



52nd IFKT International Conference

International Federation of Knitting Technologists (IFKT)
&
University of Zagreb Faculty of Textile Technology

BOOK OF ABSTRACTS

of the

52nd IFKT International Conference

Zagreb, Croatia, October 2026

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- Marcus O. Weber (Germany).

Editors' Word

It is our great pleasure to present the Book of Abstracts of the 52nd IFKT International Conference, held in Zagreb, Croatia from 30th September 2026 till 2nd October 2026. The conference has been organized by the Croatian Section of the International Federation of Knitting Technologists (IFKT) and the University of Zagreb Faculty of Textile Technology, with the support of the Croatian Association of Textile Engineers (HIST) and Technical Museum Nikola Tesla (TMNT).

This conference represents a particularly significant milestone for the IFKT community, as it coincides with the 70th anniversary of the International Federation of Knitting Technologists. This remarkable anniversary provides an opportunity not only to celebrate seven decades of professional cooperation, scientific exchange, and technological advancement, but also to look toward the future of knitting and textile technologies.

The 52nd IFKT International Conference brings together researchers, academics, professionals, and representatives of industry from different countries and areas of expertise. Their participation reflects the continuing importance of international cooperation in addressing the scientific, technological, environmental, and societal challenges facing the textile and knitting sectors, as well as discussing and establishing new opportunities for collaboration.

This Book of Abstracts contains 32 scientific and professional contributions presented at the conference, organized into five thematic chapters. Together, they reflect the remarkable diversity of contemporary knitting technology. They demonstrate how traditional textile knowledge is increasingly interconnected with digitalization, smart and advanced technologies, functional and innovative knitted structures, comfort, sustainability and circularity, and design and education in knitting technology. This expanding role in advanced textile applications illustrates the broad potential of knitted textiles in responding to current and future needs.

We would like to express our sincere gratitude to all authors and contributors for sharing their research, expertise, and ideas. We are equally grateful to the reviewers, members of the scientific and organizing committees, and all colleagues whose dedication and efforts contributed to the preparation of this conference and the present publication.

We believe that the 52nd IFKT International Conference will be not only a celebration of IFKT's 70-year history, but also a platform for shaping its future. May the discussions initiated in Zagreb inspire new research, strengthen international partnerships, encourage innovation, and contribute to the continued development of knitting and textile technology.

We are especially pleased to welcome the IFKT community back to Zagreb after 24 years and wish you a stimulating, productive, and inspiring conference.

The Editors



Prof. Vesna Marija Potočić Matković, PhD



Prof. Anita Tarbuk, PhD



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INFLUENCE OF FINISHING PROCESSES ON THE TENSILE PROPERTIES OF KNITTED FABRICS

Željka PAVLOVIĆ; Zlatko VRLJIČAK & Vesna Marija POTOČIĆ MATKOVIĆ

Abstract: *The aim of this study was to investigate the influence of finishing processes on the tensile properties of different knitted fabrics. Various double jersey and interlock knitted fabrics produced from cotton, viscose, modal, micromodal, tencel and polyester yarns were analysed in raw and finished states. Tensile properties were determined in wale and course directions using a Statimat M dynamometer. Breaking elongation and breaking force were analysed. The results showed that the finishing process significantly affected the tensile behaviour of knitted fabrics. In the wale direction, most samples exhibited increased breaking elongation and reduced breaking force after finishing. In the course direction, the changes were less pronounced, while certain polyester and interlock samples showed improved mechanical stability after finishing. Statistical analysis confirmed significant differences in tensile properties in the wale direction after finishing ($p < 0.05$), whereas no statistically significant differences were observed in the course direction. The obtained results indicate that fibre composition and knitted fabric structure significantly influence the mechanical behaviour of knitted fabrics during finishing processes.*

Keywords: *Knitted Fabrics, Finishing Processes, Tensile Properties, Double Jersey, Interlock*

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THE EFFECT OF ENZYMATIC PRETREATMENT ON THE COMFORT OF WHITE COTTON KNITWEAR

Stefana BEGOVIĆ; Anita TARBUK & Lea BOTTERI

Abstract: *This study investigates the impact of enzymatic pretreatment on the comfort properties of white cotton knitted fabric. Greige cotton French terry knitted fabric was desized with α -amylase to remove residual knitting oils, waxes, and sizing agents (by breaking down starches) before scouring. Cotton scouring was performed with a pectinase complex, and the results were compared to alkali scouring with Na_2CO_3 . Percarbonate bleaching of the fabrics was performed to achieve fully absorbent fabric ready for dyeing. Since French terry knitted fabric has a smooth, flat surface on the front and moisture-absorbing rows of loops on the back, the comfort-related properties were evaluated using the Fabric Touch Tester (FTT) and Moisture Management Tester (MMT). The results showed that the combination of enzyme scouring and percarbonate bleaching can achieve fabric performance comparable to conventional alkaline scouring after bleaching, while offering advantages in softness, fabric handle, and sustainability. Therefore, it represents a viable, environmentally friendly alternative to conventional alkaline scouring for the pretreatment of cotton French terry knitted fabrics used for loungewear, sweatpants, and hoodies.*

Keywords: *cotton French terry knitted fabric, amylase, pectinase, percarbonate bleach, MMT, FTT*

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THE INFLUENCE OF STANDARD AND INNOVATIVE WASHING PROCESS ON PROPERTIES OF KNITTED FABRIC

Kristina ŠIMIĆ & Tanja PUŠIĆ

Abstract: *Knitted fabric wash durability is essential for sustainability and waste reduction within a circular economy. The evaluation of knitted fabrics from polyester and its blend with cotton was carried out after multiple washing cycles using the standard and innovative process. Changes were monitored after five and ten washing cycles with standard detergent at 60 °C for 30 minutes. The innovative washing process was performed according to a modified rinsing protocol by cooling in four stages, gradually reducing the temperature from 60 to 30 °C. Unlike standard washing process, where knitted fabric is rinsed four times with cold tap water. Research was conducted to compare the influence of different washing processes on the properties of knitted fabric through the appearance, the tensile strength, pilling propensity and the loss of mass after washing. Optimizing the washing process by controlling the rinsing protocol had influence on the properties of knitted fabric of different composition. Knitted fabric from polyester and knitted fabric from polyester and cotton showed variation in properties due to composition and washing conditions. The obtained results offer a good platform for optimization and better understanding the proper way to wash knitted fabric to preserve its better appearance and durability for longer period of time.*

Keywords: *standard washing process; innovative washing process; knitted fabric; polyester; PES/cotton.*

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INFLUENCE OF YARN SPINNING TECHNOLOGY ON THE COMFORT-RELATED PROPERTIES OF TENCEL KNITTED FABRICS

