Strategy R&D&I 2030+ of the Faculty of Textile Engineering of TUL

Introduction

"The Strategy VVI+2030 of the Faculty of Textile Engineering ***develops and specifies the*** *Strategic Plan of the Faculty of Textile Engineering of the Technical University of Liberec for the period 2021-2030"* (hereinafter referred to as "*Strategic Plan FT*").

These documents serve as a central reference point for decision-making and formulation of future visions that are decisive for the development of the Faculty of Textile Engineering, Technical University of Liberec.

The starting point is an assessment of the current state of the FT and the current development of the relevant environment, together with a comprehensive analysis of the strengths and weaknesses of the FT, prepared with regard to its intended long-term profile in the activities of the VVI. On the basis of this analysis, the priorities for the development of the FT are set, the strategic objectives are identified, and the specific tools and means that can be used for their implementation are identified.

Strategy VVI+2030 of the Faculty of Textile Engineering of TUL was discussed by the Scientific Council of TUL on 26.4.2023 and approved by the Academic Senate of the Faculty of Textile Engineering of TUL on 26.6.2023.

General self-reflection of social contribution

The Faculty of Textile Engineering (FT), Technical University of Liberec (FT TUL) (founded in 1960) is the only one in the Czech Republic that develops creative activities and provides higher education across the entire textile field, conducting basic and applied research from design, through materials and technology, quality assessment, to a wide range of application areas. **It is one of the largest and oldest faculties in the EU with a** strong scientific and research focus that extends beyond the Czech Republic and the EU, **focusing comprehensively on fibre structures, textile quality engineering and metrology**. Scientific and research

The work follows mainly the directions of development of technological and materials research, in which the faculty has traditionally had a high level of quality personnel and a number of specialized laboratories with unique instruments.

The societal benefit is the maintenance and further development of the knowledge base in the textile sector, R&D in technological and materials engineering with a wide range of applications of fibre structures (e.g. automotive, healthcare, construction, agriculture, transport, protection of inhabitants and facilities, environmental improvement, electrical engineering, sustainable circular economy...) and the education of professionals for a wide range of application areas. Part of the R&D development strategy at TUL is to link the technological and artistic aspects of product design, taking into account the requirements for comfort and recyclability. The results of research into new materials and technologies are applied in product design and innovation, in new methods and forms of design creation, to reconcile the artistic and technological components of design.

1. Mission, vision of FT TUL

Mission; FT

- is a centre of scholarship, independent research and creative activity and plays a key role in the scientific, cultural, social and economic development of society in the spirit of Section 1 of the Higher Education Act;
- carries out accredited study programmes and creative activities related to fibre materials and textile technologies.
- is a uniquely equipped scientific centre within the global community.

Vision; FT wants

- to be an internationally respected and excellent faculty in the Czech Republic providing bachelor's, master's and doctoral education in textile and related fields.
- to maintain and further strengthen its exceptional place among the world's top workplaces dealing with fibre and textile research and other creative activities in the Czech Republic, Europe and the world;
- to further expand cooperation with industry and other partners in the field of R&D and other creative activities, to contribute to the comprehensive development of society through technology and knowledge transfer.
- actively contribute to solving the problems of the third millennium, continuing to attract the best scientists in the field from abroad.
- to attract the best possible PhD students and postdocs from around the world
- exploit synergies with other sites around the world

Strategy; *FT Strategic Plan*

- is based on the current state of the faculty and the strategic goal to maintain, verify and develop the position of the Faculty of Textile Engineering as a research-oriented faculty within the world's top academic and research institutions of similar focus; with regard to changes in the structure and focus of the textile industry in the Czech Republic and ERA, and new possibilities of applications of products based on textile fibre structures; through quality research and scientific work, inspiring and creative teaching and the creation of a demanding and also open, free and friendly university environment.

2. Comprehensive analysis of strengths and weaknesses

FT activities in 2016-2020 were implemented in accordance with the Faculty's strategy formulated in the *FT Long-term Plan* and its updates. The evaluation of the fulfilment of priorities and objectives of the FT Long-Term Plan in 2016-2020 was included in the regular *Annual Reports and the Self-Evaluation Report (Societal Contribution of R&D&I FT TUL 2014-2018).* Based on the analysis, the main strengths and weaknesses were identified and opportunities and threats to the achievement of the FT's development goals were defined.

