

University of *Ljubljana*
Faculty of *Mechanical Engineering*



Annual Report

2020

University of *Ljubljana*
Faculty of *Mechanical Engineering*



University of Ljubljana
**Faculty of Mechanical
Engineering**

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UNIVERSITY OF LJUBLJANA FACULTY OF MECHANICAL ENGINEERING

FACULTY MANAGEMENT



Dean
Prof. Mitjan Kalin, PhD



Vice Dean for Education, 1st Cycle
Assoc. Prof. Matija Jezeršek, PhD



Vice Dean for Education, 2nd and 3rd Cycles
Prof. Andrej Kitanovski, PhD



Secretary
Tone Češnovar, PhD



Vice Dean for Research and International Relations
Prof. Tomaž Katrašnik, PhD

SUPPORTING SERVICES

Faculty secretariat	Andreja Koban Domitrovič
Student office	Danijela Kotnik, MSc / Nika Vardjan Naglič
Accounts and financial department	Barbara Bergant Kaučič, MSc
Human resource department	Anja Novak
Department of international cooperation, scientific and research work	Tanja Mavrič Rušt, MSc
Department of Economic Affairs and Communications	Katja Pustovrh
Library	Zorka Kešelj
Technical and maintenance department	Vinko Tomc
IT department	Srečko Obradović
Publishing department	Pika Škraba, MSc, Roman Putrih

SCIENCE IS THE SOLUTION

Behind us is a tough year that, for the first time in history, the whole world will remember in the same way. Our lives have completely changed overnight, public life has disappeared. We have been gripped by a global epidemic that has not let until the end of the year. The new situation has changed the way we work, study and spend our free time. We moved from offices and lecture halls to home desks, which brought technical complications and other inconveniences. Mechanical engineers are used to solving many challenges, so we quickly adapted to the new situation. In just a day and a half, we ensured that the online tutorials and lectures at the faculty ran smoothly. Together we tackled the challenges and found many new solutions, possibilities and sometimes even advantages. Even in the first months of the epidemic, we prepared many proposals to combat the new disease, donated computer equipment to a primary school that needed it, made sure that the prescribed measures were followed, and tried to support students who were disadvantaged by the epidemic. We prepared well for the second wave of the epidemic, even as we desperately wished it would not come. We awaited it with a professional and interactive approach to students and a well-organized schedule of colloquia, exams, and thesis defence.

Despite the epidemic and the difficult situation, which required great efforts, our work was carried out intensively in all areas. We finally prepared and approved a new study program of the 1st and 2nd levels, which provides for a higher pedagogical quality, modern study contents and new concepts of study organization. We set up online classrooms, organized workshops for doctoral students and formally confirmed ASIIN accreditation. In the doctoral program, we established a new project method for implementing study commitments besides the traditional examination. We have adjusted the habilitation criteria, as the previous scientific criteria did not follow the outstanding achievements of the staff in the last decade. The concept of promotion, which is based on the results already achieved by staff in higher titles, is modern and stimulating, as it sets objectively achievable goals and has thus aroused great interest among other university faculties. After decades of fragmentation, we have established a single habitation area of "mechanical engineering", which will greatly facilitate administrative channels and increase the transparency of procedures.

Our research and development achievements are particularly noteworthy. For example, in 2020 we again increased the number of researchers, and so recording also the highest ever total number of all staff members at the faculty, namely 396. The promotion of research activities through co-funding of equipment and a thoughtful redistribution of laboratory space in line with actual needs had a positive impact on project work and results. Despite a significant drop in market research due to the pandemic-related cessation of these activities in some companies, we achieved research sales of almost €11 million. This year we published 16 papers with IF above 7, which is 6 more than last year, the total number of more than 130 high quality A' papers is by 50% higher than last year and the citations according to WoS by 20%. It is particularly encouraging that the number of young colleagues up to 35 years of age who meet the recognition requirements for quality publications has increased from 3 or 4 in recent years to an exceptional 15. This indicates an excellent professional quality and research oriented future for the faculty.