Dragana KOPITAR & Paula ŠTAMPALIJA

Abstract: *The research investigates the influence of yarn spinning technology (ring, rotor, and air-jet spun yarns) on the structural and comfort-related properties of double jersey knitted fabrics produced from Tencel fibres. Research aimed to determine how yarn structure affects fabric geometry and comfort-related properties, including mass per unit area, thickness, density, porosity, air permeability, pore diameter, thermal resistance (R_{ct}), and water vapour resistance (R_{et}). Ring-, rotor-, and air-jet-spun yarns with a nominal fineness of 20 tex were used to produce knitted fabrics under controlled, identical knitting conditions. The results showed that yarn type significantly influences fabric structure and functional performance. Ring-spun yarn fabrics exhibited the most compact structure, characterised by the highest mass per unit area, greater fabric density, lower porosity, and smaller pore diameter. Consequently, they showed the lowest air permeability and the highest thermal resistance (R_{ct}). In contrast, knitted fabrics produced by rotor-spun yarn have the most open structures, with the highest porosity, highest air permeability, and lowest thermal resistance. The fabrics produced by air-jet-spun yarns generally showed intermediate behaviour. Statistical analysis confirmed significant differences among yarn types for most structural and comfort-related parameters, except for water vapour resistance (R_{et}), which was not significantly affected by yarn type. A strong inverse relationship was observed between air permeability and thermal resistance, highlighting the role of fabric porosity and entrapped air in thermal insulation. Overall, the findings confirm that spinning technology is a key determinant of knitted fabric structure and comfort performance. By modifying yarn structure, it is possible to tailor fabric porosity and air transport properties, enabling targeted design of comfortable knitted textiles for apparel applications.*

Keywords: *Tencel fibre, ring-, rotor-, air-jet-spun yarns, double jersey knitted fabrics, porosity, air permeability, and water vapour resistance.*

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COMPARATIVE STUDY OF STRUCTURAL AND COMFORT PROPERTIES OF KNITTED FABRICS MADE FROM WOOL AND SUPERWASH WOOL

Ivana SALOPEK ČUBRIĆ; Goran ČUBRIĆ; Matejka BIZJAK;
Klara KOSTAJNŠEK & Živa ZUPIN

Abstract: *The growing demand for sustainable, high-performance materials in sportswear has renewed interest in wool, owing to its excellent thermo-physiological comfort, moisture management, and renewable origin. However, untreated wool is susceptible to felting and shrinkage during laundering, which can be reduced by superwash treatment. This study examines the influence of superwash treatment on selected comfort, transport, and surface properties of wool knitted fabrics intended for sportswear. Eight knitted fabric samples, produced from 100% wool and 100% superwash wool in four different knitted structures, were analysed. Fabric thickness, air permeability, water vapour permeability, drying time, and surface roughness were evaluated. The results showed that superwash treatment had no significant effect on fabric thickness or air permeability. In contrast, superwash wool fabrics exhibited considerably higher water vapour permeability and shorter drying times than untreated wool fabrics. The treatment also reduced the surface roughness of the fabrics, resulting in a smoother and more uniform surface morphology. These findings demonstrate that superwash wool offers improved moisture management and maintenance properties while preserving the comfort characteristics required for sportswear.*

Keywords: *wool; superwash; knitted structures; comfort properties*

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INFLUENCE OF FIBER COMPOSITION AND KNIT STRUCTURE ON THE MECHANICAL AND FUNCTIONAL PROPERTIES OF COTTON-BASED KNITTED FABRICS ENHANCED WITH PBT MULTIFILAMENTS

Alenka ŠALEJ LAH; Sabina GABROVŠEK; Maša HAM;
Milenko ČUBRILLOVIĆ & Živa ZUPIN

Abstract: *The increasing demand for comfortable, durable, and functionally enhanced textiles has led to greater use of fibre blends in knitted fabrics. Incorporating elastic or semi-elastic synthetic fibres into natural fibre systems has become an effective approach to improving the dimensional stability, elasticity, and recovery behaviour of knits. Among these fibres, polybutylene terephthalate (PBT) is of particular interest due to its inherent elasticity, resilience, and good recovery after deformation, even without additional elastomeric components such as elastane. This study analyses the influence of raw material composition and knit structure on the mechanical and functional properties of knitted fabrics. Cotton fabrics were compared with fabrics containing polybutylene terephthalate (PBT) multifilament yarns, produced in three weft-knitted structures: single jersey, double jersey, and single jersey mock rib 1×1. Dimensional changes after steaming, structural parameters; air permeability, tensile properties, elastic recovery, and thermal conductivity were evaluated in the experimental part. The incorporation of PBT multifilaments increased fabric shrinkage after steaming, resulting in denser and thicker structures. Fabrics containing PBT exhibited improved mechanical resistance, higher elastic recovery, and lower permanent deformation compared with pure cotton fabrics. However, increased compactness reduced air permeability and slightly increased thermal conductivity. Knit structure significantly affected fabric performance, with double jersey showing the highest mechanical resistance, single jersey the greatest air permeability, and single jersey mock rib the highest structural stability. The results demonstrate that the combination of appropriate knit structures and PBT multifilament yarns can effectively enhance the functional and elastic properties of knitted fabrics, making them suitable for sports, functional and medical textile applications.*

Keywords: *mechanical properties, functional properties, knit structures, PBT, cotton*

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CYCLIC TENSILE BEHAVIOUR OF ELASTIC KNITTED FABRICS FOR SWIMWEAR

Tea JOVANOVIĆ; Željko PENAVAL & Ana SKENDER

Abstract: *The paper presents the structures of elastic warp-knitted fabrics used in the manufacture of swimsuits, swim briefs, women's underwear, with particular emphasis on garments for plus-size wearers, as well as sportswear for people of all ages and both sexes. Three samples of warp-knitted fabrics produced in the charmeuse stitch using polyester (PES) and elastane yarns were analysed. The elastane content of the samples was 22%, 23% and 25%, respectively. The fabric samples were stretched to break in both the course and wale directions, and three characteristic points were identified on the force-elongation curves to define the maximum elongation levels for cyclic loading. Following cyclic testing, permanent deformation was observed in all samples at every elongation level. The hysteresis index and the work represented by the area under each cyclic loading and recovery curve can be used to evaluate the performance and suitability of these knitted fabrics for demanding applications, particularly in garments intended for professional athletes.*

Keywords: *warp-knitted fabric, knitted fabric structure, swimsuits, stretching to break, cyclic stretching.*

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II. KNITTING TECHNOLOGY, CHARACTERISATION, MODELLING AND DIGITALISATION

