommodate the unique behaviour of nonwoven materials. The study highlights the need for innovative pattern-making approaches to optimize garment fit, durability, and design integrity for nonwoven apparel.

By addressing these challenges, this research contributes to the advancement of fabric-specific garment engineering, offering valuable insights for designers and manufacturers in the evolving field of nonwoven textile applications.

CARBON DIOXIDE RESPONSIVE SWITCH DYES FOR DISPERSANT-FREE POLYESTER COLOURATION

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Polyester is the most widely-used textile in the world, compromising 57% of global fibre production in 2023. It is estimated 520 billion litres of water are used annually in the polyester dyeing process. As dyeing utilises extensive auxiliary chemicals, recycling this effluent is a significant challenge, necessitating treatment before disposal in waterways.

Therefore, a new class of reversibly soluble dyes have been developed which allows polyester to be dyed without the use of auxiliary chemicals. These dyes have reversible solubility behaviour, where dissolved CO_2 interacts with a switchable moiety on the dye structure. This novel dyeing system eliminates the effluent, as the spent dye liquor can be recycled by "topping up" to the desired concentration. The dyes can be mixed to achieve colour matching and produces level dyeing that meets or exceeds commercial fastness properties.

These novel dyes allow for a green alternative to reductive clearing, preventing the use of hazardous reduction solutions. This also avoids the breakdown of dyes into potentially toxic metabolites and preserves the dyes to be recovered. Additionally, due to the reversibility of the process, it is also possible to use CO2 to decolourise the dyed fabric, allowing for improved quality of recycled polyester and dye recovery.

To be able to apply this technology in a real-world scenario and realise the potential benefits, the molecular design of the dyes and their synthesis has been developed in line with green chemistry principles, to ensure this technology is sustainable by design.

SMART TEXTILE PRINTING AND CULTURAL SUSTAINABILITY: EXPLORING CREATIVE EXPRESSIONS WITH INTERACTIVE INKS

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Sustainability issues in the textile and fashion industry are becoming increasingly prominent. The culture dimension remains a vast field to explore. This study investigates how cultural sustainability can be addressed through the design of smart printed textiles with colour-changing properties. The research follows a qualitative and experimental methodology, focusing on the expressive and technical feasibility of interactive patterns. Focus groups were conducted to identify creative possibilities with cultural potential, followed by surface design. Printing tests were carried out with thermochromic inks – colour-changing materials that react to temperature variation – exploring chromatic behaviour. The results highlight the possibility to add value to textiles through interactive surface designs that promote emotional experiences and emphasize the importance of designers understanding the meanings of graphic and chromatic concepts for the cultures represented. This approach allows users to connect with meanings associated with memory and cultural heritage, through textile colours and patterns, thus fostering cultural sustainability. In parallel, it encourages a longer product lifecycle, contributing to environmental sustainability. In conclusion, integrating cultural sustainability into the textile and fashion industries can be facilitated by interactive materials through smart textile printing, bringing both environmental and cultural benefits to companies and consumers.

CLOSING THE LOOP IN THE WORKWEAR AND FASHION INDUSTRY

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Most textile products today are too complex or costly to recycle due to their lack of design for disassembly, recycling or circularity. Research shows that 9% of clothing is multilayered and 78% of all clothes contain mixed materials or disruptors such as zippers, and buttons which hinder1.

To address this challenge, this research shows the creation of a design-for-disassembly solution that simplifies textile recycling for brands, sorters, and recyclers, by combining heat-dissolvable stitching threads and thermal disassembly systems. It enables up to 65% compared to manual disassembly, while also reducing processing time by up to 90%. This solution unlocks textile-to-textile recycling, improving upgradability, repairability and circularity in textiles. Achieving circularity in textiles also requires collaboration across the entire supply chain. The company behind the technology is also spearheading the creation of localized consortia, connecting collectors, sorters, recyclers, and brands to establish an end-of-life ecosystem. This presentation highlights the first consortium in the Benelux-France region, focusing on workwear and fashion waste, and showcases innovative products that demonstrate the transformative potential of this approach.

This work exemplifies how cutting-edge technology and cross-industry collaboration can drive systemic change and set new standards for circularity in the textile sector.

THE ROLE OF CERTIFICATIONS IN CONSUMER TRUST AND GREENWASHING PREVENTION

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Certifications are one of the main tools for ensuring transparency and credibility in sustainable fashion. However, the growing number of eco-labels and the lack of clear regulations make it difficult to distinguish between legitimate certifications and misleading marketing strategies. This raises questions about the extent to which these certifications influence consumer trust and purchasing decisions. Additionally, greenwashing tactics further complicate consumer perception, as brands may use sustainability claims without real commitment to environmental responsibility.

This study examines Portuguese consumers' perceptions of certifications in sustainable fashion, investigating their impact on brand credibility and the adoption of responsible consumption practices for consumer trust. Using a quantitative and qualitative approach, the research aims to understand the level of trust placed in different sustainability labels and the need for stricter regulations to ensure their effectiveness. The findings are expected to contribute to a more informed debate on the role of certifications in building a more transparent and sustainable textile sector.

TEXTILE DEADSTOCK REPAIR AND REMANUFACTURING: A CIRCULAR BUSINESS MODEL OPPORTUNITY

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Currently, the supply chain in the textile and clothing market, particularly in the fashion sector, is mostly linear. Nevertheless, global policies, business initiatives and societal movements in recent years show that this sector must make the transition to a circular model. Based on this premise, the doctoral thesis aims to investigate and develop a circular business model tailored to the fashion textile industry, focusing on the repair and remanufacture of deadstock, such as surplus raw materials and finished products, collection leftovers, samples, and defective products.

The methodology integrates a comprehensive literature review; qualitative interviews with industry leaders, as focus group; surveys to a representative sample of Portuguese textile and clothing fashion industry; quantitative data collection; and analyses using advanced statistical tools, supported by artificial intelligence tools. A Flourish Canvas Business Model will be developed, applied to fashion repair and remanufacturing circular model, and tested in real industrial settings to validate its effectiveness.

The conference presentation will highlight the key findings of the doctoral research, which include the characteristics and volume of textile deadstock (raw material and finished product surpluses, collection leftovers, samples, and defective products), and the potential circular business models that could be implemented within the textile and clothing industry.

SUSTAINABILITY INDICATORS FOR THE TRAINING SHOE INDUSTRY

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The market size for trainers has surpassed pure sport and athletic applications in recent years, becoming the predominant choice for casual footwear. However, they pose an environmental threat due to the high levels of energy consumption in their manufacturing processes and their low recyclability at the end of their lifespan. This work examines consumers' perspective regarding sustainability in trainers' products while analysing the current indicators used by Sustainable Trainers brands to assess sustainability. Demonstrating the need of an accessible consumer-driven indicator that can assess sustainability from a Circular-Design perspective.

This study was carried in two stages. The first stage was built on the results of a survey that acknowledged consumers' preferences towards sustainability. The second analysis was built on the indicators used by Sustainable Trainers Brands to evaluate sustainable development. Results shown that consumers associate sustainability with environmentally friendly materials and recovery schemes after the product's lifetime, however no indicator that evaluates these two concepts was detected. Suggesting that, even though indicators can be a driver for influencing consumers' perspective, tools that evaluate the effectiveness of the decisions made at the early stages of footwear design need to be developed to understand how these decisions can improve the environmental performance of trainers

BIO-BASED POLYETHYLENE FOR TEXTILES: SCALABLE SOLUTIONS FOR SUSTAINABLE PERFORMANCE

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The global production of synthetic fibres continues to rise, with polyester being the dominant material in the clothing industry. However, fully bio-based alternatives remain expensive or are not yet available at an industrial scale. In a joint research project involving industry partners, bio-based polyethylene – a widely available and recyclable polymer – is being used to develop spun-dyed and textured yarns for sustainable textile applications. By developing compounds, sustainable colour masterbatches, and innovative textile finishing techniques, new materials are created that offer an environmentally friendly alternative to conventional synthetic fibres. Initial trials have already demonstrated the feasibility of producing bio-based PE yarns, with further development focusing on garment production. The textiles are equipped with elasticity through a post-treatment process involving bio-based materials. Certified raw materials ensure sustainability and enable the use of bio-based polyethylene in the mass market. The successful development contributes to the research and implementation of innovative, resource-efficient materials, aligning with many textile industry companies' commitments to advancing sustainable textile solutions. This approach provides a competitive advantage and contributes to a more sustainable textile industry.