Many of our activities in 2020 were long-term and focused on the future. We have put a lot of emphasis on planning the consolidation of smaller labs and designing new research platforms that focus on the needs and trends of modern society, such as the digital and green future. Most important, we have been striving every day for one key activity - new building! We can boast that all administrative and contractual obligations for the design of the new faculty have been completed, but without constructing a new building and new modern equipment, we cannot



Photo: Sadar + Vuga

act as a high-tech support for breakthrough solutions of the Slovenian economy. That is why a new building is currently our most important objective, in which we are investing extraordinary efforts. I must especially emphasize the role of all members of Strategic Council the Faculty and the Chamber of Commerce and Industry of Slovenia, who are constantly actively supporting us and cooperating with us, because they know this is one of the key investments for the Slovenian economy to an even higher level of international competitiveness. I wish that soon we can proudly enter the new building of the Faculty of Mechanical Engineering we as a society deserve and need.





Photo: Sadar + Vuga

Science is not an end in itself, as 2020 showed when science, too often pushed to the background, proved to be the only solution to the health crisis threatening us. However, the role of scientists is far from over, for we will be important in eliminating the consequences of the crisis. I am convinced that, at the Faculty of Mechanical Engineering, we will combine our broad knowledge and experience and contribute to the well-being of the entire society as one carrier of technologically advanced Slovenia.

Prof. Mitjan Kalin, PhD

Dean of the Faculty of Mechanical Engineering,
University of Ljubljana

A handwritten signature in blue ink, appearing to read 'Mitjan Kalin', written in a cursive style.

INTRODUCTION

UNIVERSITY OF LJUBLJANA

University of Ljubljana is the oldest and largest higher education and scientific research institution in Slovenia. University with its rich tradition was founded in 1919. It has approximately 41,000 undergraduate and postgraduate students and employs approximately 6,000 higher education teachers, researchers, assistants and administrative staff in 23 faculties and three arts academies. The central building, all three academies and faculties are located in the centre. Some of the most recent and modern buildings were constructed on the outskirts of Ljubljana, giving the university and its students a ubiquitous presence in the city.

The University of Ljubljana is renowned for its quality social and natural sciences and technical study programmes, structured in accordance with the Bologna Declaration. Our projects keep pace with the latest developments in the areas of arts, sciences and technology at home and abroad.

The University of Ljubljana ranks among the top 3% of universities in the world. It has been ranked among the top 600 universities by the prestigious Academic Ranking of World Universities (ARWU); it is placed 384th in The Center for World University Rankings (CWUR), and listed in the 800-1000 group in the Times Higher Education (THE) ranking.

The University of Ljubljana is the central and largest educational institution in Slovenia. It is also the central and largest research institution in Slovenia with 30 percent of all registered researchers (according to the data from the SICRIS database).

The University takes a central pedagogical position by performing public services in the areas of special social importance which ensure the preservation of the national identity.

The University of Ljubljana has close ties with Slovenian companies and foreign enterprises. Our partners include multinational corporations and the most successful Slovenian companies. As we are fully aware of the importance of knowledge and skills in obtaining our own financial sources, we are increasingly developing our market oriented activities every year.



FACULTY OF MECHANICAL ENGINEERING, UNIVERSITY OF LJUBLJANA

The Faculty of Mechanical Engineering is a member of the University of Ljubljana, and an important educational and research institution with high international standards in the field of mechanical engineering in Slovenia and the wider region of the Central and Southeast Europe. Through the history and with development the faculty overcame the classic understanding of mechanical engineering, since today it offers programmes from numerous specialised engineering fields.



Foundation

Throughout history, technical occupations were well established among the Slovenes, although until the establishment of the University in Ljubljana in 1919, students had to attain their knowledge abroad, mostly in the Austrian universities. After the end of the World War 1, which also meant the end of the Austro-Hungarian rule, the wish to establish our own university, which would include a faculty of technical sciences also came to life. Even before the formal establishment of the University of Ljubljana there were organised lectures for the students of mechanical, electrical and civil engineering. The Faculty of Technical Sciences in Ljubljana was established through the effort by Milan Vidmar, PhD, and it remained in such form until 1957, when the departments of electrical and mechanical engineering were united. In October 1960, under the resolution of the University Board, the Faculty of Mechanical Engineering became an independent member of the University of Ljubljana with study programmes on all three levels. In the beginning it had four chairs – organisational units – where the faculty and assistants performed teaching and scientific work. The faculty was at first housed in the so called old building on Aškerčeva cesta 6; in 1971 it moved into a new building at the same location. Today, the Faculty of Mechanical Engineering of the University of Ljubljana is still located in both buildings.