INFAKEWE – RESEARCH INTO COMPONENT OPTIMISATION FOR HIGH-SPEED YARN GUIDING ELEMENTS FOR PROCESSING HIGHLY ABRASIVE YARNS AT HIGH SPEEDS BASED ON CERAMIC MATERIALS AND HIGH-FREQUENCY VIBRATIONS

Thomas MUTSCHLER & Marc KÜPERKOCH

Abstract: *The current state of the art for yarn feeders in circular and flat knitting machines is investigated, evaluated, mathematically modelled and presented in a simulation. Preliminary tests with existing yarn deflection systems will be analysed as analysis of the current state of the art. The resulting model forms the basis for the simulation of the yarn path of a circular and a flat knitting machine. The increase in yarn tensile force due to yarn friction on fixed machine components is modelled as a function of the parameters relevant to knitting production as follows: Yarn surface and structure; Deflection angle; Yarn friction coefficient; Yarn speed; Influence of high-frequency vibrations.*

Based on the simulation results innovative, passive, ceramic components are developed and the positioning in the yarn path is identified. The test series on the machine using the newly developed components are evaluated in order to optimise the simulation. The development of passive sintered ceramic components with active reduction of yarn friction using high-frequency vibrations and the simulation of the yarn feeding process are the development focuses followed with the development of a knitting machine based on these findings. The development of sintered IR-lucent, non-magnetic and electrically insulating ceramic components with adapted topography for use in knitting machines represents technological challenge and the planned project will develop: Passive ceramic deflectors with optimised surface texture and component geometry; Friction reduction using high-frequency vibrations at the deflection points (avoidance of stick-slip effects and variation thread speed); Detection of yarn breaks or irregularities directly in the yarn path (translucent ceramic).

The ZIM project “InFaKeWe” (KK5163014PK4) is funded by AIF within the framework of the Central Innovation Program for SMEs by the Federal Ministry for Economic Affairs and Energy, based on a resolution by the German Bundestag.

Keywords: *Knitting, knitting process, yarn tension, friction coefficient, friction reduction*

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A NOVEL LOW-CONTACT THICKNESS MEASUREMENT METHOD FOR 3D SPACER FABRICS

Arzu MARMARALI; İrem ÇAKIR; Cansel DEMİR & Betül PALA

Abstract: *Three-dimensional spacer fabrics are widely used in technical applications due to their unique structural and functional properties, such as high compressibility, lightweight structure, and enhanced thermal and mechanical performance. However, accurate thickness measurement of these materials remains a significant challenge, as conventional contact-based methods can cause structural deformation depending on the applied pressure. In this study, a novel low-contact optical-based thickness measurement system was developed for three-dimensional textile structures. The system consists of a microscope camera, colored reference plates, and an image processing algorithm that calculates the distance between fabric surfaces with minimal mechanical interaction. A total of 10 warp-knitted spacer fabric samples were tested, and the obtained thickness values were compared with measurements from a digital thickness gauge and a digital caliper. The results demonstrated that the proposed method provides reliable and consistent measurements while significantly reducing compression-induced errors compared to conventional techniques. Due to its ultra-low measurement pressure (0.037 kPa), the system enables more accurate characterization of highly compressible textile structures. The developed method offers a practical, cost-effective, and user-friendly alternative for thickness measurement, with strong potential for both academic research and industrial quality control applications.*

Keywords: *spacer fabrics; thickness measurement; optical measurement; image processing; low-contact method*

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II. KNITTING TECHNOLOGY, CHARACTERISATION, MODELLING AND DIGITALISATION

FRACTAL CHARACTERISTICS OF KNITTED FABRICS

Tomasz BLACHOWICZ & Andrea EHRMANN

Abstract: *Microscopic images are often used to investigate the structure of textile fabrics. While such micrographs usually allow for determining the woven or knitted structure, respectively, or the cover factor, other parameters that are visible for the human observer are often hard to describe quantitatively and thus reproducibly. One of the techniques that can be applied in quantitative image evaluation is the random-walk approach that results in calculation of the Hurst exponent, a measure of the complexity of a black-and-white image. Besides, more fractal characteristics of an image can be calculated, such as capacitive fractal dimension, correlation fractal dimension, succolarity, lacunarity or topothesy along with surface fractal dimension. This paper gives an overview of the possibilities of a newly developed simulations, enabling the evaluation of micrographs of knitted fabrics. For this, two microscopic images of single jersey fabrics, knitted from viscose and polyacrylonitrile yarns, respectively, are compared regarding their fractal characteristics. The results indicate how these fractal characteristics can be understood in terms of knitted fabric structures.*

Keywords: *fractals; fractal dimension; topothesy; lacunarity; succolarity*

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INFLUENCE OF KNITTED STRUCTURE ON THE SURFACE WAVINESS EVALUATED BY OPTICAL PROFILING

Ana KALAZIĆ; Gabriela VANJA & Snježana BRNADA

Abstract: Surface topography is an important factor influencing the tactile properties and comfort of knitted fabrics. In plated knitted structures, the arrangement of plating yarns may affect the geometry of loops and consequently the surface characteristics of the fabric. The aim of this study was to investigate the influence of different plating arrangements and plating yarns on the surface waviness of 1×1 rib knitted fabrics using optical surface analysis. Five 1×1 rib knitted fabric samples made from the same viscose ground yarn were analysed. The samples differed in plating yarn type and plating arrangement. Surface images were acquired using a Dino-Lite digital microscope and analysed in MountainsLab software. A Gaussian filter with a cut-off wavelength of 0.8 mm was applied to separate the long-wavelength waviness component from short-wavelength profile irregularities. The waviness parameters Wq (root mean square deviation) and Wsk (skewness) were determined in both vertical and horizontal measurement directions. The results revealed a pronounced anisotropy of the knitted structures, with significant differences between the two measurement directions. The highest waviness amplitudes were observed for the sample plated in every second course, indicating that alternating plated and non-plated courses promote the development of a more pronounced surface relief. Samples containing elastane exhibited lower waviness values, suggesting a stabilising effect of the elastane component on the knitted structure. The waviness profiles also showed a characteristic asymmetrical shape related to loop geometry. The study demonstrates that optical waviness analysis can provide valuable information about the structural characteristics and surface topography of plated knitted fabrics.