Strengths of FT

- The international and national **uniqueness of** the field and the **prestige of** the institution.
- **Tradition** in fibre and textile research and development (both material and technological), linking the technological and artistic aspects of product design.
- **Innovative** R&D activities in line with the orientation of companies towards higher value-added products, multifunctional and smart textiles, special structures and the application of textile structures to new industries.
- **Excellence of** R&D activities - evaluation of TUL's results in international rankings.
- **Interdisciplinarity**, ability to build R&D teams and find innovative, complex solutions across disciplines. Formation of teams composed of R&D and artistic staff capable of solving complex tasks related to the development of professional and creative activities of the company.
- **A balanced** range **of** study programmes at all levels of study. Accreditation of all study programmes for the maximum possible time in both Czech and English.
- **Flexibility of** training procedures. Individual approach to students; involvement of students in R&D activities.
- **Professionalism** of academic staff and students of doctoral study programmes. Habilitation and professorial appointment procedures.
- State-of-the-art **infrastructure**; laboratory equipment in line with new R&D trends in the field of fibre materials and textile technologies.
- Success in the field of **internationalization** - active connection with major world university departments working in the field of textiles, both in the field of teaching and research.
- **Openness** for cooperation - active involvement in the development of national and international strategies for the development of the textile and clothing industry; a wide network of partnerships; joint R&D projects; professional internships. Openness in interdisciplinary cooperation.
- Successful presentation and popularization of the results of creative activities.
- Possibility to exploit synergies with other parts of the university

Weaknesses of FT

- The exclusivity of the field limits the possibility of massive recruitment of academic staff from external departments.
- Overload of staff with activities unrelated to science and teaching (administration, other activities), which can lead to loss of motivation.
- Limited involvement in international R&D projects. Low success rate of project applications.
- Still relatively low levels of key science and research results.
- Few effective activities to increase the interest of secondary school students in studying technical fields.
- High proportion of students failing their studies. Low effectiveness of innovations in pedagogical methods to motivate students.
- Lack of inter-departmental cooperation.

- Insufficient consideration of the principles of *the Methodology for the Evaluation of Research Organisations and Programmes of Targeted Support for Research, Development and Innovation* ("M17+").
- Little pressure to produce significant scientific and artistic results and their presentation, especially in the form of publications.

Opportunities in the external environment

- New opportunities for the application of research results in the field of fibre structures and new materials to the design of hybrid and composite structures, tissue engineering and other engineering fields and disciplines.
- Response to current needs of industry development (demand for technically educated graduates, interest in cooperation on R&D topics).
- Offering the possibility of commercial exploitation of application potential, intellectual property and technical facilities in the Czech Republic and abroad
- Detailed evaluation of research in international rankings and presentation of achievements.
- Use of EU support programmes and national agencies.
- Obtaining institutional accreditation.
- Marketing outreach to applicants; leveraging the demographic growth curve, increasing interest in technical fields.
  - Possibility of cooperation with primary and secondary schools - popularization of technical fields and preparation of potential future students.
  - Strengthening the pedagogical competences of academic staff focused on student motivation
  - Increasing the proportion of international students.
- Improving contacts with alumni (both in Czech and English).
- Recruitment of experts also abroad, also outside the textile industry.
  - Presentation of results, knowledge and equipment of TUL to the professional and general public.

Threats from the external environment

- Economic and political instability at national/global level.
- The limitations of the long-term political strategy of R&D in the Czech Republic. Unclear priorities of the government regarding R&D funding and evaluation.
- Excessive earmarked funding at the expense of institutional funding, which leads to precarious employment and living conditions for researchers and faculty members
- Uncertainty and instability of the state education and higher education concept (low share of tertiary education spending in GDP, new system of financing higher education institutions).
- Quality of knowledge and intrinsic motivation of secondary school graduates. Decrease in interest in studying technology and material oriented fields.
- Inappropriateness of the M17+ methodology for so-called "small industries".
  - Inconsistency between the policy of internationalization of the HE environment and the visa policy of the state.
  - Inappropriate grant policy of the state taking into account either basic research or implementation but not transfer of applied scientific results
  - Lack of institutional accreditation
  - Increasing demands on project administration and bureaucracy from providers.
  - Low public support for the development of university education.