Today

The Faculty of Mechanical Engineering of the University of Ljubljana is today the largest institution for education and research of mechanical engineering in Slovenia. In-house design and research work, and quality transfer of knowledge to the students and research partners enables a competitive integration into the international environment.

The Faculty of Mechanical Engineering carries out its **educational activities** for all three study cycles in accordance with the Bologna Declaration guidelines. Two first cycle study programmes, the professional and academic programmes, deliver an insight into a wider field of mechanical engineering; the second cycle master's programme is a continuation of the first cycle; the individually tailored third cycle doctoral programme is based on solving problems at the highest scientific level. The educational process in the first and second cycles is carried out in the form of lectures and practicals, where the lectures provide theoretical knowledge, and the laboratories perfect practical skills. The degree, obtained at the Faculty of Mechanical Engineering, is internationally accredited on the European level (ASIIN, ENUA, EUR-ACE), and is equal to other degrees in Europe.

Scientific research work at the Faculty of Mechanical Engineering is carried out in the fields of power and process engineering, design, mechanics and maintenance of machines, production engineering, mechatronics, micromechanic systems and automatisaton. The researchers are involved in national basic and applicative projects, and in numerous international projects, actively working with scientific research centres and the industry. Through cooperation with the industry and other institutions the faculty is contributing toward higher economic growth, and is publishing the results of innovation potentials in international scientific journals. Special attention is also given to the education of young and promising researchers, who decide on the career path in research also because of the tenders from ARRS (Slovenian Research Agency).

CHAIRS AND LABORATORIES AT THE FACULTY OF MECHANICAL ENGINEERING

CHAIR OF SYNERGETICS

Laboratory for Synergetics
[LASIN](#)

1

CHAIR OF MACHINE ELEMENTS AND DEVELOPMENT EVALUATION

Laboratory for Machine
Elements [LASEM](#)

Laboratory for Structure
Evaluation [LAVEK](#)

2

CHAIR OF POWER ENGINEERING

Laboratory for Internal
Combustion Engines and
Electromobility [LICeM](#)

Laboratory for Heat and
Power [LTE](#)

Laboratory for Hydraulic
Machines [LVTS](#)

Laboratory for Pumps,
Compressors and Technical
Acoustics [LEDSTA](#)

3

CHAIR OF CYBERNETICS, MECHATRONIC AND PRODUCTION ENGINEERING

Laboratory for Control and
Manufacturing Systems
[LAKOS](#)

Laboratory for Digital Systems
and Electrical Engineering
[LDSE](#)

Laboratory for Process
Automation [LPA](#)

Laboratory for Manufacturing
Systems and Production
Process Planning [LAPS](#)

Laboratory for Manufacturing
Cybernetics and
Experimentation [MCE](#)

4

CHAIR OF MANUFACTURING TECHNOLOGIES AND SYSTEMS

Laboratory for Forming [LAP](#)

Laboratory for Alternative
Technologies [LAT](#)

Laboratory for Handling,
Assembly and Pneumatics
[LASIM](#)

5

CHAIR OF MATERIALS, SCIENCE AND TECHNOLOGY

Laboratory for heat treatment
and materials testing [LATOP](#)

Laboratory for Welding
[LAVAR](#)

6

CHAIR OF HEATING AND PROCESS ENGINEERING

Laboratory for Measurements
in Process Engineering [LMPS](#)

Laboratory for Heating
Technology [LTT](#)

7

CHAIR OF MECHANICS

Laboratory for Non-Linear
Mechanics [LANEM](#)

Laboratory for Numerical
Modelling and Simulation
[LNMS](#)

Laboratory for Dynamics
of Machines and Structures
[LADISK](#)

8

CHAIR OF MECHANICS OF POLYMERS AND COMPOSITES

Laboratory for Experimental
Mechanics [LEM](#)

9

CHAIR OF OPTODYNAMICS AND LASER APPLICATIONS

Laboratory for photonics and laser systems [FOLAS](#)

Laboratory for laser techniques [LASTEH](#)

10

CHAIR OF TRIBOLOGY AND MAINTENANCE SYSTEMS

Laboratory for tribology and interface nanotechnology [TINT](#)

Laboratory for Fluid Power and Controls [LFT](#)

11

CHAIR OF FLUID DYNAMICS AND THERMODYNAMICS

Laboratory for Fluid Dynamics and Thermodynamics [LFDT](#)

