Research Activities at the Vilnius Gediminas Technical University

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1 Introduction

Vilnius Gediminas technical university (VILNIUS TECH) is an innovative Lithuanian university that cultivates creative and highly qualified specialists. The university is a leader in the field of technological sciences with modern and labour market-oriented approach to education.

VILNIUS TECH inspires and develops talents: socially responsible, creative, forward-thinking individuals who together bring change to the environment and large university community, working toward social, economic, cultural welfare and technological progress.

VILNIUS TECH's vision for 2030 is to be an international and prestigious European technical university that stands out for the quality of its education and research, as well as its significant impact on individuals, communities, and society.

The value system of VILNIUS TECH's mission and vision is ingrained in the university's DNA and is demonstrated through its promoted activities.

The following values are fostered by the VILNUS TECH community and then shared with our partners:

- Sustainability. For us, this entails adopting a sustainable approach to nature and the environment, laying a foundation for long-lasting economic well-being, establishing and building a forward-thinking, harmonious society. It's about prioritising environmental and social needs over our own and adopting a future-orientated mindset.
- Connectivity. We define this as the synergy among various technologies, subjects, social groups, and problem-solving methods; as well as a continuous drive to collaborate, seek common ground, and contribute to the development of a multi-layered and multicultural society.
- Creativity. We have the courage to experiment, apply non-standard thinking, look for new unique opportunities in any situation, create solutions to overcome the challenges of the present and the future. VILNIUS TECH promotes the culture of technical makers who create for tomorrow.

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- Openness. We are the university without borders, where cooperation and networking with partners around the world, transparency of activities, acceptance of each person's individuality and uniqueness, opportunity to express one's ideas and be heard by others are important. We are open to the world and new experiences.
- Innovation. We persistently search for the best technological solutions that contribute to global progress in this rapidly evolving world.

2 The Research Landscape and Outstanding Research

Scientific research and experimental development projects are conducted across 13 institutes, 3 scientific centers, and 22 research laboratories. Some major facts and numbers:

- 1563 employees work at the university;
- 930 lecturers, scientists and researchers;
- 75% of the academic personnel hold a degree in science;
- Commercial research output of €4,3 million;
- 532 articles published in Clarivate Analytics Web of Science database journals;
- 543 articles for Scopus database publications;
- Doctoral studies are offered in 12 scientific fields.

In line with VILNIUS TECH's 2021–2030 Strategy and its established four moonshots, the university conducts research and innovation activities that support all moonshots, with a focus on empowering two of them: "International center of attraction for talent, business, society" and "Each partner receives a knowledge-based smart solution". The primary direction of the University Research Strategy is to carry out research and experimental development (R&D) activities in priority cross-cutting focus areas and fields:

1. **Sustainable building:**
   - smart building structures,
   - low emissions building materials and technologies,
   - architecture and build environment,
   - BIM and sustainable lifecycle of structures,
   - geodetic technologies;
2. **Environmental and energy technologies:**
   - efficient use of resources and energy,
   - environmental protection technologies,
   - building energetics,
   - renewable energy,
   - change of anthropogenic environment;
3. **Sustainable transport:**
   - autonomous land and air transport,
   - environment-friendly transport,
   - green logistics, international transport corridors,
   - traffic safety technologies,
   - urban mobility;

4. Mechatronics:
- smart embedded systems,
- mechatronics for Industry 4.0 systems,
- metamaterials and nano-structures,
- bionics and biomedicine engineering systems,
- innovative electronic systems;

5. Information and communication technologies:
- information and IT security,
- smart signal processing and telecommunication technologies,
- artificial intelligence and decision-making systems,
- geoinformation technologies,
- virtual and augmented reality;

6. Fundamental research on materials and processes:
- mathematical models of physical, technological and economic processes,
- investigations of cells and their biologically active components,
- economics engineering, management and communication,
- management of the development of contemporary organizations,
- high value-added economy,
- dynamic management,
- communication management in an inclusive and creative society,
- creative industries for digital society development.