3. Prediction of research trends in the Czech textile and clothing industry

As part of its mission, the TUL FT is a partner in cooperation with research institutions and the business community and strives for the **relevance** of its R&D processes. Its strategy is based on research and predictions for the Czech Republic and the European and global research area.

The Strategic Areas respond to **cross-cutting themes** of long-term societal urgency (formulated e.g. in[1]). This study describes the key transformational processes (**mega trends**) that are already evident and that will have a major impact on the development of the sector in the coming years, the main expected **impacts of** the sector trends (TOP), the potential **opportunities that** may emerge as a result of the impact of the new trends on the sector and the **research topics** that open up these opportunities.

Trends - Impacts - Opportunities of the TOP CR development

Trends	Impacts/needs	Opportunities for research
Social		
Ageing population	Emergence of new market segments	▪ High-performance fibres and textiles to reduce safety risks ▪ New textile structures ▪ Textiles reflecting the needs and requirements of the older generation ▪ Multifunctional textile surfaces ▪ Functional and intelligent textile products for health, sport and personal protection ▪ Textile materials and garments for healthcare and well being
	Higher demand for specialised "SMART" products	▪ Multifunctional textile surfaces and related processing technologies ▪ E-textiles for intelligent structures, functional interiors or intelligent wearable systems ▪ Offer of products for institutional and home care
Higher purchasing power of younger population/customization	Demand for specialised (functional) products	▪ New flexible technologies for the different stages of textile production, the "Factory of the Future" strategy ▪ Increasing the effective utilisation of existing production technologies for the production of small production runs/series (minimising investment conditionality in the transition to "production on demand") ▪ Step-by-step steps and pilot capacities for the introduction of "digital (micro)factories" and for the growth of the e-shopping segment, including the criterion definition of specific textile parameters ▪ Adaptation of digital presentation for textile products using virtual reality and avatars
Technologica		
Industry 4.0	Increase in demand for employees	▪ Digitalization and growth of flexibility in production processes and manufacturing plants ▪ Development of the integration of

[1] *Home-ČTPT - Czech Technology Platform for Textiles, z.s.* [online]. Copyright © [cit. 10.10.2022]. Available from: https://ctpt.cz/img_webimg/img_editor/soubory/Foresight_vyzkumnych_trendu_CTPT.pdf

		communication, monitoring and "smart" responsive elements into textile substrates; prerequisites for integration with next generation IT - "big data" for product flows in production cycles, dematerialization, interfacing with the user sphere and professional maintenance; personalization of PPE, medical textiles and products for living standards, leisure activities and telemedicine of the aging generation (incl. "home-care")
	High financial requirements for infrastructure acquisition	▪ Standardization and digitalization of textiles, especially for their sale in e-shops ▪ Robotization, automation of the entire production chain, including the development of an information system linking the sales and production chain and user service (maintenance, sharing...)
Economic		
Specialized custom production	High demands on know-how	▪ Composite structures and laminates for textiles, emphasis on renewable, recyclable and bio-degradable (compostable) materials, bio-composites ▪ Digitalization and growth of flexibility in production processes and manufacturing plants ▪ Virtual modelling involving the design of fibres and textile materials and products in a simulated climatic environment
	High demands on R&D	▪ Higher emphasis on technology transfer, transfer of R&D results into industrial and product innovations ▪ Expanding shared pilot and scale-up capacities
	High demands on pre-production and follow-up services	▪ Further development of research within clusters and deepening multidisciplinary collaborations ▪ Integration of production and service conditions - dematerialisation (life extension), move towards an integrated reuse regime within the circular economy
Increasing production of textile products for other application sectors (electrical engineering, healthcare, construction, automotive, agriculture, environment, aviation)	Creating new business models	▪ Textiles for resource conservation (water, agriculture, energy storage, and more) ▪ Textiles for safe and energy-efficient buildings and smart and functional interiors ▪ E-textiles for intelligent wearable systems ▪ Textiles for lightweight, clean and safe transport systems, smart roads ▪ Textiles for insulation and filter materials ▪ Textiles for building safety (identification and prediction of occasional risks in buildings) ▪ Textiles to improve road user safety
	Flexibility of production, active search for new business opportunities	▪ Digitalization and growth of flexibility in production processes and manufacturing plants