Keywords: Plated knitted fabrics; Surface waviness; Optical profilometry; 1×1 rib structure

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II. KNITTING TECHNOLOGY, CHARACTERISATION, MODELLING AND DIGITALISATION

PREDICTION OF MECHANICAL PROPERTIES OF WEFT KNITTED FABRICS USING ARTIFICIAL NEURAL NETWORKS

Sajeevika LIYANAGE; Marcus O. WEBER

Abstract: *Mathematical models have long been used to predict mechanical properties in knitted fabrics. Since the 80ies, multilayer artificial neural networks (ANN) are available in different data processing software tools. The usability and availability have significantly improved with the development of computer capacities.*

The use of a statistical design of experiments is very useful for good results in the field of examination. Nevertheless, it is not essential for the evaluation of different data sets with ANN. Furthermore, it is possible to evaluate even data sets with missing data or non-numerical data. These investigations concentrate on a simple knitting design of experiments with structures full needle rib, full cardigan, half cardigan 2x1 rib and 3x2 rib in different stitch cam settings. Mechanical data such as stitch density and bursting strength deliver with help of MATLAB® and weak AI in regression application.

Keywords: knitting, cardigan, needle cut structure, artificial neural network, predictive analysis

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II. KNITTING TECHNOLOGY, CHARACTERISATION, MODELLING AND DIGITALISATION

3D YARN LEVEL MODELLING OF CIRCULAR WEFT KNITTED PRODUCTS

Anselm NAAKE; Yordan KYOSEV

Abstract: *Circular weft knitting is applied both in the area of fine products like t-shirts, or materials for home textiles, as in area of compression products and sport socks. The engineering development of such products required knowledge about the mechanical behaviour of the fabrics, which is highly dependent on the pattern and the knitting parameters. In the literature are available many geometrical and few mechanical models of knitted unit cells, but only few works succeed to extend the 3d models at the product level.*

This work presents latest developments of the authors for 3D simulation and visualisation of circular weft knitted structures both at the level of unit cell, as on a complete product size. Problems regarding the computational speed for the different size of the structures and difference of the accuracies at different approaches (linear interpolation between points or fitting of the curves with high order polynomials) are discussed.

Keywords: *circular weft knitting, 3D modelling, yarn level, textile products*

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II. KNITTING TECHNOLOGY, CHARACTERISATION, MODELLING AND DIGITALISATION

KNITTING FAILURE DETECTION USING NEURAL NETWORKS

Lennart HELLWEG; Lisa-Marie BRODKA; Natalie RADAU; Alen TABAKOVIC;
Thorsten BACHE & Mathias BEER

Abstract: *Quality control is a fundamental requirement in modern textile manufacturing. In the production of flat knitted fabrics, defects such as run stitches, dropped stitches, and entangled threads arise during the knitting process and must be reliably identified before products reach the customer. Traditional manual inspection is time-consuming, subject to human error, and insufficient for high-throughput production environments. This paper presents an AI-based approach to automatic defect detection in flat knitted fabrics using convolutional neural networks, specifically the YOLO (You Only Look Once) object detection architecture. After a general review of machine learning methods applicable to textile quality inspection, the work introduces a practical implementation developed in collaboration with Bache GmbH, a specialist manufacturer in seamless and flat knitting technologies. A dedicated image dataset was assembled comprising four defect categories, no defect, run stitch (German: 'Laufmasche'), stitch not cast off (German: 'Masche nicht abgeschlagen'), and entangled thread (German: 'Faden verhakt'), with approximately 100 annotated images per class, captured under standardized acquisition conditions using a high-resolution smartphone camera mounted on a fixed tripod. A YOLO-based model was trained on this dataset, and the results are discussed in terms of mean average precision (mAP50) and class-wise detection performance. The findings demonstrate that a structured dataset with clearly defined defect classes enables effective model training even at a relatively modest dataset scale, providing a solid foundation for subsequent integration into an inline production inspection workflow.*

Keywords: *flat knitting; defect detection; neural networks; YOLO; quality control; image recognition*

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EFFECT OF MISS-KNIT PATTERN ON PROPERTIES OF NOVEL ELASTIC MATERIALS FOR REHABILITATION PRODUCTS

Liudmyla MELNYK; Irena LENFELDOVÁ & Olena KYZYMCHUK

Abstract: *Stretchability, elasticity, and dimensional stability are the major properties of textile materials used for rehabilitation products. These properties are achieved through the use of elastomers, both in their pure form and as the core of a core-spun yarn. The most commonly used methods of introducing elastomer into the knitted structure are the following. In warp knitting, it is longitudinal threads fixed between loops' underlap and overlap in each wale, (bandages and elastic bands). In weft knitting, it is the bent-weft thread fixed by tucks according to a certain repeat (compression stockings). Both of these most commonly used methods provide fabric stretchability in one direction (along the elastomer); however, when the fabric is cut, there is a high probability of the elastomer "running"— and, consequently, a loss of functional properties. The novel elastic material was developed in this work using a miss-knit for elastomer in weft knitting and samples were produced on a 12-gauge SRY 123LP flat-bed knitting machine with a triple KNITRAN system from Shima Seiki. To investigate the effect of the miss-knit pattern on fabric properties, one or two elastomeric yarns used to form loops on one or both needle beds, on needles positioned either directly opposite one another or with an offset. Investigation of the stretch properties and thermo-physical characteristics of knitted fabrics was performed according to standard methods. The study results demonstrate that the developed fabrics are not inferior to existing counterparts in terms of extensibility and elasticity. Thus, the proposed method for incorporating elastomers represents a promising approach to the production of rehabilitation products, particularly given flat-knitting machines' capabilities for fully fashioned and seamless knitting.*

Keywords: *elastic weft knit, miss knit, elastomer content, loop size, stitch density.*

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PREVENTIVE AND COMPRESSION THERAPY HOSIERY

Miloš LOZO & Zlatko VRLJIČAK

Abstract: *The article summarizes several national norms that describe hosiery compression on the human leg. A device with wooden leg models used to measure hosiery compression on a rigid surface is presented. The importance of hosiery compression on the human leg is described. According to the German norm, hosiery compression on the leg up to 18 mmHg (24 hPa) is not harmful to human health and can therefore be used at one's own choice. Compression on the leg above 18 mmHg (above 24 hPa) presses the leg tissue significantly. Such hosiery is to be prescribed by a doctor and used under their oversight. Doctors recommend compression hosiery to help treat venous insufficiency and similar diseases.*

Keywords: *preventive compression hosiery, compressive medical therapy hosiery*

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A STUDY ON BOA-LIKE POLAR FLEECE FABRIC USING LONG-PILE TERRY STRUCTURE