BREAKING BARRIERS TO TEXTILE CIRCULARITY: INNOVATIONS IN FIBRE-TO-FIBRE RECYCLING

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Globally, less than 1% of textiles are recycled into new clothing, resulting in a loss of over 100 billion US dollars in materials each year. Fibre-to-fibre recycling presents a transformative opportunity for the fashion and textile industry by enabling a circular solution in one of the most wasteful sectors. However, contaminants in post-consumer textiles significantly degrades the recyclate quality, while the slow adoption of innovative yarns by brands further limits the widespread use of recycled textiles.

This study integrates environmental science, social science, and textile recycling expertise, in collaboration with Project Plan B, to address these challenges. Specifically, by: (a) developing a novel pre-recycling treatment process to remove organic contaminates in post-consumer polyester textiles and enhance fibre quality, (b) conducting key stakeholder interviews across the supply chain to identify and overcome barriers to fibre recycling, and (c) informing textile design principles that minimise environmental impact, including reduction of microfibres released from recycled polyester garments during laundering.

Our findings will provide actionable strategies to enhance the efficiency, scalability, and adoption of textile recycling within the industry. This research will also help embed circular economy principles, reduce textile waste, improve recycled garment performance, and drive the transition toward more sustainable fashion practices.

SYNTHESIS AND PROPERTIES OF WATERBORNE POLYURETHANE USING BIOBASED POLYOL FOR BREATHABLE MEMBRANES

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In recent years, waterborne polyurethane (WPU) has emerged as a sustainable alternative to conventional solvent-based polyurethane due to its use of water instead of organic solvents for processing and application. However, WPU synthesis still depends largely on petroleum-derived raw materials, much like other polymers. As a result, there has been increasing interest in developing bio-based WPU systems that utilize renewable resources. This study focuses on incorporating bio-based poly(trimethylene ether) glycol (P3MEG), a renewable polyol, into conventional WPU formulations traditionally synthesized using petroleum-derived poly(tetramethylene ether) glycol (PTMEG). The objective was to partially replace PTMEG with P3MEG to enhance the bio-content of WPU systems.

Experimental results showed that increasing P3MEG content slightly increased particle size, but all dispersions-maintained sizes below 150 nm, ensuring excellent dispersion stability. The inclusion of P3MEG improved the molecular weight, thermal stability, and elongation at break of WPU films. However, higher P3MEG concentrations led to slight reductions in tensile strength and water resistance. Optimal P3MEG-to-PTMEG ratios of 50:50 and 25:75 was identified, producing waterproof, breathable membranes. These findings demonstrate the potential of P3MEG to create sustainable, high-performance WPU systems with reduced reliance on fossil fuels while maintaining key material properties.

INNOVATION POTENTIAL IN THE CIRCULAR TEXTILE ECONOMY: NEW SUCCESS METRIC TRANSFORMERS

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To be added.

DYEING OF TENCEL FABRIC WITH NATURAL DYE EXTRACTED FROM *ACACIA NILOTICA* BARK USING ULTRASONIC-ASSISTED DYEING

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Since the continuously growing environment-related and health problems arising out of synthetic dyes, the world is moving towards natural dyes as a substitute. In this study, the Acacia Nilotica natural dye was extracted from the bark of Acacia Nilotica and applied to Tencel fabric using an ultrasonic-assisted dyeing method. The initial step was optimizing the extraction of natural dye. The extracted dye was then applied to the Tencel fabric. Different liquor ratios, time, temperature, and pH were used to optimize the dyeing parameters. The optimized sample showed higher color yield and excellent color fastness properties. The effect of different mordants was also studied and it was observed that by using different mordants, different fashion hues were created from the same dye extract since the addition of mordants changed the color values. Additionally, tensile strength, stiffness, and analysis of wastewater quality were also performed on the optimized sample and found acceptable. This fundamental investigation into natural dye extraction and dyeing revealed that cellulosic fabrics could benefit from the usage of this dye.

TEXTILE DYEING POLLUTION AND SOLUTION

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The textile dyeing industry is a cornerstone of global economies but remains a significant contributor to environmental degradation. This study investigates the ecological challenges posed by conventional dyeing practices, including excessive water consumption, effluent pollution, and carbon emissions. To address these issues, the research highlights the transformative potential of digital dyeing technologies. Successful bulk production trials across diverse fabrics showcase digital dyeing's ability to drastically reduce water usage, dyestuff consumption, and wastewater generation, while integrating clean energy to lower carbon footprints.

In parallel, the study evaluates the limitations of current wastewater treatment methods, such as coagulation, and proposes integrated solutions to enhance their efficiency and practicality. These findings emphasize the need for collective action among policymakers, researchers, and industry leaders to implement sustainable practices. Balancing environmental goals with industrial scalability, this research provides critical insights into reshaping the textile dyeing industry for a cleaner and greener future.

ENHANCING URBAN SAFETY PERCEPTIONS: THE ROLE OF SMART GARMENTS IN SUPPORTING WOMEN

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The safety of women in urban environments is threatened by overcrowded, rapidly expanding cities and the absence of gender-specific safety measures. Despite increased surveillance, traditional safety solutions may often overlook the lived experiences of women, reinforcing spatial and structural variations in accessibility. This research explores smart garments, as technologies that could reshape how women engage with urban spaces. The study highlights design considerations related to autonomy, privacy, and inclusivity, presenting fashion-led smart wearables as important tools for addressing urban vulnerabilities and rethinking safety through an inclusive and user-centred approach.

It adopts a mixed-method approach, combining a pilot and main survey (n~ 200) to explore how smart garments are perceived concerning personal safety among urban women. The study uses a two-way ANOVA and effect size analysis to compare participants' responses on usability, trust, and desirability. The results indicate women have more safety concerns and interest in wearable safety technologies. These findings offer new insights for wearable design, demonstrating how smart garments can be co-designed as creative, ethical interventions that empower users and support safer, more responsive urban futures. The work contributes to inclusive computing by advocating for women's experiences and underscoring the need for gender-responsive innovation.

THE EFFECT OF PREPARATION, DYEING AND FINISHING TREATMENTS ON THE BIODEGRADATION OF CELLULOSIC MICROFIBRES

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Microfibres have been identified in terrestrial and aquatic ecosystems with 80% of fibres found in ocean samples reported as cellulosic. This poses the question – what factors are preventing these natural fibres from degrading in the environment? This research aims to develop understanding of the effect of preparation, dyeing and finishing treatments on the biodegradation of cellulosic microfibres in aquatic environments. Eight cotton fibres that have received differing chemical treatments were exposed to environmentally representative aquatic environments and measured for biodegradation through biological oxygen demand and fibre analytical data. Results identified fibre biodegradation across all tested fibres after 366 days at lower levels than previously reported. Significant reductions in the level of biodegradation were measured with fibres dyed with a monofunctional reactive dye suggesting that the presence of these dyes reduce accessibility of degrading enzymes to the cellulose polymer. The results from this study raise concerns surrounding the biodegradation and environmental fates of cellulosic microfibres suggesting that these microfibres may be more persistent than previously assumed. Due to the high level of chemical alteration that these fibres undergo during textile manufacturing, it should be considered that these microfibres are not naturally occurring and should therefore be referred as synthetic.