Environmental		
Rising prices of raw materials, energy and labour	Development of new technologies and materials	▪ Development of technologies capable of minimizing production runs/digital printing, jet dyeing, coating and functional finishing ▪ Textile technology (machine technology and new chemical processes) minimising consumption ▪ Highly functional and durable fibres and textile materials ▪ New one-, two- and three-dimensional fibrous structures ▪ Multifunctional textile surfaces and related processing technologies ▪ Sustainable substitutes for hazardous textile production ▪ Processing of domestic/EU bast fibres and woody biomass, including waste into non-woven or technical textiles ▪ Hi-tech processing of textile waste ▪ Recycling of recycled materials and textile waste
The growing importance of recyclable materials and the circular economy	Research and development of new materials for textile production	
	Waste management	▪ New flexible and economically acceptable technological processes for the reuse of water, energy and chemicals
The growing potential of water ecology	Products enabling accumulation, etc.	▪ Strategic development of "wet to dry" production systems ▪ Products to prevent evaporation, desalination and filtration of process (and seawater) water, etc.
Securing life on earth	Reducing the proportion of life-limiting compounds	▪ Comprehensive solutions to reduce CO_2 in the atmosphere ▪ Comprehensive solutions to reduce the use of volatile organic solvents, potentially toxic substances and non-removable environmental pollutants ▪ Comprehensive solutions to fibrous microplastic problems
Political/Legislative		
Legislative regulations and market regulation by the Czech Republic and the EU	Residual waste management solutions	▪ Proactive policy development and implementation of directives and regulations creating space for safe implementation without compromising the sustainability of resources and industrial production

4. Strategic objectives

The development of FT in the field of creative activities will be specifically oriented to **strategic research areas and implemented by specific R&D&I research programmes.** Strategic areas, research programmes and specific research activities are defined in the following subchapters.

The strategic objectives of the FT TUL are:

- To optimize and diversify the structure of creative activities of the TUL Faculty of Science with regard to the excellence and progressiveness of individual research directions.
- For strategic areas, systematically build up scientific schools with regard to their provision in terms of capacity and qualification of staff, experimental facilities and possibilities of cooperation with both the business sphere and foreign institutions.
- Individual research topics should be addressed in interaction with each other. Develop interdisciplinary teams with a focus on research into flexible hierarchical materials based on fibre structures for sophisticated applications that have a wider reach beyond the standard use of fibre materials.
- Fiber structures are applied in hybrid and composite structure design, tissue engineering and other engineering fields such as automotive, energy, etc., as well as in solving fundamental societal problems such as health care and quality of life, reducing energy needs and efficient use of waste.
- Stimulate research performance and the quality of the results produced,
- Increase the social and economic impact of university research results
- To strengthen the position of the TUL Faculty of Science as a partner for searching and solving research tasks and societal challenges.

Departments of FT

Department	**Short name**
Department of Technology and Structures	KTT
Department of Nonwovens and Nanofibrous Materials	KNT
Department of Clothing	KOD
Department of Design	KDE
Department of Materials Engineering	KMI
Department of Textile Evaluation	KHT

4.1 Strategic research areas

Based on the traditional disciplines and the survey of trends and needs of the 21st century, strategic areas of research, development and innovation are defined for the further direction of creative activities of TUL.