Jonglyel LEE; HyunJae KIM & Young Gu HWANG

Abstract: Worldwide, polar fleece products have been widely favored by consumers due to their unique appearance, soft texture, and excellent thermal insulation. Conventional polar fleece fabrics are mainly manufactured based on Boa structures, as their long pile length is suitable for creating a voluminous, wool-like, and fluffy surface. However, Boa fabrics are relatively expensive to produce, and therefore, the development of alternative fabrics using more cost-effective structures is required to popularize polar fleece materials and improve price competitiveness. In this study, a Boa-like Terry fabric was developed using a Terry structure in order to achieve an appearance and texture similar to those of conventional Boa fabrics. General Terry fabrics have shorter pile lengths than Boa fabrics, which limits their ability to express a rich pile surface and wool-like bulkiness. Therefore, long-pile Terry fabrics were produced by modifying the sinker and adjusting knitting conditions to increase the pile length. In addition, the surface characteristics and dimensional stability of the developed long-pile Terry fabrics were investigated according to heat treatment conditions in order to improve the fluffy surface and distinctive tactile properties of polar fleece. Dyeing tests were also conducted to evaluate the dyeability of the developed fabrics, including color development, dyeing uniformity, and color fastness. Finally, this study examined the applicability of bio-based yarns, such as biodegradable PET yarn, as well as conventional PET yarn, to expand the developed fabric into eco-friendly polar fleece materials. Biodegradability tests were carried out on the developed Boa-like Terry fabrics to confirm the possibility of developing new polar fleece materials with cost-effectiveness, high sensibility, and eco-friendly properties.

Keywords: Polar fleece; Boa-like Terry fabric; Long-pile Terry; Biodegradable.

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THERMOCHROMIC PIGMENTS IN SPORTSWEAR: A REVIEW OF THEIR APPLICATION POTENTIAL FOR THERMOPHYSIOLOGICAL COMFORT ASSESSMENT

Gabriela VANJA & Vesna Marija POTOČIĆ MATKOVIĆ

Abstract: *Sportswear comfort is a multidimensional concept strongly influenced by fibre composition, yarn characteristics, fabric structure, moisture management, thermal behaviour, and garment design. Recent developments in smart textiles have introduced thermochromic materials as a promising approach for providing visual feedback on thermo-physiological conditions during physical activity. This review examines the potential of thermochromic systems for application in knitted sportswear, with particular emphasis on their suitability for thermo-physiological comfort assessment. Relevant literature concerning sportswear comfort, yarn selection, knitted structures, thermochromic pigments, integration techniques, and durability aspects was critically reviewed. The analysis indicates that thermochromic systems are most effective when used as visual indicators of thermal state rather than as direct thermoregulation mechanisms. Their performance depends not only on thermochromic chemistry but also on the properties of the underlying textile structure, including air permeability, moisture transport, elasticity, and wearer comfort. Current applications are primarily based on printing and coating technologies, while fibre- and yarn-integrated thermochromic systems represent a promising direction for future development. The review highlights the importance of combining thermochromic functionality with body-mapped knitted structures and comfort-oriented garment design. Future research should focus on durability under realistic wear conditions and on integrated evaluation of colour response, thermo-physiological performance, and wearer perception.*

Keywords: *thermochromic pigments; sportswear; knitted fabrics; thermo-physiological comfort; smart textiles; functional yarns*

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DIRECTIONAL MECHANICAL BEHAVIOUR AND SEAM EFFICIENCY OF WARP-KNITTED REINFORCED AUTOMOTIVE UPHOLSTERY LAMINATES

Ana KALAZIĆ & Ivana SCHWARZ

Abstract: Automotive upholstery materials are continuously exposed to complex non-axial loading conditions generated during prolonged service life. Beyond aesthetic appearance and passenger comfort, modern upholstery systems must meet demanding requirements for tensile stability, deformation adaptability, seam durability, dimensional recovery, fatigue resistance, and long-term structural integrity. Although numerous studies have investigated coated and laminated upholstery materials, limited attention has been devoted to the orientation-dependent mechanical response and seam-induced weakening of automotive upholstery laminates reinforced with warp-knitted backing structures. This study investigates the off-axis tensile behaviour, mechanical anisotropy, seam efficiency, and bursting response of laminated automotive upholstery composites reinforced with warp-knitted locknit structures. Two multilayer composites composed of artificial leather surface layers, polyurethane foam interlayers, and warp-knitted reinforcement fabrics were analysed under uniaxial tensile loading in six radial directions (0°, 30°, 60°, 90°, 120°, and 150°), seam loading conditions, and complex ball burst deformation. The obtained results revealed pronounced anisotropic tensile behaviour together with strong directional dependence of mechanical properties. The highest tensile resistance was recorded in the wale direction due to dominant load transfer through aligned loop columns of the warp-knitted structure. However, substantial differences were identified regarding directional deformation stability and resistance to off-axis loading conditions. Composite B exhibited lower anisotropy, reduced directional variability, improved seam efficiency, and superior bursting resistance compared with Composite A. Advanced interpretation based on anisotropy coefficients, coefficients of variation, and complex deformation mechanisms demonstrated that warp-knitted reinforcement structures strongly influence stress transfer capability and directional mechanical stability of laminated upholstery systems. The results provide a scientific basis for optimisation of reinforcement structures, seam positioning, and orientation-dependent performance of automotive upholstery composites.

Keywords: automotive textiles; warp knitting; off-axis tensile behaviour; anisotropy; seam efficiency; laminated composites.

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HOW TO KNIT AN ANTENNA

Eyal SHEFFER

Abstract: Carbon nanotube (CNT) yarns have promising potential for high-energy electromagnetic cathode applications. A target geometry for such cathodes is a terry-like structure with dense loops of uniform height. Because very high temperatures may occur during an energy burst, the final structure should be essentially all-carbon and free of residual organic materials that could melt, decompose, or otherwise undergo thermally induced transformations.

In this project, terry-like cathode structures were developed using CNT yarns supplied by Tortechn Ltd. The yarns are produced by chemical vapor deposition (CVD) and consist of ultralong single-, double-, and multi-walled CNTs. To enable textile processing, a removable ethyl cellulose coating was developed to protect the yarns against mechanical damage and maintain their integrity during fabrication, thereby reducing the risk of disintegration and electrical short circuits. Following textile processing, the coating was removed by Soxhlet extraction with methanol.

Several fabrication methods were developed using computerized weft knitting and manual weaving, and dense terry-like CNT structures were successfully produced. Some knitted structures were fabricated with water-soluble sacrificial PVA yarns, which were removed by washing after knitting. The results demonstrate the feasibility of producing dense, essentially all-carbon looped structures from CNT yarns using adapted textile manufacturing techniques.

Keywords: carbon nanotube yarns; terry-like structures; weft knitting; electromagnetic cathodes; textile manufacturing.