MECHANICAL AND CHEMICAL PARAMETERS OF PROTECTIVE MATERIALS CONTAINING CARBON ADDITIVES

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At workplaces to protect workers exposed to mechanical risks the personal protective equipment (PPE), including footwear with adequate protective properties, is used. Mechanical properties of materials for PPE should be suitable for their function in specific working conditions. The aim of the study was to assess the effect of carbon additives on the properties of poly(vinyl chloride) composite and determine what kind of carbon additives allow to obtaining the mechanical and chemical properties desired for application in personal protective equipment. The poly(vinyl chloride) material were made with application of carbon additives. Protective properties in terms of mechanical and chemical parameters were evaluated with methods dedicated to materials used in protective footwear in accordance with Regulation (EU) 2016/425 of the European Parliament and of the Council of 9 March 2016 on personal protective equipment. The samples were prepared according to the EN ISO 20344:2021 standard. The results obtained from the use of carbon additives indicated an improvement in mechanical properties in terms of tear and tensile properties. Addition of carbon additives is not the only factor improving protective properties, the other ones being the concentration and size of flakes incorporated into the polymer matrix.

EVALUATION OF CUT RESISTANCE OF PROTECTIVE MATERIALS COATED WITH GEOMETRIC STRUCTURES

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The purpose of the study was to evaluate the effect of different geometry variants on the anti-cut properties of coated textile materials. The testing material were made using knitted fabric, which was subsequently coated with latex containing inorganic fillers. Coating layers were applied to the knitted fabric using designed pattern matrices. The geometric design of the molds was made using the 3D printing method from thermoplastic material, with ellipse-shaped, diamond-shaped and striped-shaped geometries. Materials were subjected to the action of a blade performing a sliding movement at a constant speed (2.5 ± 0.5) cm/s. The specimen holder was a metal cylindrical piece, the surface of which forms a radius of curvature of (38 ± 0.5) mm. Blades with a cutting edge length of 65 mm, thickness of 1 mm and a cutting edge angle of 22° were used. During the test, the blade was directed across the curvature of the sample holder at an angle of 90°.

The tested variants of geometrized three-dimensional structures applied to aramid knitted fabric were characterized by cut resistance in the range from 7.8 N to 23.8 N. Tests performed allowed to evaluate the influence of the coating layer geometry on the anti-cutting properties.

ADVANCING SUSTAINABLE TEXTILE PROCESSING THROUGH INPUT CHEMICAL MANAGEMENT

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Sustainability implementation programs in the textile, apparel, leather, and footwear supply chain often focus on end-of-pipe treatments, controlling hazardous chemicals in end product, wastewater, air emissions, and sludge. However, true sustainability starts with Input Management to prevent hazardous substances from entering the production processes.

The Zero Discharge of Hazardous Chemicals (ZDHC) initiative has pioneered this paradigm shift in the apparel and footwear industry through the ZDHC Manufacturing Restricted Substances List (ZDHC MRSL)- the first harmonised list restricting hazardous substances in chemical formulations, ensuring safer inputs. Continuously updated based on scientific and regulatory advancements, this proactive approach protects workers, communities, and the environment.

Going beyond the MRSL, the ZDHC Chemicals to Zero (CtZ) framework connects into product safety and helps transparency through risk- based evaluation after application of a formulation for RSL compliance. Future iterations of the CtZ will incorporate Full Material Disclosure (FMD) for hazard identification and other sustainability aspects such as biodegradability, carbon intensity, resource efficiency and waste efficiency.

This paper elaborates how input chemical management in the textile and leather processes can advance sustainable textile processing leading to a world where better chemistry protects life, land, air, and water.

SUSTAINABLE FIBRES FROM VINEYARD WASTE: A CIRCULAR APPROACH FOR PRODUCING YARNS AND COMPOSITES

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Grapevine pruning's, amounting to 36.5 million tonnes annually, are traditionally considered waste and discarded via burning or decomposition, contributing to greenhouse gas emissions and environmental degradation. This research explores a novel approach to vineyard waste management by transforming prunings into functional fibers, offering a sustainable alternative to synthetic and conventional fibers. The study evaluates the mechanical properties, and industrial applications of these fibers.

The methodology involved chemical and mechanical fiber extraction along with assessment of physico-mechanical properties. Yarns and composites were developed in various combination ratios, and their properties were analyzed. Results demonstrate that grapevine fibers possess superior mechanical properties, making them viable for textiles, automotive, and packaging industries. This approach aligns with circular economy principles by reducing agro-waste and generating economic opportunities for vineyard farmers. By repurposing agricultural byproducts, this study supports decarbonization efforts and strengthens rural economies, aligning with COP 29 and COP 30 agendas.

This research highlights the scalability of grapevine fibers as an environmentally responsible material. The findings contribute to climate resilience by reducing waste and emissions while advancing sustainable industry practices. This study aligns with the 12th and 13th Sustainable Development Goals (SDGs) of the United Nations.

FROM LAB TO LOOM: THE FUTURE OF FASHION

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Bacterial cellulose (BC) is increasingly recognized as a next-generation biomaterial, offering a sustainable alternative to synthetic and plant-based cellulose due to its renewability, biodegradability, and superior mechanical properties. While BC has been extensively utilized in biomedical applications, its integration into textile manufacturing remains limited.

A key challenge in BC processing lies in its dissolution and fibre spinning, attributed to its unique structural characteristics. The dense network of intra- and intermolecular hydrogen bonds, along with its high crystallinity and degree of polymerization, makes BC highly insoluble in conventional solvents. This insolubility complicates fibre processing, as incomplete dissolution leads to inconsistencies in regenerated fibres, affecting their mechanical performance and processability.

On the other hand, companies such as Nanollose have demonstrated BC-based yarn production using traditional viscose and lyocell processes. However, these methods predominantly rely on petroleum-derived solvents, and involves processes that are expensive, toxic, and difficult to recycle, thereby diminishing BC's sustainability potential.

While alternative BC processing strategies have been underexplored in textiles, this study aims to bridge the gap by assessing existing approaches and optimizing a hybrid method that integrates mechanical processing with greener solvent selection and enhanced spinning techniques to achieve durable BC yarns. By addressing these challenges, this research contributes to the development of more sustainable and innovative fibre solutions, positioning BC as a potential material for the future of eco-friendly textile manufacturing.

TEXTILE WASTE RECYCLING IN INDIA: CHALLENGES, INNOVATIONS, AND SUSTAINABLE SOLUTIONS

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The textile industry in India is one of the largest and most dynamic sectors. It produces a significant amount of waste during production, consumption, and disposing cycles. A very large quantity of textile is manufactured, worn, and discarded every year, creating severe environmental issues. Textile waste is a major concern for it's role in landfills, greenhouse gas emissions, water pollution, chemical usage due to the dumping of used clothes. While textile recycling has a long history in India, it has gained major attention because of increasing fast fashion, which encourages overconsumption resulting in increased textile waste. In recent years, textile waste recycling has evolved into a multibillion-dollar industry, with innovations in sorting machines, design strategies, and the development of high-value recycled products. This paper highlights the ongoing efforts by various agencies and stakeholders to transform textile waste into valuable and sustainable products, thereby contributing to a more eco-friendly and circular economy.

MIND THE GAP: SKILLS NEEDS FOR A CIRCULAR FASHION AND TEXTILE INDUSTRY

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The UK Fashion and Textiles (F&T) industry contributes to global carbon emissions, with consumption generating circa 300,000 tonnes of waste annually to landfill or incineration (WRAP, 2017). The circular economy proposes a more sustainable model with initiatives responding to legislation requiring F&T companies to meet environmental and carbon reduction targets (WRAP, 2021; BFC, 2022).

Circular F&T design is more complex than traditional linear approaches, due to environmental impacts across the whole product lifecycle requiring consideration (Ellams and Goldsworthy, 2019). Circular supply chains are more extensive and require materials innovation, improved management of waste and emissions, reverse logistics and recycling infrastructure (Niinimäki, 2018). Inevitably, skills and knowledge gaps are emerging.

The NERC funded project 'Back to Baselines' (B2B) aims to map the UK F&T industry to provide a baseline of current practice from which to transition to sustainability within a circular framework (University of Leeds, n.d.). An essential element is to define the skills gaps across the industry and consider its alignment with educational provision.