The priority cross-cutting focus areas align with the most recent national (Smart Specialization, Lithuania 2030, New Generation Lithuania), European research and innovation strategies (Science Europe; Europe 2030;) and the United Nations Sustainable Development Agenda.

3 From Research to Innovation

The University's vision for 2030 is for VILNIUS TECH to become a prestigious and international European technical University, distinguished by the quality of studies and research, as well as its significant impact on individuals, communities, and society. Main objectives are directly related to scientific excellence in R&D, the European Universities initiative, integration into the European Research Area, empowerment and nurturing of talents for R&D activities and dissemination of knowledge for the application of solutions addressing society's needs.

The main means to achieve R&D goals are:
- Establishing research centers and enabling shared infrastructures that unite research groups from aviation, mechanics, transport, civil and environment engineering, electronics, informatics, management, economics, communication, humanities and other newly emerging priority fields to initiate and implement long-term international research and research-based innovation (Horizon 2020; Horizon Europe).
- Promoting Open Science, multidisciplinary R&D teams, and attracting frontier researchers and academic staff focused on tackling societal challenges.

- Developing and attracting talents to state-of-the-art international doctorate programmes that will provide next generation of researchers capable of conducting research across the European Research Area.
- Harmonizing university-level processes and refining personnel competencies that deal with all aspects supporting R&D project activities – from project idea generation and planning to its initiation, implementation and results dissemination.
- Developing new approaches to better recognise and promote a broader array of research outputs, as well as various career pathways and activities.
- Shaping of the remuneration and evaluation system to encourage influential scientific publications, cross-border R&D collaboration, and participation in the international research and research-based innovation projects.

To achieve the intended strategic goals, VILNIUS TECH community regularly analyses the results of R&D activities, consolidates human resources, and promotes interdisciplinary research activities. All processes for making strategic decisions and prepare strategic documents are defined in the VILNIUS TECH Quality Management System.

In order to reach this heights, VILNIUS TECH faculties, research centres, applied science institutes, and accredited laboratories already provide R&D services, offering innovative solutions, testing mock-ups in laboratories, and debugging prototypes in real-life conditions, in cooperation with fast-growing innovative businesses and young technological companies. It is encouraging to see the activity of all the units, the wide range of applications of their solutions, the orientation towards advanced technologies, and companies that implement them. VILNIUS TECH's strong relationship with Vilnius city as the main testing ground for our experiments and the latest smart solutions works well. We believe it is accurate to say that VILNIUS TECH already connects ambitious scientists, fosters technical creativity and the arts, and addresses societal challenges through the application of advanced technologies.

VILNIUS TECH researchers have developed a software tool to determine the emotional impact of visual content on viewer. The software is unique because it utilises affective computing technology. The viewer is shown visual content (e. g., an advertisement, a film) and a camera captures their facial expressions, while an artificial intelligence-based algorithm recognises the emotions the viewer is experiencing (e. g., sadness, boredom, interest, etc.). Content creators can check whether the viewers' reactions align with their intended outcome and make decisions on editing and improving the content. The software could be used by advertising, film, television and other visual content creators.

VILNIUS TECH scientists have created a unique demonstration structure – a pedestrian bridge using bio-concrete. Only a few experimental programmes worldwide have used bio-concrete for real structures. What makes bio-concrete special is that the bacteria inside it can spontaneously fill cracks in the structure without the need for routine repairs. This can significantly extend the structures life and reduce maintenance costs. Both the materials used in the construction of the bridge and the architecture emphasise the connection with nature.

This summer, graduates of the Antanas Gustaitis Aviation Institute and the founders of the space technology company Astrolight, together with the European Space Agency, carried out successful optical satellite communication tests at the Teide Observatory in Tenerife, Spain. During this test, the laser signal from the satellite was successfully redirected to the detector of the mobile station developed by VILNIUS TECH and Astrolight. Free-space

optical communication systems offer higher security and data throughput than radio communications. A laser satellite communication system is being developed for use in low Earth orbit and, in the future, throughout the Solar System to provide communications for missions to other planets.