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IV. SUSTAINABILITY AND INNOVATION IN KNITTED TEXTILES

COTTON GRASS FIBERS - TEXTILE TECHNOLOGICAL APPROACH

Marc KÜPERKOCH

Abstract: *Peatlands account for only about 3% of terrestrial land area, but with nearly 600 billion tons of carbon, they store about twice as much carbon as the total phytomass of all the world's forests combined. This characteristic makes peatlands an important component of environmental protection. The problem is that nearly 25% of peatlands in Europe and 50% of peatlands in the European Union are degraded. This means that the ecosystem is disturbed and, instead of storing carbon, it emits carbon in the form of CO₂. In order to protect and rewet degraded peatlands, an alternative form of agricultural use is needed. The so-called paludiculture aims for a sustainable, economical use of wet peatlands. The challenge is to find suitable plants that offer valuable resources. One of such plants is the cotton grass with its fibrous seed hairs that is under investigation for a textile technological use. In first trials, cotton grass has been processed with cotton to produce a blended yarn. This yarn has been knitted in order to get a first idea of technical possibilities. Further investigations will clarify other possibilities, characteristics and the actual potential of this material.*

Keywords: *natural fibres, yarn, knitting, sustainable process, peatland, cotton grass*

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COMPRESSIBILITY OF KNITTED FABRICS PRODUCED FROM CONVENTIONAL AND BIOBASED POLYAMIDE

Miroslav KALANJ & Snežana STANKOVIĆ

Abstract: *In response to global pressure for sustainable resource use and production, and growing awareness of eco-friendly products, research on polyamide synthetic fibres goes towards enhancing their sustainability and eco-friendliness. The investigations go in two directions. One is the recycling of polyamide fibres, which is relatively affordable. The alternative approach is to focus on developing polyamides using natural raw materials. In this investigation, biobased polyamide textured filament (EVO[®]) was used to produce three plain knitted fabrics, differing in loop length, which were further analysed with respect to compressional behaviour. Corresponding knitted fabrics, counterparted with the biobased ones, were produced from conventional polyamide textured multifilament to compare the tested properties. The knitted fabrics were subjected to five successive compression-release cycles. The compressibility and deformation components of compression were determined from the compression-release curves and some specific compression parameters. All polyamide knitted fabrics demonstrated a high level of compressibility, which is caused by the high bulk of textured polyamide multifilaments, with somewhat greater compressibility of the biobased polyamide knits. Both groups of knits showed increased compressibility with longer loops. According to a specific procedure, the compressional deformation components were determined, indicating that plastic deformation exceeds viscoelastic deformation in all knits, except for the biobased polyamide knit with the shortest loop length. In conclusion, the biobased polyamide (EVO[®]) knitted fabrics are comparable to conventional polyamide knits and even have advantages regarding compression behaviour.*

Keywords: *polyamide; compression; deformation components; knitted fabric; textured filament*

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FROM FISH-SCALE WASTE TO SKIN-FRIENDLY KNITWEAR: MULTIFUNCTIONAL PERFORMANCE OF BIO-BASED U MORFIL® VISCOSE KNITTED FABRICS

Bilge KOYUNCU; Cevza CANDAN; Banu NERGİS; Murphy Murat PEKŞEN; Çiğdem ÖZDEMİR

Abstract: Sensitive skin, reported by approximately 50% of women and one-third of men worldwide, is a critical determinant of next to skin garment design. Conventional ultraviolet (UV)-protective textiles rely on chemical finishes that raise concerns over wash durability, sustainability and dermatological safety. This study investigates the multifunctional performance of knitted fabrics produced from a bio-based, collagen-peptide-enriched regenerated viscose fibre (U morfil® Beauty), derived from upcycled fish-scale waste. An Ne 40/1 core-spun yarn was engineered with 97% U morfil® viscose wrapped around a 22 dtex elastane core, combining the inherent UV blocking and skin-comfort properties of the fibre with elastomeric recovery while preventing direct skin elastane contact. Three weft knitted structures (single jersey, 1×1 rib and interlock) were industrially produced, heat-set, and sanforised. Specimens were evaluated in greige and after ten domestic laundering cycles using standardized tests covering structural, dimensional, mechanical, thermophysiological and UV-protective properties. Following ten wash cycles, all structures retained at least good UV protection: UPF values ranged from 33.2 (S, UPF 30) to 64.6 (R) and 194.1 (INT) (UPF 50+); dimensional change remained below 6%; air permeability spanned 10–14 cm³·cm⁻²·s⁻¹; thermal conductivity scaled with knit density (49.2–62.8 ×10⁻³ W·m⁻¹·K⁻¹, S→INT) supporting cool-touch sensation; overall moisture management (OMMC = 0.42–0.50) remained within the good-management band. Two-way ANOVA confirmed highly significant fabric and wash effects on UPF, structural and comfort properties, and a Derringer–Suich multi-criteria optimisation identified greige (unwashed) interlock as the configuration with the highest composite desirability (D = 0.563). Consumer needs were quantified through a 429 respondent industrial survey of skin sensitive consumers. And, the findings demonstrate that biobased U morfil® viscose, combined with appropriate yarn and knit architecture, delivers durable UV protection and multidimensional comfort without chemical UV finishes, offering a sustainable pathway for sensitive skin apparel.

Keywords: U morfil® viscose; collagen peptide fibre; UV protection (UPF); knitted fabric; thermal comfort; digital twin; sensitive skin

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IV. SUSTAINABILITY AND INNOVATION IN KNITTED TEXTILES

CARBON FOOTPRINTING IN KNIT PRODUCTION: CONCEPTS, CHALLENGES AND PRACTICAL APPLICATIONS

Swea WEX

Abstract: *The textile industry is facing increasing pressure to reduce its environmental impact and improve transparency regarding greenhouse gas emissions. In this context, Greenhouse Gas Balances (GHGB), Corporate Carbon Footprints (CCF) and Product Carbon Footprints (PCF) or Life Cycle Analyses (LCA) are becoming increasingly important tools for measuring, understanding, and communicating climate-related impacts. This presentation focuses on the relevance and practical application of GHG assessments, focused on knit production. It will provide an overview of the concepts and possibilities behind GHG, PCF and CCF, explain which emission sources need to be considered, and illustrate their application using knitted textile products as an example. Particular attention will be given to the challenges associated with calculating carbon footprints in textile production, including data availability, system boundaries, and the comparability of assessments over time. Reliable and repeatable carbon footprint calculations can support companies in identifying emission hotspots, monitoring progress, and evaluating the impact of measures aimed at reducing greenhouse gas emissions. GHG assessments are not a solution to all sustainability challenges in the textile industry but nevertheless, they can provide an important foundation for more transparent decision-making and continuous improvement. With increasing regulatory requirements and growing demand for more sustainable products, understanding and applying carbon footprint methodologies is expected to become increasingly relevant throughout the textile value chain. The presentation aims to encourage discussion about their role in the industry's transition towards greater sustainability.*