This paper outlines the qualitative research as part of the B2B project, reflecting upon a series of focus groups comprising of F&T educators and industry specialists. The paper will discuss opinions and experiences of best practice for sustainable and circular F&T and explore the perceived alignments, and misalignments, of skills to inform future approaches.

CRAFTING CIRCULARITY: DIGITALLY-SIMULATED FASHION FROM NATURALLY DYED HANDLOOM YARNS

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This study presents an integrated approach to sustainable fashion development by combining natural dyeing, traditional handloom weaving, and digital simulation technologies. Utilizing biodegradable and renewable yarns—including cotton, regenerated cellulose, recycled cotton, and bamboo—plant-based dyes were applied to create naturally coloured yarns. These were then handwoven into fabrics designed for wellness and eco-conscious fashion accessories, emphasizing low-impact processing and the preservation of artisanal heritage.

To address the high material costs and limitations associated with physical sampling of handloom fabrics, the dyed yarn profiles and colour characteristics were digitized and used within 3D virtual prototyping software. This enabled realistic simulation of fabric textures, construction patterns, and final apparel outcomes, allowing for accurate aesthetic and functional assessments prior to physical production. The adoption of digital prototyping reduces fabric waste and resource use, aligning with circular design principles.

The approach demonstrates that the fusion of traditional textile practices with advanced digital tools can yield sustainable, zero-waste fashion solutions. The incorporation of recycled cotton further reinforces circularity by reintroducing textile waste into the production cycle. This work underscores the value of integrating craft, material innovation, and virtual technologies to create environmentally responsible and culturally rooted fashion pathways.

ADVANCING REALISTIC SUSTAINABLE APPAREL MANUFACTURING THROUGH CIRCULARITY, DIGITALISATION, AND COMMUNITY-FOCUSED INNOVATION

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Over the next decade, sustainable fashion must move from aspiration to implementation. This expansive work presents a pragmatic framework for circular fashion development grounded in textile recycling, local supply chain integration, and community-accessible digital manufacturing. Based in Braddock, Pennsylvania, Imura Apparel is expanding beyond small-scale apparel manufacturing to building a hyper-local, scalable ecosystem for sustainable design, combining community education and training with modern technologies, business models, and smart textiles. The model emphasizes material recovery, garment upcycling, and the development of circular business models to reduce waste and extend the life cycle of textiles. Key insights from our sustainable apparel incubator reveal the need for low-barrier entry to digital fashion tools and localized digital retailing strategies. Our findings suggest bridging fashion, sustainability, and digital innovation through inclusive infrastructure can empower marginalized communities and deliver scalable solutions.

DESIGNING FOR DIFFERENCE: CULTURAL INTELLIGENCE IN AI-DRIVEN FASHION FORECASTING AND GARMENT DESIGN DEVELOPMENT

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Artificial intelligence (AI) is transforming fashion trend forecasting and garment design, enabling faster innovation and data-informed decision-making. However, such progress brings growing concerns around cultural erasure, aesthetic bias, and ethical accountability. This research explores the ways cultural intelligence can be embedded within AI-driven design systems to promote authenticity and sustainability. Employing a mixed-methods approach, combining qualitative interviews with designers, AI specialists, and industry professionals, and comparative analysis of prominent AI forecasting platforms, the study reveals some systemic gaps within cultural representation and the risks from homogenised, algorithm-influenced design outcomes. Drawing from frameworks within creative technology and ethical AI literature, the research identifies key outcomes such as the potential of explainable AI (XAI), the importance of diverse and inclusive training datasets, and workflows for human-AI design that are collaborative. Additionally, the key findings suggest that culturally responsive AI systems could preserve creative plurality and support sustainable practices such as digital prototyping, resource optimisation, and circular garment development. This research reimagines AI as a co-creative collaborator that contributes to a more equitable, culturally diverse, and ethically grounded future for digital fashion and textile supply chains.

THERMOPLASTIC ELASTOMERS AS MATERIAL-BASED SOLUTION FOR THERMOMECHANICAL RECYCLABILITY OF ELASTIC TEXTILES

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The increasing demand for elastic textiles and the dominance of elastane-containing fibre blends in apparel pose a major challenge for textile recycling. Elastane, the most common material for stretch functionality, is incompatible with thermomechanical recycling processes due to its cross-linked polymer structure. Although mostly used in small quantities, it severely limits the recyclability of garments, especially considering that approximately 80% of all garments on the market contain elastane.

This work explores melt-spinnable thermoplastic elastomers (TPEs) as a more environmentally friendly and recyclable alternative to elastane. Unlike conventional elastanes made from elastomeric polyurethanes, TPEs can be processed via melt spinning and offer compatibility with common thermoplastic fibres like PET during thermomechanical recycling. Compared to solvent-based spinning methods, melt spinning eliminates the need for hazardous chemicals, enables higher production speeds, and significantly reduces both environmental and health-related risks. By selecting polymer combinations with matching melting behaviour and processing parameters, melt-spun elastic yarns can be developed that enable recyclability of elastic synthetic textiles.

Experimental results from blending and melt-spinning trials demonstrate the feasibility of elastic TPE yarns and provide insights into their recyclability, processability and material behaviour. This approach aligns with circular economy principles, offering a scalable route towards recyclable elastic textiles.

DIGITALISATION IN TEXTILE MANUFACTURING: A NEW APPROACH FOR REGIONAL AND PERIPHERAL BUSINESSES

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The fashion and textiles sector in the Global North faces structural challenges in advancing sustainable innovation, particularly in peripheral regions where labour shortages, fragmented supply chains, and limited collaboration hinder progress. In the Southwest of England, businesses navigate the liability of peripherality, lacking access to knowledge networks, infrastructure, and investment compared to metropolitan hubs. However, digitalisation presents transformative opportunities to overcome these barriers.

This study reinterprets regional sustainability and business challenges through a digitalisation lens, demonstrating how emerging technologies reshape traditional supply chain models. Using a qualitative, mixed-methods approach, it draws on seven workshops with 45 participants and 12 semi-structured interviews with designers, business owners, and sustainability advocates. Thematic analysis identifies three key areas where digitalisation drives innovation: (1) Knowledge and Technology Adoption, (2) Social Media as a Business and Consumer Education Tool, and (3) Digital Networks for Regional Collaboration.

Findings show that digital tools such as Computer-Aided Design (CAD), 3D printing, and digital manufacturing optimise resource efficiency, reduce waste, and support sustainable production. Social media enhances consumer engagement, while digital databases improve SME visibility and foster collaboration. By applying a digitalisation framework to long-standing supply chain challenges, this study highlights new pathways for sustainable innovation in regional textile industries.

UNRAVELLING KNITWEAR FOR A CIRCULAR ECONOMY

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This project considers the potential contribution to the circular economy of yarn-to-yarn recycling for knitwear. Unlike warp-knitted or woven fabrics, weft-knitted textiles use one or more ends in a continuous looped path, allowing garments to be unravelled from the finished edge. This construction enables material recovery from pre- and post-consumer waste, with minimal mechanical intervention. The technique may circumvent large-scale recycling challenges like handling blends and preserving wool and acrylic fibre quality.

Although knitted yarn is known to suffer damage and strength loss, little is understood about the impact of wear-and-care functions, such as laundering, or how these effects differ by fibre type. The research explores these gaps by examining unravelling practices in both craft and industrial contexts and considers if waste garments or panels can produce new finished items.

The experimental design addresses pre- and post-consumer waste. Recovered second-hand garments were unravelled and tested, with little knowledge of prior wear and care. In a controlled experiment, fabrics made from 100% wool and a wool/acrylic blend were knitted, unravelled, and reknitted at intervals between laundering and drying. Strength tests evaluated yarn strength before and after multiple unravelling and reknitting cycles to determine the method's viability for circularity and waste reduction.