VILNIUS TECH researchers have developed a product that allows people with visual impairments to move independently on public transport. The technology, called the Blind and Visually Impaired Information System, enables a blind or visually impaired person to identify the route number of a public transport vehicle that has stopped at a bus stop. The core of the system is the interactivity of a smart device owned by a blind or partially sighted person with the equipment installed in the public transport vehicle. The communication is two-way – the driver is also informed of the presence of a blind or partially sighted person near the vehicle. The prototype product was successfully tested in near real-life conditions with the participation of representatives from public transport entities and the Lithuanian Association of the Blind and Partially Sighted.

The Klaipėda Vaidila Square project, created by the researchers from the Faculty of Architecture at VILNIUS TECH, has been recognised by the international jury as the best landscape architecture project in Lithuania in the "Green Space 2022" competition. The authors of the project aimed to create a contemporary image of the city by preserving the original design of Vaidila Square and to breathe life into the square so that it would be a bustling place for people. While retaining the square's original rectangular structure, the designers added new spaces and activities, such as lounge areas, benches, moving urban furniture, significantly more greenery and trees, a stage, children's playgrounds, a dancing fountain, and a new bicycle path.

In a significant move this year, VILNIUS TECH is launching a joint laboratory facility that brings together the Faculties of Mechanics, Electronics, and Transport Engineering. This initiative aims to centralize and concentrate our capacity for research and experimental development. By consolidating our human resources and infrastructure within this innovative laboratory facility, we seek to foster a more dynamic interaction between academia, research, and innovation.

VILNIUS TECH is not only open to, but also particularly encourages, our ATHENA partners to engage in joint research projects, PhD student internships, and various other collaborative initiatives within these state-of-the-art facilities.

Figure 1. Joint Laboratory Facility for the Faculties of Mechanics, Electronics, and Transport Engineering

4 Involvement of Students

VILNIUS TECH aims to prepare and support the next generations of scientists, as it is a crucial factor in the development of advanced and modern technology and innovations. Nowadays, this goal of VILNIUS TECH is essential, considering the intense global competition for talent and the rapid and inevitable pace of scientific changes.

The university is working towards creating the conditions and meeting the needs for the next generation of researchers to flourish: it fosters early-stage researcher talents with attractive career structures, provides research positions with access to research facilities in laboratories and research centres, promotes careers in the research and academic sectors, and finances international mobility. Furthermore, VILNIUS TECH is creating the conditions at the university level to attract the brightest people to the doctoral programs.

Involving students in the research activities of departments and institutes significantly enhances their practical and theoretical skills and encourages them to pursue a scientific career in the future. VILNIUS TECH departments and institutes ensure their accessibility to students at all levels (bachelor's, master's, and doctoral students). Students have the opportunity to participate in research projects and are involved in research activities as laboratory staff.

Students have been able to take advantage of additional funding for research (Lithuanian Academy of Sciences, Competition of University Students' Research) and internships during the summer or their studies (Research Council of Lithuania, Internships during Summer and Semester).

A new VILNIUS TECH initiative, the "Student Involvement in Research Incentive Competition" (according to the internal competition of VILNIUS TECH Students' Involvement in R&D), was launched in the 2020/2021 academic year to encourage undergraduate students to get involved in research and pursue a career as a scientist. More than 90 research project topics have been offered to students.

VILNIUS TECH participates in both pre- and post-doctoral training programs that provide collaboration not only with experienced supervisors and scientists at VILNIUS TECH to support a student's pathway to becoming an independent researcher but also with an outstanding international scientific community to make science an integral part of a changing culture and policy worldwide.

5 The vision of ATHENA research-based cooperation

Trends in Europe and around the world, such as rapid technological development, digital transformation, the Green Deal, and the Industrial Revolution, are prompting universities to change. Global challenges – including climate change, economic instability, pandemics – pose threats, yet they also provide unique opportunity to pursue cutting-edge technological solutions, motivating swift and effective responses as well as long-term thinking.

VILNIUS TECH is prepared to face these challenges and changes. By building on the values of our community – sustainability, connectedness, creativity, openness, and innovation – we leverage our strengths.