12

CHAIR OF THERMAL AND ENVIRONMENTAL ENGINEERING

Laboratory for Heating, Sanitary, Solar and Air Conditioning Engineering [LOSK](#)

Laboratory for Refrigeration and District Energy [LAHDE](#)

Laboratory for Sustainable Technologies in Buildings [LOTZ](#)

13

CHAIR OF MACHINING TECHNOLOGY MANAGEMENT

Laboratory for Cutting [LABOD](#)

Laboratory of Quality Assurance [LAZAK](#)

14

CHAIR OF ENGINEERING DESIGN AND TRANSPORTATION SYSTEMS

Laboratory for Engineering Design [LECAD](#)

Laboratory for Material Handling and Machine Structures [LASOK](#)

15

CHAIR OF MODELLING IN ENGINEERING SCIENCES AND MEDICINE

Laboratory for Modelling Machine Elements and Structures [LAMEK](#)

16

AVIATION DIVISON

Laboratory for aeronautics [AEROL](#)

17

UNIT FOR SUPPLEMENTARY DIVISION

Mathematics Research Team [RSMAT](#)

Unit for Supplementary Division [EDZ](#)

18

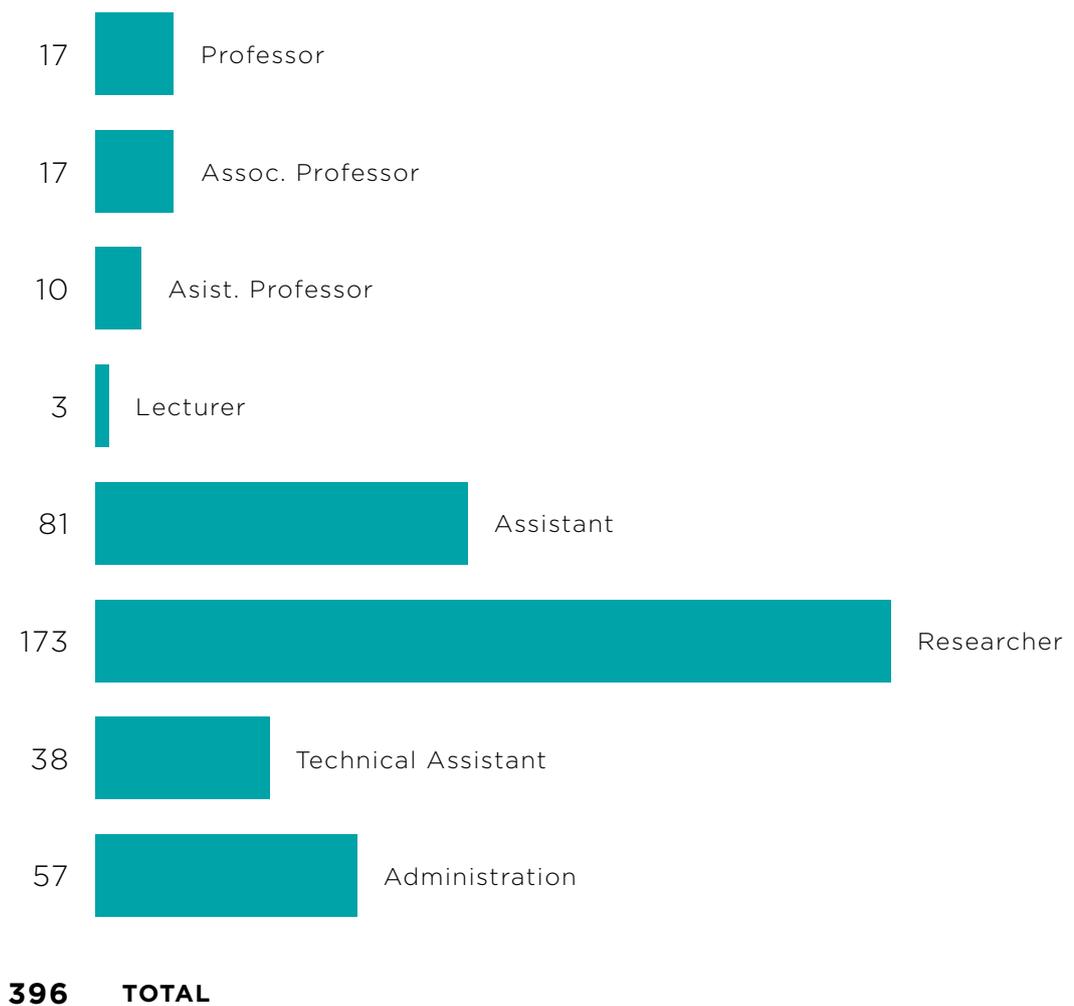
The Faculty of Mechanical Engineering has been broken into units called chairs since the very start of its independent operations. The organisational structure derives from the basic courses, which further spread and evolved into specific areas or subunits called laboratories with the development of research engineering.