ONE-BATH NATURAL BLACK DYEING OF WOOL FABRIC USING POMEGRANATE RIND EXTRACT AND IRON MORDANT

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Black is a timeless and widely preferred color in the fashion industry. However, natural black dyes for textiles remain commercially unavailable, with limited research in the literature. Tannins serve as a key source of natural black dye, producing deep black shades when combined with iron mordants. However, conventional natural black dyeing with tannins typically follows a resource-intensive two-bath process involving pre- or post-mordanting with iron. This study investigates a one-bath natural black dyeing process for wool fabric using tannins extracted from pomegranate rind agro-waste and ferrous sulfate as an iron mordant. Initially, pomegranate rind water extract was applied with varying mordant concentrations in a single dye bath. However, the fabrics exhibited a lighter black shade with poor color levelness, which worsened with increasing mordant concentration. To address this, the mordant was introduced in split additions during the dyeing temperature rather than entirely at the start. This modification resulted in a deeper black shade with improved color levelness. Further optimization of split addition conditions enhanced both color depth and levelness. The dyed fabrics were assessed for fastness to washing and light, confirming the effectiveness of this approach in achieving high-quality natural black dyeing while improving the sustainability of the dyeing process.

WETSUITS REIMAGINED: EXAMINING CONSUMER READINESS FOR RECYCLED NEOPRENE IN THE UK

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Neoprene, widely used in wetsuits and watersports equipment, presents significant environmental challenges, with over 380 tonnes of waste annually landfilled or incinerated in the UK. Addressing this issue requires a shift towards circular economy practices, particularly through the adoption of recycled neoprene products.

This study explores the social science dimension of consumer perceptions, via an online survey of a representative sample of 1,000 members of the UK general public and semi-structured interviews with 30 consumers of watersports brands. The research assesses consumer awareness of the environmental impacts of fashion and fashion accessories, attitudes towards recycled products, and the factors influencing purchasing decisions, with a specific focus on recycled neoprene.

Whilst data collection will be concluded by May 2025, the findings are expected to provide valuable insights into consumer willingness to adopt products made from recycled neoprene, as well as the perceived barriers to uptake, such as concerns about quality, durability, and hygiene. By identifying key drivers of consumer acceptance and the role of sustainability credentials and industry endorsements, this research will offer evidence-based recommendations to inform brands, policymakers, and manufacturers. These insights can help drive innovation and support a transition towards more sustainable material use in the watersports industry.

CHALLENGES TO SCALING TEXTILE CIRCULARITY: EVIDENCE FROM UK INDUSTRY STAKEHOLDERS

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Despite the growing emphasis on circular economy principles, fibre-to-fibre recycling in the textile industry faces significant barriers, particularly regarding the adoption of recycled fibres. This study sits within the "Increasing Textile Circularity" project and focuses on identifying stakeholder perceptions of challenges impeding the scalability of textile recycling in the UK.

Using qualitative methods by conducting 20 semi-structured interviews with key stakeholders across the UK textile supply chain, the research explores their experiences, perceptions, and systemic barriers hindering the widespread integration of recycled fibres into production within existing industry frameworks, regulations, and market dynamics.

Data collection will be completed by June 2025, and the findings are expected to offer critical insights into challenges facing textile circularity, including technical limitations related to fibre quality, economic concerns over cost competitiveness, and the lack of standardised recycling infrastructure. Additionally, cultural and organisational barriers, such as resistance to change within supply chains and insufficient consumer demand for recycled products, are expected to play a significant role.

By unpacking these complexities, this research will contribute to strategic interventions aimed at enhancing the adoption of recycled fibres. The insights generated will inform industry practices and policy frameworks, supporting the transition towards a more sustainable textiles system.

STRENGTHENING OF TEXTILE SUPPLIERS TOWARDS MAKING OPERATIONALLY RESILIENT APPAREL MANUFACTURING INDUSTRY

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The Indian apparel industry, the country's second-largest revenue generator, is highly vulnerable to disruptions that threaten its sustainability, profitability, and workforce well-being. Strengthening its operational resilience is imperative, with a key focus on reinforcing textile suppliers—the backbone of the industry. Enhancing supplier resilience enables apparel manufacturers to navigate market fluctuations, supply chain disruptions, and external risks effectively.

This study examines the role of textile vendor management in fostering operational resilience by improving supply chain efficiency, cost optimization, risk mitigation, and sustainability. Through a comprehensive literature review and structured focus group discussions with industry leaders, the research develops a tailored operational resilience framework for Indian apparel manufacturers. A survey-based approach further refines the framework, ensuring alignment with real-world challenges.

Findings emphasize that strategic supplier partnerships enhance product quality, agility, and innovation while ensuring compliance with ethical and environmental standards. The proposed five-tier resilience maturity framework offers actionable insights for companies seeking long-term adaptability. Strengthening textile suppliers is not merely a competitive advantage but a necessity for sustaining growth in an increasingly unpredictable global landscape.

SUSTAINABLE FASHION, DIGITALLY EMPOWERED

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The textile industry, a cornerstone of the global economy, represents approximately 3% of global GDP and 2% of household expenditure in developed countries. However, its economic significance is matched by its environmental impact, accounting for 10% of global carbon emissions (UN, 2023). The industry now faces unprecedented sustainability challenges across its entire value chain.

Regulatory pressures are intensifying, with initiatives such as the European Sustainability Product Requirements (ESPR), the EU Strategy for Sustainable Textiles, France's Anti-Waste Law for a Circular Economy (AGEC), and the proposed New York Fashion Act. These regulations aim to transform the industry's practices, from production to end-of-life management.

Despite its current environmental footprint, the textile sector harbours immense potential for improvement. The key to unlocking this potential lies in developing verifiable, communication-ready, and systematic digital solutions that integrate the entire value chain. This approach demands a shift towards digital-empowered sustainability.

The research integrates company insights, market watch, customer survey, solution benchmarking with support from AI technologies. It includes findings from grey or white literatures.

The keynote will explore, with return of experience, how emerging technologies and digital tools can address the textile industry's sustainability pain points such as ROI justification, high SKU diversity, fast iteration, supply chain data availability and so on.

DIGITAL PROTOTYPING STUDY OF SMART CLOTHING WITH ELECTRODES

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Growing interests in healthcare and fitness has activated the use of smart clothing with sensors and devices to provide real-time biometric data and enhance exercise performance. Since 2000th, compression garments with sensor-embedded design for accurate sensing are developed. A critical factor in manufacturing of smart clothing is the accurate placement of sensors and devices, especially in compression garments, where precise positioning is essential for effective data collection.

For this reason, when it comes to designing that digital prototypes match actual garment configurations requires reliable data on the tensile properties and strain of both digital and physical fabrics.

In this study, compression garments with six different polyester-based stretch fabrics were studied to find the critical parameters to exact match the position of electrodes.

This study revealed that while digital fabrics closely mirrored the tensile properties of real fabrics, strain distribution differed, particularly in high-stretch regions such as the chest and abdomen.

Experimental results showed the need for refining digital fabric parameters to ensure accurate strain representation and precise sensor placement, and provides fundamental data for enhancing digital prototyping accuracy in smart clothing design and future wearable applications.

REGENERATED CELLULOSE FIBRES FROM ALL CELLULOSE COMPOSITES

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All Cellulose Composites (ACCs) are materials made from cellulose based products, which have the potential to replace fossil fuel derived materials. These composites can be used in industries such as packaging, automotive, and biomedical fields. ACCs simultaneously use renewable sources of cellulose and textiles – in this case cotton fabric, that may otherwise have been wasted. Cotton has been chosen as the primary material for exploration, as the fibre is made from 95% cellulose, and is the most consumed source of cellulosic textiles.

One potential route to recycle ACCs includes regenerating the materials in cellulosic fibres, where ACCs are used as the source of cellulose within the spinning dope. A combination of both the ionic liquid EMIMAC and cosolvent DMSO have been used to first produce the ACCs in addition to the dissolution process. Thus far, single monofilaments have been wet spun from solutions of IL, DMSO and shredded ACCs, using various cellulose concentrations. Pre-consumer cotton fabric has been evidenced thus far, yet the aim is to focus on second-hand cellulosic textiles. The resulting fibres can be spun into yarns, ready to be used for both fabric and composite products, supporting a circular materials economy.