Keywords: Carbon Footprints, Textile Production

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V. DESIGN, EDUCATION AND HUMAN-CENTRED PERSPECTIVES IN KNITTING

EMPLOYMENT IN THE CROATIAN TEXTILE AND CLOTHING INDUSTRY: WITH SPECIAL EMPHASIS ON THE KNITWEAR INDUSTRY

Zlatko VRLJIČAK

Abstract: *Basic information on the Republic of Croatia is presented. Tables provide data on employment in the Croatian textile and clothing industry for the period from 1990 to 2026. For the same period, employment figures are presented separately for the production of yarns, woven fabrics, knitted fabrics, textile finishing, other textile products and clothing. The paper also identifies major factories that once employed between 500 and as many as 12,000 workers, as well as factories that are currently operating successfully on the European market. Between 1990 and 2026, employment in the Croatian textile and clothing industry declined from 83,200 to approximately 10,000, representing a decrease of 88%. In contrast, employment in dry-cleaning establishments and textile laundries has continued to increase.*

Keywords: *Republic of Croatia; textile industry; clothing production; employment*

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EXPLORING THE PRINCIPLES OF KNITTING THROUGH SERVICE-LEARNING

Alenka PAVKO ČUDEN; Barbara SIMONČIČ & Matejka BIZJAK

Abstract: *Knitting, one of the oldest textile production techniques, has evolved from a traditional domestic craft into a multifaceted industrial, artistic, and educational practice with broad societal relevance. This paper examines the potential of hand knitting as a versatile tool within service-learning frameworks, exploring its use across formal and alternative primary school settings, extracurricular programmes, and community-engaged student projects. Grounded in experiential learning theory, particularly Kolb's experiential learning cycle, and in service-learning pedagogy, the paper situates contemporary hand knitting within a wider cultural landscape encompassing artistic expression, therapeutic practice, DIY culture, craftivism, and sustainable consumption. Service-learning is distinguished from other experiential approaches by its deliberate integration of structured community service with academic learning objectives and critical reflection. The paper argues that embedding hand knitting within service-learning programmes yields significant educational, social, and wellbeing outcomes. As a STEAM-related activity, knitting supports fine motor skills, creativity, critical thinking, and intercultural understanding, while promoting textile literacy, preserving traditional craft knowledge, and fostering civic engagement and social responsibility. Through its accessibility, portability, and multidisciplinary potential, hand knitting offers an effective bridge between higher education institutions, primary schools, and community organisations, contributing to individual development, social cohesion, and community resilience.*

Keywords: *knitting education, experiential learning, service-learning, hand knitting, textile literacy, community engagement, craftivism*

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TEACHING BEYOND THE CLASSROOM

Linda OHRN-MCDANIEL & Krissi RIEWE STEVENSON

Abstract: *Teaching digital knitting takes many forms. In the classroom, learning is structured around specific content, defined outcomes, and graded assessments. While hands-on projects and exploratory learning have proven effective, classroom instruction alone is not always sufficient for students pursuing careers in knitting. Limited course availability, curriculum constraints, and growing student interest often create a need for additional learning opportunities. This presentation explores approaches that extend beyond the classroom. Drawing on Experiential Learning Theory, we have found that student-driven learning outside formal coursework provides a more holistic experience, emphasizing the learning process as much as the final outcome. These environments foster deeper engagement, stronger commitment, and the development of critical thinking through problem-based learning. At our institution, this need led to the development of the KnitLAB, a student-run laboratory supported by a faculty director. Although not originally designed as a formal teaching model, the KnitLAB has become an important learning environment. Student workers troubleshoot machine and programming challenges, develop products, and support peers through collaborative learning. The space encourages peer-to-peer knowledge sharing and allows students to engage with projects beyond the curriculum. Our institution offers one elective digital knit programming course, taught in two sections each semester, serving approximately 60 undergraduate students, primarily fashion design majors. Through hands-on work with Stoll industrial knitting machines, many students discover a desire to further develop their skills through independent projects, interdisciplinary collaborations, or careers in programming and manufacturing. KnitLAB provides a pathway for this continued growth. It also expands access for students who cannot enroll in the course or who wish to pursue projects outside the classroom. In a curriculum with high student interest but limited course capacity, KnitLAB serves as a valuable extension of the learning experience.*

Keywords: *Teaching; experiential learning; peer-to-peer learning; hands on experience.*

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INTERDISCIPLINARY COLLABORATION IN KNITTED TEXTILES

Linda OHRN-MCDANIEL & Yusuf DIKICI

Abstract: *Knit technologists hold specialized knowledge that is valuable across many industries, yet connecting this expertise with those who need it remains a challenge. This study examines experiences of collaborating with external stakeholders, researchers, and businesses seeking to develop products in which knitted textiles play an integral role. While companies sometimes have access to textile developers capable of producing prototypes, textile development is frequently outsourced, creating missed opportunities for communication and innovation. Clients commonly approach projects with a product idea but limited understanding of the capabilities and constraints of knitted textiles. As a result, information often flows in one direction, with developers responding to predefined requirements rather than contributing to the design process. On the other hand, knitting technologists often want to develop knitted products for fields outside their own, this sometimes leads to decision making based on the textile opportunities rather than the true need in the product. This is why both parties need each other in these types of functional textile developments. A truly collaborative approach addresses these challenges through open dialogue, mutual learning, and shared decision-making. Such collaborations require participants to engage in honest conversations, ask fundamental questions, and remain open to perspectives outside their own expertise. This process enables both technical and product-focused partners to better understand the overall project goals as well as the possibilities offered by knitted textile technologies. By creating a more balanced relationship between engineers, product developers, and knit researchers, collaboration shifts the focus from individual responsibilities to a shared commitment to the final product. Although business environments are often constrained by time pressures and clearly defined roles, a research-through-practice approach provides greater opportunity for ongoing discussion and reflection throughout the development process. This fosters a mutual understanding of roles, encourages knowledge exchange, and allows each stage of development to evolve through the combined expertise of all collaborators.*

Keywords: *interdisciplinary; collaboration; functional fabric; technical textile.*