Progressive fibre materials
- multifunctional fibres for sustainable and degradable textile materials and structures
- Biopolymer fibre materials and their bio-based processing
- high performance fibres for technical applications

Innovative products
- designing high added value products for apparel, technical textiles and interdisciplinary applications
- eco-design for reusable products
- smart high-performance materials and products, functionalised textiles and e-textiles
- sophisticated product design methods

Advanced and Circular Technologies
- optimization, modification and development of technologies for processing and production of new materials and structures
- environmentally friendly, non-toxic, energy efficient technology
- new energy sources and new transport media in textiles
- circularity (closed loop), recycling, recovery of raw materials from waste, transformation of fibrous waste

Nanomaterials and nanotechnology
- production of nanofibres and nanofibre structures (AC, DC electrostatic, centrifugal softening, etc.)
- applications of nanofibrous materials for technical, medical and biological applications
- application of nanoparticles for special and functional effects
- deposition of nanolayers on the surface of textile materials

Metrology and quality assessment
- quality management (comprehensive quality assessment and non-traditional computer-oriented procedures)
- Use value of textiles, statistical quality control
- evaluation, analysis and modelling of structure and properties, parameters of sustainable processes
- processing of experimental data (focusing on modelling and specific textile problems)
- development of special experimental methods and instruments

Artistic creative activity
- design of textiles, clothing, glass, jewellery
- new methods and forms of art/design creation

THE INVOLVEMENT OF FT TUL DEPARTMENTS IN STRATEGIC AREAS	KMI	KTT	KNT	KHT	KOD	KDE
Progressive materials	X		X			
Innovative products	X	X	X	X	X	X
Advanced technology		X	X	X	X	
Nanomaterials and nanotechnology	X		X			
Metrology and quality assessment	X	X		X	X	
Artistic creative activity						X

4.2 R&D&I research programmes

The RDI strategy is based on the research programmes of individual departments and research teams. The research programmes, their implementation and evaluation, are both a basic tool for the implementation of the strategy and a platform and offer for scientific research cooperation between university and non-university departments.

Research programs R & D / CONNECTION / Strategic areas of research	Functionalised fibres and surfaces	Fibrous microplastics	Highly functional 2D and 3D woven and knitted structures	Combined non-woven fibre structures	Nanofibre materials	Structures for tissue engineering and healthcare	Composite materials	Activation of fibrous surfaces and membranes	Smart materials and products	Design of textiles, clothing, glass, jewellery	Useful value and product lifetime
Progressive materials	X		X		X	X		X	X		X
Innovative products	X	X	X	X	X	X	X	X	X	X	X
Advanced technology			X	X	X	X	X	X	X		X
Nanomaterials and nanotechnology	X	X		X	X	X	X	X	X		X
Metrology and quality assessment	X	X	X	X	X	X	X	X	X		X
Artistic creative activity	X		X	X	X				X	X	X

Priority application areas (R&D&I outputs)

- Hygiene and health care (health care, personal, wellbeing, institutional and home care, needs and requirements of the elderly, disabled, sensitive and vulnerable populations)
- protection of man, environment (health, sports, military, protective clothing)
- resource conservation (water, agriculture, energy storage, etc.)
- e-textiles for intelligent wearable systems, smart constructions, functional interiors (e.g. smart garments monitoring the wearer's vital signs, communicating with monitoring)
- safe and energy-efficient buildings, intelligent and functional interiors, textile architecture
- lightweight, clean and safe transport systems, smart roads (e.g. automotive applications taking into account electromobility, comfort and smart features)
- insulation and filter materials
- building safety (identification and prediction of building risks)
- increasing the safety of road users
- products for water recovery from air humidity, wastewater treatment, desalination and filtration of process (and seawater) water
- reuse schemes in the circular economy, recycling practices, advanced waste treatment
- adaptation of digital presentation for textile products using virtual reality and avatars, standardization and digitalization of textiles (for e-shops, e-prototyping and others)
- robotization, automation of the entire production chain (maintenance, sharing, e-passports, ...).