IMPACT OF YARN AND FABRIC PARAMETERS ON THE FIBRE OUTCOMES FROM MECHANICAL RECYCLING PROCESSES

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Closed loop recycling, in which textile waste is returned to production and used in applications of greater or equal value, is essential for establishing a circular economy and reducing the environmental impacts of the textile industry. Although mechanical recycling is an established closed loop solution for pre/post-consumer textile waste, the scalability and efficiency of existing methods are limited by the availability and quality of homogeneous textile feedstocks. A systematic study was conducted to investigate the impact of different yarn structures and fabric constructions on the mechanical recyclability of cotton textile waste. By understanding the impact of different structural parameters on the properties of mechanically recycled fibres, the opportunity to produce a textile feedstock that is better suited to mechanical recycling and therefore yields recycled fibres of a higher quality is presented. Furthermore, the results from this study can be used to inform more sustainable design choices, identify how different textile structures could be sorted and treated prior to mechanical recycling processes and increase the output of spinnable fibres that can **be** used in a closed loop system.

THE FINANCIAL SUSTAINABILITY OF CLOTHING MANUFACTURING THROUGH EQUITABLE ORDER DISTRIBUTION: AN EXTENDED ENTERPRISE

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One of the main causes of clothing factory closures is the precarity of operating at full and optimum capacity – when orders do not meet the minimum factory production revenue to meet the financial commitments of the organisation. Conversely, the over subscription of orders to one organisation can lead to 3rd tier outsourcing with the potential for ethical, governance and sustainability deficiencies. Extended Enterprise (EE) is a conceptual framework that suggests how firms should work synergistically. Through the framework of an Extended Enterprise, small and medium-sized enterprises (SMEs) – could receive and equitably distributed (assigned) share of orders placed by commissioning brand or retailers or 3rd parties. The modelling and simulation of processes used during decision making when distributing (allotting) apparel orders to a cluster of SME firms - in an extended enterprise network was sued to assess the suitability of an extended network of independent manufacturers been allocated orders in such a way as to give equity and match their specific factory capacity. The distribution processes proposed in this study is focused on allocating, sharing or dividing order quantities amongst the collaborating business entities in an EE framework to provide a financially sustainable business model that benefits one and all within the network. Arena software, as one of the most popular discrete-event simulation software packages was used to illustrate the distribution processes of the received order quantities, particularly when many retailers request apparel quantities from many manufacturers. Through an EE framework, firms can manufacture at sustainable optimum factory efficiencies by strengthening their supply chain partnerships acting as one large, distributed manufacturing 'virtual' factory. And sharing 'the load' in a fair and equitable way. This simulation proffers a methodology for achieving such a fair and symbiotic relationship between manufacturers and the internal customers they serve.

AN AI-APPROACH TO THE FUTURE OF CREATING FASHION

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This paper explores the potential for generative-AI to contribute to conceptualisation and visualisation of fashion design for purposes of streamlining creative processes and minimising resource-intensive garment prototyping.

The practice-based study introduces a conceptual Gen-AI prototype which exploits text-to-image synthesis and the conversion of hand-drawn sketches into photorealistic images.

Utilising latent diffusion models, with fashion-specific parameters defined by end-users, the work-in-progress prototype produces high fidelity 2D garment renderings and visualisations based on designer insights and user preferences. Designers retain control over the parameters and adjustments which enable them to rapidly explore unlimited design variations. This virtual approach could serve as an alternative to conventional design ideation methods and training-intensive 3D virtual prototyping, to speed up design iteration, reduce material waste and promote sustainable practices in the fashion industry.

Our work to date is at an early stage and shows how the prototype is 'learning and improving' its capability to interpret designs accurately. We present early qualitative findings gathered through ongoing interactions and feedback gained from prototype demonstrations with various focus groups.

We discuss limitations and focus on potential future developments which could benefit the fashion industry by creating an intuitive interface, supporting better-informed trend forecasting and realising scalability to improve industry workflows.

COLOURED SILK FIBROIN FROM WASTE SILK FOR WOOL DYEING

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Waste recycling is an important topic, closely tied to current imperatives for reducing carbon emissions and promoting sustainable development. In this work, we recycled dyed waste silk into coloured silk fibroin (CSF) as aqueous dyes. The colour retention results showed that over 90 % of the original colour in waste silk could be retained in regenerated CSF. The novel "CSF-dye" could be used for wool dyeing at low temperature (75 °C), with higher dye uptake of over 90% and better penetrability than that dyed with traditional dye, typically carried out at 95 °C. The better dye diffusion and infiltration using CSF-dye for wool dyeing can be accounted for by the amphiphilic property of silk fibroin, which acted as a surfactant to facilitate the dyeing process. The dyeing mechanism is attributed to the dissociation of negatively charged dyes from silk and re-interaction with cationic wool. In this novel approach, dyes were derived from silk waste, and no new synthetic dyes and other chemical auxiliaries were required, resulting in waste valorisation and resource consumption reduction. Importantly, this recycling method can be readily applied to discarded commercial silk fabrics. This study has the potential to valorise silk waste and contribute to fashion sustainability.

SEPARATION OF TEXTILE POLYMERS FROM BLENDS AND COMPOSITES FOR CIRCULARITY: A REVIEW

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At the end of life of textile products, polymers can be separated from discarded products and used in the same production cycle or another product cycle. Circularity in textile manufacturing has been the focus of several discussions. Literature sourced on the methods and approaches to recovery of at least one fibre type. This paper reviews the strategies for recycling, the mechanical, chemical, and enzymatic recycling methods, best practices by companies, and case studies. These include studies focussed on polymer separation from blends and composites. The degradation of polymers during the separation process may result in the loss of properties, making them unsuitable for reuse. Overcoming practical challenges in recycling that require a critical analysis of processes based on their efficiency in supporting circularity.

In order to have a cleaner environment, the textile industry will have to adopt a more rigorous and sustainable approach to circularity by improving the process of identifying and separating polymers and scaling up recycling. Polymers separated from composites and blends must be scalable, feasible, efficient, and environmentally friendly. Research on life cycle analysis LCA of textile products efforts to extend product life will pave the way for products to be designed and manufactured.

RECOVERY FF TEXTILE POLYMERS FOR UPCYCLED PRODUCTS

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At the end of life of textile products, polymers from discarded products can be recovered and used in the same production cycle or another product cycle. Circularity in textile manufacturing has been the focus of several discussions. This paper aims to identify recycling strategies, methods, and best practices by companies. The visits to the textile recycling industries to observe and understand the development of products from waste for domestic consumption and export. Literature was sourced on the methods and approaches to recovery of at least one fibre type. The degradation of polymers during the separation process from blends and composites result in the loss of properties, making them unsuitable for reuse. Products from recycled textiles must be scalable, feasible, and environmentally-friendly. Overcoming practical challenges in recycling requires a critical analysis of processes based on their efficiency in supporting circularity. In order to have a cleaner environment, the textile industry will have to adopt a more rigorous and sustainable approach to circularity by improving the process of identifying and separating polymers and scaling up recycling for global production. The efforts of the textile recycling industry have been encouraging but urgently require consolidation and scaling up for global production.