In 2020, 37 laboratories and a Unit for Supplementary Division operated within the scope of 16 chairs.

THE FACULTY OF MECHANICAL ENGINEERING IN NUMBERS

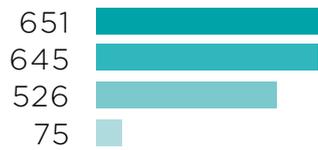
EMPLOYEE STRUCTURE

2020



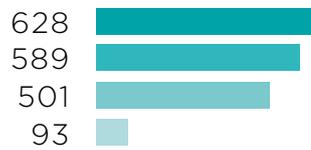
NUMBER OF ENROLLED STUDENTS

2016/17

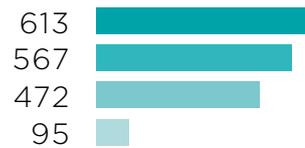


- 1st Cycle - Academic Programme
- 1st Cycle - Professional Programme
- 2nd Cycle - Master Programme
- 3rd Cycle - Doctoral Programme

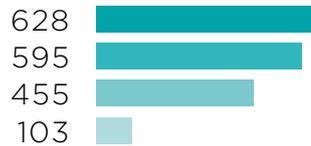
2017/18



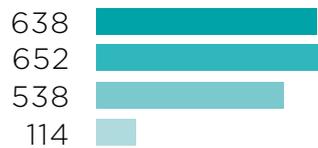
2018/19



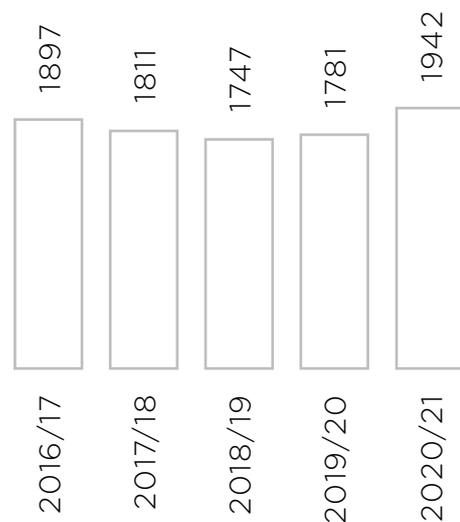
2019/20



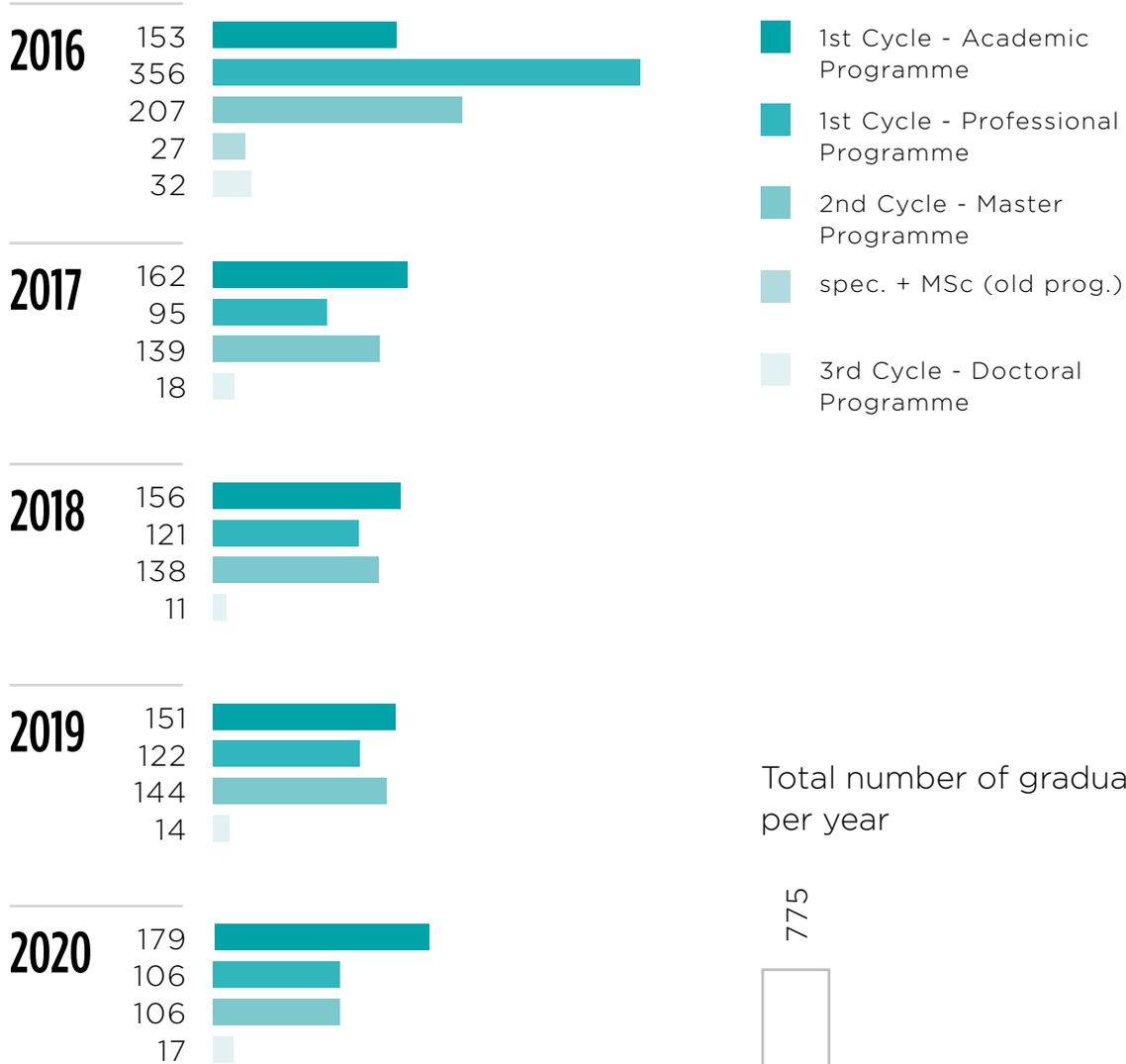
2020/21



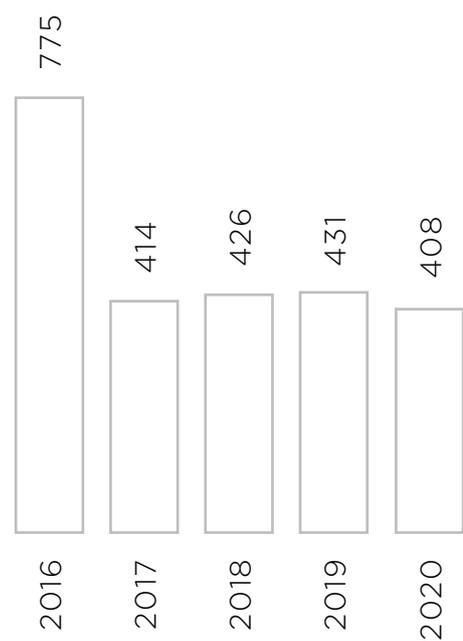
Total number of enrolled students per year