4.3 Research activities in research programmes

Research programme: Functionalised fibres and surfaces
Research and development in the areas of:

- Innovative textile fibres (sustainably grown natural fibres and synthetic fibres from renewable sources), fibre recyclates, biodegradable fibres from renewable sources, modified fibres from recycled waste
- High performance specialty fibers and fiber materials for industrial applications (inorganic fibers, optical fibers with lateral radiation, fibers with enhanced electrical conductivity, metal fibers with shape memory, fibers containing carbon nano powders, use of PCM and encapsulation, fibers with sensing capabilities)
- Textile structures with increased electrical conductivity (carbon fibres, metallic fibres, coated fibres, conductive polymers)

Research programme: Fibre microplastics
Research and development in the areas of:

- Global life cycle analysis of textile materials with respect to sustainability in materials engineering
- Analysis of the formation and emission of fibrous microplastics - specification and evaluation of the composition, structure and formation processes of fibrous formations
- Environmental testing of textile microplastics and nanoplastics
- Design and implementation of textiles with minimal emission of microplastics, limiting the release of microplastics from textiles during maintenance processes and the entire life cycle
- Design of a system for removing microplastics from wastewater after washing
- Use of fibrous microplastics in the formation of new structures

Research programme: High performance 2D and 3D woven and knitted structures
Research and development in the areas of:

- 2D and 3D knitted and woven structures for apparel and technical applications using textile and non-textile materials, including bio-based, recycled and waste materials
- Design of knitted and woven structures intended to protect pedestrians in road traffic
- Design and technological solution of 3D biomass carriers for wastewater treatment
- Special 2D and 3D fibre formations with controlled transport and water absorption
- Analysis of textile morphology in relation to the properties of fibre formations
- Special test methods for evaluating the transport properties of fibre structures
- Production of special and traditional textile structures for functionalisation (integration of high-functional and special fibres and use of nanofibres)
- Development of technologies increasing the utility and durability of textiles

Research programme: Combined non-woven fibre structures
Research and development in the areas of:

- Nonwovens for hygiene, construction, architecture, automotive and other industrial applications
- Specialty nonwovens combining microfibres and submicron fibres for the development of filtration and industrial sorbent materials
- Non-woven structures made of highly sorptive fibres for hygienic applications
- Development of technologies increasing the utility and durability of textiles
- Non-woven construction with reduced flammability
- Processing of recycled fibre materials into nonwovens for industrial applications

- Processing of biodegradable polymers by meltblown technology to prepare new generation sorbents
- Production of materials by perpendicular filament lay-up and other possible combinations
- Manufacture of mechanically reinforced nonwovens

Research programme: Nanofibre materials
Research and development in the areas of:

- Composite materials containing nanofibers and microfibers, creation of 3D structures, combination of nanofiber structures with 3D printing.
- Composite nanofibrous materials in filtration, separation or sorption of chemical substances, for protection against CBRN substances, as extraction materials for chromatographic analysis, for electrical insulation applications.
- DC and AC softening technology. Combination with centrifugal softening technology or direct melt softening.
- Study and analysis of periodic surface phenomena in polymer solutions during the electrospinning and centrifugal softening of nanofibers.
- Study of physical effects during microampere discharges at the start of electric softening and study of phenomena on asymmetric high-voltage capacitors.

Research programme: Structures for tissue engineering and healthcare
Research and development in the areas of:

- Nanofibrous materials from natural and synthetic polymers for tissue engineering applications
- Tissue carriers - skin covers, cartilage, artificial bone, glaucoma treatment, artificial thymus
- Materials for organ replacement e.g. artificial blood vessel, anastomoses, peripheral nerves, hard brain diaper.
- Functionalization of fibrous material surfaces to improve cell adhesion affecting material adhesion. Modification of hydrophobicity, hydrophilicity by plasma treatments and coating
- Functional degradable membranes for organs on a chip.
- Materials for controlled release of drugs and other specific active substances into the body.
- Interaction of variable electric fields with cell cultures cultured on a fiber support.
- 2D and 3D structures for medical applications (synthetic vascular replacements, ligaments, skin wound coverings and dressing materials)
- Bio-composites with textile reinforcement for skin grafts in burn medicine

Research programme: Activation of fibre surfaces and membranes
Research and development in the areas of:

- Activation of fibre surfaces using physical and chemical methods (chemical etching, plasma, microwave, laser, deposition of thin layers, nanoparticles, microparticles, capsules containing active substance, etc.). Activated systems are tested as sorption and adhesion substrates for applications of eco-technical materials and technologies (e.g. wastewater treatment, recycling processes)
- Bio-based processing, non-toxic, energy-efficient processing and finishing, bio-based chemicals, solutions to environmental processing problems (e.g. photolytic reactor for decolourisation of cellulose fibre recyclate and wastewater)
- Environmentally acceptable functional treatments of cellulose fibres. Development of special materials and membranes based on nanocellulose and bacterial cellulose
- Combined non-flammable treatments from waste materials. Systems to ensure the reduction of flammability of textiles with long-term effects
- Textiles limiting the absorption and emission of radio frequency radiation
- Water-repellent surfaces, water-absorbing and fast-drying surfaces

- Advanced technologies for local deposition of functional layers (ink-jet material printing, controlled localised photoactivation)

Research programme Composite materials
Research and development in the areas of:

- Textile composites for structural applications with inorganic reinforcement (carbon, basalt and glass-ceramic fibres) - analysis of the effect of fibre reinforcement on selected mechanical and physical properties of composites (fibre properties, fibre-matrix interaction, design of composite products)
- Special textile reinforcements for composite materials (2D and 3D woven and knitted structures, influence of manufacturing technology on reinforcement geometry, modification of manufacturing processes)
- Integration of high-functional and specialty fibres, nanofibres and materials into textile structures
- Membranes for barrier fabrics (construction by perpendicular laying, wrapping, electrospinning and electrospraying, laminating and other permanent bonding)
- Membrane composite structures for separation applications. functional membranes for wastewater treatment
- Eco-friendly sandwich textile structures for hygiene products (e.g. nappies, diapers, incontinence pads with enhanced physiological comfort)
- Material composition, structure and comfort of car seats and car upholstery

Research programme: Smart materials and products
Research and development in the areas of:

- Functional dyes (focus on the development of photochromic, thermochromic and chemochromic materials and sensors); Systems for complex colour appearance assessment (development and design of measurement systems, special experimental methods using AR and VR systems, colorimetry (colour appearance assessment under different illumination and observation conditions)
- Textile surface modification to achieve increased visibility and special optical effects. Predicting the colour appearance of functional fibre materials
- Design and evaluation of smart textiles - smart protective and professional clothing (e.g. military, police, paramedics, special medical clothing for recumbent patients) and technical textiles (e.g. car seats)
- Developments in textile sensors and sensors suitable for use in textiles and clothing
- Textile surface modification using advanced material printing and implementation of sensors in the fabric surface - design and application for smart hybrid

Research programme: design of textiles, clothing, glass, jewellery
Research and development in the areas of:

- Application of artistic creativity in product design and innovation (textiles, clothing, glass, jewellery)
- The production of textile/glass/jewellery accessories and the influence of its tradition on the specifics of national cultural identity
- Forms and methods of artistic creation in connection with the application of innovative materials and progressive technologies
- Forms of presentation of art/design work in public space
- Harnessing the potential of the visual arts in finding uses for waste materials and recycled materials
- Reconciling the artistic and technological components of design for the sustainable development of cultural creative industries

Research programme: use value and product lifetime
Research and development in the areas of:

Durability / Maintenance

- Analysis of the life cycle of textiles and the life cycle of a garment product, identification of the causes of the end of the life cycle of a garment product from the point of view of product quality and the user
- Extension of garment life, optimization of maintenance, modelling of external influences on garments, defect detection, life prediction
- Analysis of durability and resistance of automotive materials (e.g. mechanical stress, flammability)
- Evaluation and expression of the ecological footprint of a textile and clothing product. Digital manufacturing and supply chains (standardisation, outsourcing, legislation, interconnected supply chains to the end consumer)
- Utility / Structure / Features
- Metrology of textile performance characteristics (clothing, technical - e.g. new requirements for interior textiles in cars brought by electromobility (comfort, heating, etc.))
- Evaluation, analysis and simulation of the structure of textile fibre formations
- Evaluation and design of performance properties of textiles