FEASIBILITY ANALYSIS OF NATURAL BIOPOLYMER-COATED ELECTROSPUN NANOFIBROUS MAT AS PROSPECTIVE WOUND DRESSING

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Human skin is subjected to injuries due to constant exposure to external factors. However, the human body's natural healing system is relatively slow. Moreover, traditional wound dressings lack advanced wound-healing functionalities, with added difficulties of frequent replacements. Combining biomaterials and nanotechnology is an exciting contemporary avenue for fabricating biomedical textiles with improved performance. This study explores the practicality of the nanostructured Sodium Alginate-Bacterial Cellulose (SA-BC) as a promising wound dressing. To this end, SA was electrospun to fabricate a nanofibrous mat, followed by cross-linking with calcium chloride and coating with BC suspension. Electrospinning parameters were optimized to 2 mL/hour flowrate, 24.92KV and -2.15KV voltage, 15cm distance and 20s coating duration to achieve a bead-free and uniformly coated nanofibrous surface, evident from rigorous image analysis. FTIR analysis revealed the retention of BC's intrinsic properties with the concurrent healing-friendly moist environment. Mechanical analysis displayed Young's modulus of the raw, cross-linked and BC-coated samples to be 5.60, 10.37, and 1.99 MPa, aligned with the stiffness outcomes. DSC study concluded, BC-coated sample exhibited melting and recrystallization temperatures well above the body's temperature and solubility analysis ensured hydrolytic stability. Overall, the results were consistently positive, indicating the product's potential for use as a dressing material.

Cu_2O/PLA Fibers with Coordination Crosslinking: Enhanced Mechanics and Antibacterial Activity

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Public textiles require materials that combine durability, biosafety, and resistance to microbial degradation. Conventional natural fibers (e.g., cotton, silk) are inherently susceptible to pathogen colonization and mechanical compromise. Here, we report a dynamic trace-coordination-bond crosslinking strategy to engineer nano-Cu2O/polylactic acid (Cu2O/PLA) fibers with exceptional antimicrobial activity, mechanical robustness, and closed-loop recyclability. Mechanistically, coordination bonds between Cu2O nanoparticles and PLA enable uniform nanofiller dispersion and strengthened interfacial interactions, yielding a tensile strength of 48.75 MPa—superior to most PLA-based composites. The synergy of nano-Cu2O's biocidal properties and PLA's acidic microenvironment achieves >99.99% antimicrobial efficacy against multidrug-resistant pathogens, surpassing commercial antimicrobial textiles. These fibers exhibit an ultralong functional shelf life (>6 months) with negligible performance decay. Critically, the reversible coordination network allows full fiber reprocessing via solvent dissolution, retaining 93% of initial strength after three recycling cycles. This work advances a scalable paradigm for next-generation public textiles, simultaneously addressing microbial resistance, mechanical failure, and environmental sustainability.

PERSPECTIVE IN TEXTILE ENERGY STORAGE INTEGRATED TEXTILE ELEMENTS: TEXTILE MATERIALS, STRUCTURE, AND MANUFACTURED METHODS

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Designing textile-based energy storage with both high electrochemical performance and available textile performance is crucial for developing smart textile. In this perspective, the concept of textile-based energy storage and the viewpoint of balancing electrochemical performance and textile performance is proposed, which is paramount to establish high-energy-power density textile-based energy storage devices; some key challenges are discussed in order to provide a framework on how textile materials and structures are employed in textile energy storage research; it further compiles and generalizes current findings in the fiber, yarn, and fabric-type components/devices area and preliminary work in the manufactured and programmed textile-based energy storage. The objective here is to establish a set of practical principles for commercial textile energy storage from textile perspective and describe in detail the scientific and technological breakthroughs that are shaping in energy storage area.

MECHANICAL RECYCLING OF TEXTILE MATERIALS AND DIFFERENT VALORISATION METHODS FOR RECYCLED FIBRES

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Millions of tonnes of textile waste are generated annually in the world. There are different possibilities to recycle textile waste, but mechanical recycling proposes a cost-effective way to valorise old textiles into secondary raw material. The main advantage of mechanical recycling is that big quantities of textiles can be recycled at once. Moreover, different fibre mixtures could be recycled with this method. On the other hand, mechanical recycling proposes several challenges. The main disadvantage of this method is that the fibre mass received after recycling contains a lot of short fibres and textile dust.

It is important to find the best possible routes for valorising each sort of mechanically recycled textile fibres. Long fibres can be used for producing yarns from which woven and knitted fabrics could be made. Shorter fibres can be used inside of nonwovens and composite materials. Textile dust can be used as a filler in different types of materials. Current study aims to give an overview of mechanical recycling methods of different textile materials, with an emphasis on different novel and sustainable valorisation methods for mechanically recycled fibres.

ROBOTICS AND REVOLUTION: TRANSFORMING NICHE TEXTILE MANUFACTURING FROM STREETWEAR TO SCHOOL UNIFORM

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The UK textile manufacturing sector faces persistent challenges, particularly in small-batch production, where high labour costs, limited automation, and slow digital adoption hinder efficiency and competitiveness. This paper examines case studies from the North of England, spanning streetwear, cycling apparel, school uniforms, handmade leather goods, and industrial textiles, to highlight barriers and opportunities for modernising production.

First, we explore the role of digitisation in small-scale manufacturing, assessing the impact of digital work instructions, stock monitoring, and order management on productivity. Next, we address the difficulties of automating textile handling and sewing operations, comparing current small-batch practices with more advanced approaches available in mass manufacture. Finally, we discuss how long-established efficiency methodologies, such as lean manufacturing, remain underutilised in small-scale textile production. While full automation may be impractical in many areas, cultural shifts towards process improvement can drive significant gains without heavy investment.

By analysing real-world examples, this paper presents a roadmap for small to medium scale textile manufacturers to enhance sustainability and competitiveness through strategic digital adoption, targeted automation and robotics, and process optimisation. These lessons offer valuable insights for industry stakeholders, policymakers, and researchers seeking practical pathways to a resilient and future-proof the smaller niche textile industries.

FUNCTIONAL MODIFICATION OF POLYESTER FIBERS BASED ON ESTERASE-CATALYZED TRANSESTERIFICATION REACTION

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Polyethylene terephthalate (PET) fibers were enzymatic modified with polyethylene glycol (PEG400 / PEG200). Lipase from Aspergillus oryzae (LA) and Candida Antarctica (CALB), cutinase from Humicola insolens (CUT) were used as catalysts respectively. Terephthalic acid bis(2-hydroxyethyl) ester was selected as the model substrate of PET. The wetting behavior of modified PET fibers was characterized by water contact angle, water adsorption dynamics and moisture regain. The initial water contact angle of CALB-catalyzed modification of PET fabric decreased from 138.25° to 44.7°, with a decrease of 67.8%. The water absorption dynamics result indicated that the equilibrium water absorption amount of modified PET fabric was about 10 times higher than that of untreated sample. And the moisture regain was higher than 1.2% after enzymatic modification. SEM presented the granular and sheet coatings on the surface of modified PET fabric. The chemically linkage of PEG400 / PEG 200 onto PET fibers was confirmed by ATR-FTIR spectra. The modification had no significant effects on the thermal property of PET fabrics according to TG and DSC. And the mechanical properties of modified PET fabric were slightly improved. Therefore, the esterase-catalyzed transesterification between PET and polyethylene glycol would be a potential novel modification approach to add-value PET fiber textiles.

MODULAR FASHION – A PATHWAY TOWARD CIRCULARITY

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With the fashion industry moving toward a circular economy, modular design is indicated as a potential circular approach. Modular fashion introduces a new system where garments are made up of individual and interchangeable clothing parts (e.g., sleeves, collars and main body), and assembled through non-sewing methods (e.g., zip and snap-on buttons). Due to this easily detachable and reassembled structure, modular garments demonstrate sustainable potential by providing greater customisation and facilitating easier repair, updating and upcycling in the manner of individual garment parts.

Current research on modular fashion has focused on its potential to prolong garment lifetime and reduce overall consumption during the user phase. Yet, its role in the post-consumer stream has not been discussed in great detail. This paper aims to bring modular fashion into the discussion of advancing circularity through the lens of simplifying garment recycling and contributing to a circular fashion economy. Through a critical literature review and analysis, three key benefits are identified: (1) reducing resource consumption, (2) improving resource efficiency, and (3) unlocking economic opportunity as a new business model. However, challenges still exist, including uncertain consumer acceptance and the lack of established rules for modular fashion.