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V. DESIGN, EDUCATION AND HUMAN-CENTRED PERSPECTIVES IN KNITTING

CRAFTING ISLAND IDENTITY: CO-DESIGNING A RATHLIN FAIR ISLE AND RATHLIN ARAN

Alison GAULT; Anna DUFFY & Jessica BATES

Abstract: *This paper presents research undertaken as part of the AHRC-funded Green Transition Ecosystem Future Island-Island project (7M), which explores innovative uses for underutilised wool resources on Rathlin Island, Northern Ireland. Alongside investigations into rope, braid, non-wovens and knitted structures, this strand of the project focused on the cultural and technical traditions of Fair Isle and Aran knitting as vehicles for contemporary place-based design. Rathlin Island occupies a unique geographical and cultural position between Ireland and Scotland, reflecting influences from both traditions in language, heritage, and craft practice. Drawing upon oral histories collected on the island, the research examined local knitting narratives, including references to garments such as the knitted tammy, fishermen's sweaters, and practical Aran-style garments adapted to island life and maritime occupations. These historical accounts provided the foundation for the development of a contemporary Rathlin Aran design. A complementary design fellowship investigated Fair Isle knitting traditions and their relevance to Rathlin. Through collaboration with island makers and crafters, a series of co-designed Fair Isle motifs were developed, drawing inspiration from local landscapes, heritage, biodiversity, and community narratives. Knowledge gained through the study of Fair Isle colourwork systems informed the creation of a distinctive Rathlin Fair Isle identity that reflects the island's unique cultural position between the knitting traditions of Scotland and Ireland. The research adopts a practice-based and participatory approach, combining historical investigation, oral history, design development, and community engagement. It demonstrates how traditional knitting systems can be reinterpreted through contemporary co-design processes to create new expressions of place-based textile heritage. The paper discusses the resulting Rathlin Fair Isle and Rathlin Aran designs and considers their wider potential to support community craft activity, local wool utilisation, natural dyeing initiatives, cultural sustainability, and rural economic development. In doing so, it highlights the role of knitting as both a cultural archive and a catalyst for sustainable island futures.*

Keywords: *knitting, wool, Aran, Fairisles, bio, community*

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FASHIONABLE ROBOT APPAREL: ENHANCING HUMAN ROBOT INTERACTION

Krissi RIEWE STEVENSON & Linda OHRN-MCDANIEL

Abstract: *Emerging technologies increasingly shape everyday life, with robotics playing an important role in connecting humans to technology. From food delivery systems on college campuses to autonomous vehicles, robots are rapidly becoming part of human environments. While textile applications contribute to robot flexibility and mobility, fashion may also influence how humans perceive and interact with robots. Here, we examine the relationship between robotics and fashion, proposing that clothing can support successful robot implementation and human acceptance. Robots are active objects designed to perform tasks, often with forms determined by function. Robots used for dangerous, dirty, or inaccessible environments prioritize performance, while robots designed to support humans may also benefit from aesthetic considerations. A self-driving vehicle, for example, could take many forms but is designed to resemble a familiar automobile. This demonstrates that appearance, in addition to function, influences human-robot interaction. For humans, clothing provides protection and serves as a form of social and psychological expression. Fashion communicates identity and establishes familiarity, influencing how people relate to one another. Applying these principles to robotics suggests that clothing may make robots appear more approachable and socially familiar. For example, in Dell's 2025 "Giving Bot" campaign, a delivery robot receives a scarf and googly eyes, transforming its perceived personality. Similarly, Robotics for Good found that adding a scarf to a social robot used to support isolated and elderly people improved users' perceptions and interactions with the robot. In both cases, a simple garment altered the robot's perceived character and approachability. These examples suggest that robot clothing warrants further theoretical and design research. Interaction Design (IxD) provides a framework for developing physical and emotional connections between people and products, while the Robot Fashion Psychology Model considers robot form, programming, context, cultural norms, and human perception. Together, these approaches can guide research into how apparel may improve human-robot interaction.*

Keywords: *Robot Fashion; Human Robot Interaction; Interaction Design; Fashion Psychology*

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V. DESIGN, EDUCATION AND HUMAN-CENTRED PERSPECTIVES IN KNITTING

SPARKS OF JOY

Mira SWATSCHEK

Abstract: *The design project Sparks of Joy was developed during the sixth semester of the Fashion Design programme at TEXOVERSUM, Reutlingen University, in the context of the exhibition Dancing with Reality at the Kunsthalle Tübingen. The capsule collection comprises two garments inspired by West Palm Beach by Alex Katz. The painting is characterized by a dark surface with dots in pastel colours, evoking reflections of light and creating an impression of visual depth. The points of light in the painting were translated into textile form and incorporated into the surface design of the first dress. The garment features a four-colour jacquard with a twill backing, partially knitted as a tubular jacquard. Different yarns, including viscose and lustrous yarns, were used to reproduce the interplay of colours observed in the painting. The textile surface reveals that the seemingly black areas contain a variety of subtle colour nuances. In the second dress, the points of light were transformed into illuminated objects integrated into the garment. A lampshade structure made from peddig reed was covered with a variety of knitted fabrics that were hand-sewn together. Flat lights, concealed beneath additional knitted lampshades, illuminate the garment from within. The knitted fabric softens and diffuses the light, creating a warm, glowing effect. As the light passes through different layers of textile, it shines through the knitted stitches and produces a shimmering appearance that changes according to the viewing angle.*

Keywords: *fashion design; knitted textiles; jacquard; textile surface design; illuminated garments; wearable art*

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BORDERS OF PERCEPTION: MULTISENSORY INTERACTION AND EMOTIONAL DESIGN IN KNITTED RIB APPAREL

Duje KODŽOMAN & Vanja ČOK

Abstract: *This study presents a quantitative method for assessing multi-sensory experiences in clothing, analyzing how visual, tactile, olfactory, and auditory modalities collectively influence the emotional perception of knitwear. A sample of participants (N=60) evaluated 18 garments on a 1-to-7 attractiveness scale. To isolate the effects within knitwear design, this paper focuses on the findings for garments featuring a cotton rib knit structure across three colorways (Caramel Café, Black, Pink Yarrow) and two applied fragrances (lemon essential oil, liquid ammonia). While participants self-reported sight as the primary modality for evaluation, Pearson's correlation coefficients revealed that general perception is heavily tied to other sensory inputs, showing strong positive correlations with visual ($r=.97$), tactile ($r=.87$), and auditory ($r=.88$) attractiveness, and a moderate correlation with olfactory attractiveness ($r=.75$). Furthermore, a Multivariate Analysis of Variance (MANOVA) showed significant main effects for texture, scent, and color ($p<0.001$). A significant texture $\times$ scent interaction indicated that structural tactile differences matter significantly when scent intensity is low, but these differences decrease as scent intensity increases. Within the knitted rib subset, the lemon-infused Caramel Café garment (Garment 6) achieved the highest olfactory attractiveness rating, demonstrating a high intensity on the rib structure. Conversely, the ammonia-treated brown cotton rib knit (Garment 5) received the lowest overall attractiveness rating ($M=4.1$, $SD=1.5$) due to the negative valence of the scent, despite maintaining a high tactile rating ($M=5.0$ to 5.4). These findings highlight the complex, multifaceted nature of emotional responses to garments, proving that the interaction of texture, color, and scent must be managed collectively in knitwear design.*

Keywords: Knitwear Design; Sensory Evaluation; Multisensory Interaction; Knitted Rib

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