Comfort / Sustainability

- Evaluation, analysis, modelling and simulation of pathophysiological, thermophysiological, sensory, aesthetic and psychological comfort of clothing and technical textiles
- Transfer phenomena in the heat and moisture transfer areas of textiles (clothing and technical textiles)
- Fabric feel (objective/subjective prediction procedures, creation of calibration models)
- Somatometry and the development of parametric design of patterns
- Aesthetic comfort: the involvement of an artistic approach as a key tool to integrate functional, emotional and social experiences of the customer into an eco-friendly clothing product, a way to find a sustainable compromise between cultural practices, ecological requirements and user comfort.
- The social (psychological) comfort of clothing and the effect on consumption. Mechanisms influencing consumer behaviour. Factors influencing consumer behaviour (purchase, use, maintenance, retirement of textile product).
- Factors of sustainability of business models aimed at extending the life cycle of textile products, analysis of the importance and use of marketing tools in the transition to more responsible and sustainable consumption of textile products (from the perspective of consumers and economic operators).

5. Strategic tools

The strategic tools leading to an increase in the internationally competitive quality of research are: human resources development, infrastructure retrofitting, networking and expansion of professional research teams, development of internationalisation and building links with foreign research partners, which will lead to the creation of new results (publications, patents, etc.) and to the submission of joint project proposals focused on strategic areas:

Academic staff

- Seek and train specialists for core research areas. Activate quality human resources from among talented students. Recruit experts from abroad.
- To fill the positions of scientific researchers, academic staff and other professional staff or specialists in a transparent and targeted manner according to the needs of the FT disciplines.
- Raise the qualification level of a decisive part of the staff participating in creative activities and improve its age structure.
- Motivate and support the qualification growth of staff, optimise the number of highly qualified R&D staff. Promote habilitation and professorship procedures.
- Motivate and support academic staff to produce more qualitatively demanding publications.
- Support the involvement of academic staff and students in regional, national activities, multidisciplinary projects, international research teams, etc.
- To create conditions for the inclusion of disadvantaged groups (mothers with children, people with disabilities, etc.) in the work process.

Indoor environment

- Sustainably increase the number of grant projects supported by national or international donors.
- Increased involvement of students and foreign specialists, as well as other universities, in the solution of grants.
- Seek support from industry.

Relevance

- To respond to local, regional, national and international conditions and problems through its research, artistic and other activities.
- Use cooperation with external partners to improve the relevance of R&D processes.
- Search for new research directions, collaborate on analyses, studies, provide consultations, work on joint R&D projects, custom research.
- Continue to participate in clusters and professional associations (ATOK, CLUTEX, CTPT, etc.) as well as in international organizations bringing together companies and institutes with a textile and engineering focus (AUTEX, FEANI, etc.).
- Increase the amount of knowledge usable in theory and practice.
- Develop a strategy for the protection of industrial and intellectual property, transfer of knowledge, experience, know-how and technology. Focus on patent registration and licensing.
- To develop a commercialisation system aimed at putting the results of science and research into practice and protecting intellectual property.
- Through the solution of joint projects of applied research and experimental development,

develop cooperation with the business sector in the preparation and implementation of the role of grant recipients.

Internationalisation

- To develop and strengthen its position as an important partner in the international research area of textile technologies and materials. To cooperate with foreign partners within the "Textile Region" and interdisciplinary links.
- To create conditions for intensive involvement of the Faculty of Science in broader international cooperation in research, development, innovation and other creative activities.
- Promote international cooperation in research and development based on personal contacts of individual academics.
- Involve faculty in international projects and grants. Intensify the preparation of projects.
- To make effective use of short- and long-term mobility of students, academic and non-academic staff.
- Seek funding opportunities for FT specialists at partner universities and foreign FT specialists from external sources.
- Organize international conferences and specialized seminars.

Specific and measurable objectives

- Develop a staff mix with an optimal professional and age structure.
- Improve the quality of publications presenting the results of scientific and research activities, increase their international profile and strengthen their impact in the relevant field.
- Increase the number of working groups actively involved in international cooperation in science and research not only through bilateral cooperation but also through participation in international consortia.
- Increase the volume of licensing agreements with a defined profit of a material or immaterial nature.
- Increase the volume of intellectual property products - utility models, patents, licenses and motivate employees to create them.