TACKING CRITICAL CHALLENGES IN SUSTAINABLE TEXTILE: A REVIEW ON CHEMICAL RECYCLING OF BLEND TEXTILE WASTE

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The growing global population and increasing consumer demand for fashion have increased the driven fibre production, with projections reaching 149 million tons by 2030 if business continues as usual. The rise of fast fashion exacerbates textile waste, with over 50% of garments discarded under a year, contributing to an estimated 92 million tons of waste annually. However, fibre-to-fibre recycling rate remains below 1%, with most materials being downcycled into lower-value applications. A major barrier to achieve closed-loop recycling is the lack of efficient separation technology that separates different types of fibres from blends, which dominate the market. The development of sustainable recycling technologies capable of processing complex blended textiles will expand the range of recyclable textile waste, thereby reducing the amount of waste that would otherwise go to landfill of incineration. This would enhance the circularity of textiles in the economy. This paper explores the mechanism and advanced developments in textile recycling, their technical feasibility, advantages and limitations are also analysed. Finally, recommendations are proposed to align future technological innovations with sustainability principles to ensure a comprehensive green transformation of the textile industry.

HIGHLY SENSITIVE BIOMASS-BASED COLORIMETRIC SENSING FIBERS FOR WEARABLE TOXIC AMMONIA MONITORING

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Colorimetric sensors are widely utilized in gas monitoring due to their ability to provide rapid and straightforward detection via visible chromatic transitions. Nonetheless, achieving high sensitivity in these sensors remains a significant challenge. In this study, we developed a highly sensitive biomass-based colorimetric sensing fiber by using sodium alginate (SA) as the substrate materials, incorporating anthocyanins as the biochromic dye, and hyaluronic acid (HA) as an effective moisture adsorbent. Remarkably, the inclusion of HA significantly enhanced the sensitivity of the colorimetric fibers, reducing the detection limits from 20 ppm to approximately 10 ppm, surpassing the sensitivity thresholds of most biochromic dye-based colorimetric sensors. The fibers also demonstrated excellent degradability, attributed to dynamic non-covalent interactions during the fiber formation process, which was achieved by the SA-Ca2+ polymeric network. Furthermore, the fibers exhibited outstanding selectivity and reusability. This work advances a straightforward, scalable fabrication strategy for eco-conscious wearable technology, combining real-time visual monitoring with recyclability for environmental and healthcare applications.

LIQUID PHOTONIC CRYSTALS FOR THE HIGH-EFFICIENT STRUCTURAL COLORATION OF TEXTILES

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Textile coloration is traditionally achieved by means of using chemical colorants such as dyes and pigments. In contrast, photonic crystals rely on their periodic microstructures to confine and control the propagation of electromagnetic waves in specific wavelength ranges to produce structural colors, and then realize the brilliant structural coloration of textiles. Using monodisperse nanospheres as the building blocks to construct PCs by colloidal self-assembly is an effective approach for the eco-friendly coloration of textiles. However, the self-assembly process of colloidal nanospheres is usually complicated and time-consuming, making it difficult to realize large-scale assembly. In this presentation, we demonstrate pre-crystallized liquid colloidal crystals of polystyrene beads pre-formed spontaneously over a critical volume fraction or below a limit ionic strength. Additionally, innovative assembly techniques have allowed us to create structural color coatings and pigments with well-ordered PC structures. The resulting structural colors can be finely controlled and tuned across the entire visible light spectrum by varying the size of the nanospheres. By designing photonic crystal structures with dynamic response capabilities, we can develop smart color-responsive textiles that respond to environmental stimuli. This environmentally friendly fabrication process effectively addresses the challenges of producing structural color textile materials for practical applications in coloration technology, optical anti-counterfeiting, and radiation cooling, among others.

MODELLING THE ELASTIC MODULUS OF BASALT FIBERS: BRIDGING PRODUCTION AND MICROSTRUCTURE WITH MACHINE LEARNING

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Continuous basalt fiber (CBF), recognized as an eco-friendly material for the 21st century, exhibits high mechanical performance including elastic modulus. The elastic modulus is influenced by two primary factors: chemical compositions and production parameters. While existing studies predominantly focus on chemical composition, discrepancies in production conditions and testing standards make it difficult to compare the results. To resolve this gap, a methodical analysis of production parameters—notably cooling process—is essential, as it critically regulates dimensional stability and microstructural transformations during fiber solidification. However, experimental measurement of temperature in thin, moving fibers remains challenging. This study proposes a novel theoretical framework integrating machine learning to predict viscosity and elastic modulus, thereby simulating the CBF drawing process. By extending the current 1D and 2D melt-spinning models for basalt and glass fibers, we establish a quantitative relationship between the drawing process and elastic modulus, bridging external process conditions with internal microstructural characteristics. Given the industry's reliance on stable mineral sources and controllable production parameters, this work provides actionable insights for optimizing fiber manufacturing processes and enhancing the mechanical performance of CBF.

ADJUSTABLE TEXTILE RECYCLING MACHINE: IMPACT OF MACHINE SETTINGS ON FIBRE QUALITY

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The rapid growth of the textile industry has led to significant environmental challenges, particularly due to textile waste. Mechanical textile recycling, which converts textile waste into recovered fibres, is a promising solution. However, the quality of recovered fibres is often compromised due to fibre shortening during the process. The settings of a recycling machine, which directly control the shredding of textile waste into fibres, are likely to have a significant impact on fibre quality. This study addresses this critical factor by designing a laboratory-scale textile recycling machine with adjustable settings, including the speed of the opening roller, the speed of the feeding system, and the distance between the feeding system and the opening roller. The machine integrates a precision-controlled feeding system and a shredding unit with a customized opening roller, enabling controlled experimentation to investigate the impact of machine settings on fibre quality. The findings aim to provide valuable insights for optimising mechanical recycling processes, advancing more efficient and sustainable textile recycling technologies.

3D Body Scanning: Better User Experience in the Digital-Virtual World and Solution to Anthropometry and Fashion Industry

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The data produced by 3D body scanners is in the form of a 3D point cloud, which can then be imported into virtually any software application. Compared to manual measures, 3D body scanning is faster, more accurate, more suitable, and delivers more thorough information about the human body. This opens more data for academics to use in evaluating body measurements with forms. Measurements of both height and circumference are critical for the garment. One of the three body scanners that can collect measurements from a scan is Size Stream Studio v 5.2.9. Conventional garments measurements of both circumference and height i.e., vertical distance pre-programmed into the scanning software for the following areas: ankle, calf, knee, mid-thigh, thigh, crotch, hip, seat, abdomen, stomach, and waist based on their definitions. It is also capable of doing measurements of the ground-to-point distance, Measure line, curve, and multiple-point distances. measure cross-sectional shape at a body point in a slice form from leg or horizontal to the floor, volume between any two shapes, cross-sectional slice between any needed points. For a good garment fit, it is necessary to have both the measurements and the change or variation between them, since the increase or decrease between these points is not linear. The author analysed default measurements: calf, knee, mid-thigh, crotch, hip, seat, and waist, captured according to the software definitions, constructed some fixed measurements between these default measurements and analysed the circumference measurements continuously with a height increase of one centimetre in the software to analyse the body measurement in detail. It allows the variation to be captured accurately and the developed garments ensuring fit to be achieved at every point on the body. Pattern makers can utilize the digital version of the measurement to create garments that are truly tailored to everyone especially required in the current fashion industry to improve the user experience and requirement from the garments. The authors analysed the data from 278 male scans using this software to find the correlation between different discussed measurements. The findings of the study reveal that there is a correlation between the measurement location i.e., length and height measurements, as well as between the circumference and weight measurements. Combining height and circumference measurements is the best way to create a sizing system. Sizing systems can benefit from this research in two ways: first, by minimizing the number of control measurements, which helps keep sizing systems manageable; and second, by identifying strongly correlated measurements that could be utilized for system development. Beyond the uses, this research has medical potential in the form of personalised compression garments created through scanning individuals, and it has potential in the realm of athletic compression garments, where each athlete may benefit from the benefits of precisely tailored compression.