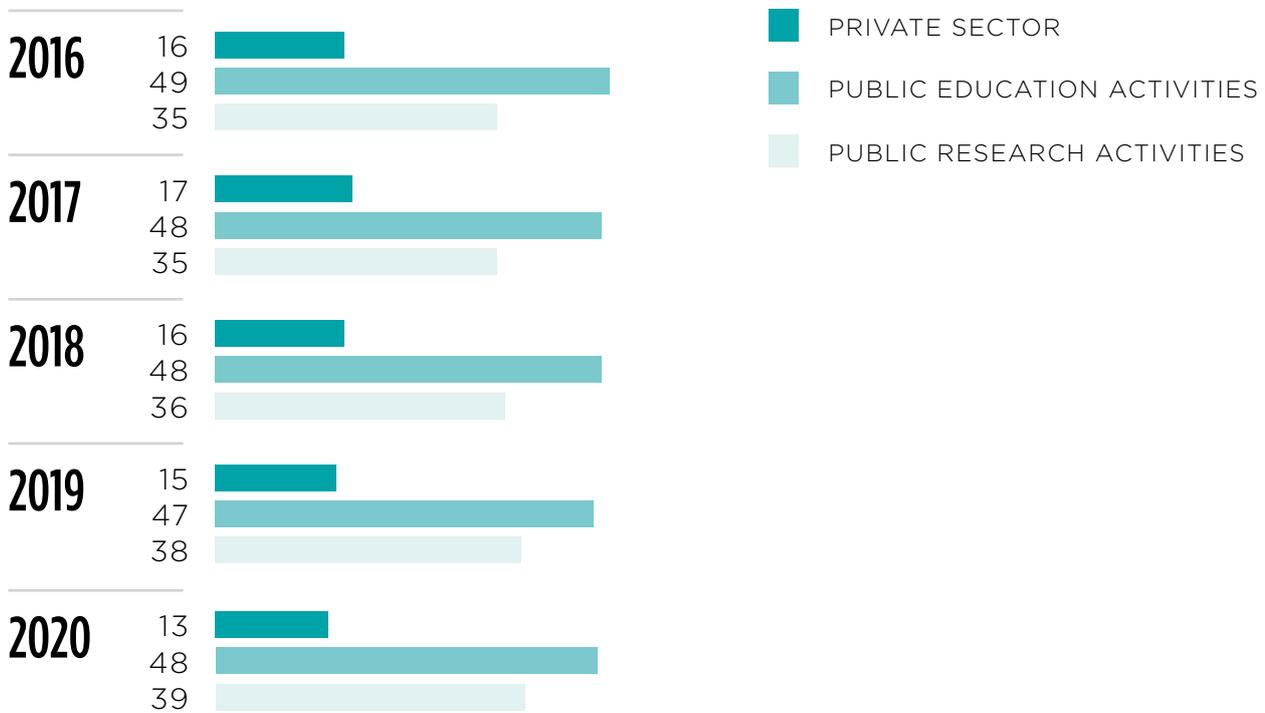
NUMBER OF GRADUATES



Total number of graduates per year



FINANCING STRUCTURE IN %



NUMBER OF INTERNATIONAL RESEARCH PROJECTS

Programm	2016	2017	2018	2019	2020
Horizon 2020	5	7	11	11	12
7. frame programm	2	2	2	2	2
ERDF - European regional development fond	6	7	9	10	4
ERA-NET M-era.Net	0	1	1	1	1
Life+	1	1	1	1	1
Erasmus +	3	5	6	9	8
LLP life long learning programm	3	2	2	2	2
European defence agency (EDA)	0	0	0	1	1
European space agency (ESA)	1	2	1	1	0
Eureka	0	1	1	1	1
EIT - European Institute of Innovation & Technology	0	0	2	2	2
COST	6	8	8	8	7
Other	6	7	5	5	8
Total	33	40	45	50	45

NUMBER OF MARKET-ORIENTED PROJECTS WITH THE INDUSTRY



NUMBER OF ORIGINAL SCIENTIFIC ARTICLE



NUMBER OF PATENTS



PUBLISHING AND JOURNALS

PUBLISHING

The publishing department of the Faculty of Mechanical Engineering is publishing study materials and other non-periodicals. The department is following the rules, set out by the Senate of the faculty, which define the main framework of its activities. The publishing department publishes 25 publications per year with an international standard book number (ISBN) and CIP, the acronym for the cataloguing in publication. The publishing department began using the ISBN system in 1986; since then it published almost 340 works with the ISBN number. These are course books, proceedings of domestic and international conferences, organised by chairs and laboratories of the faculty, printed editions of doctoral works, and scientific monographs. In the recent years the publications are also available in electronic form on CDs and USB sticks; free course books are available at the faculty website and the Repository of the University of Ljubljana.

With the introduction of digital printing technology the process for printing publications is significantly shorter and also much cheaper. Digital printing technology provides quality and relatively low cost printing also for limited editions. Due to this new technology the policy of the publishing department is to sell the entire edition of a textbook in three years; after this it gets reprinted with any possible revisions and updates. The editions for the first year programmes have up to 400 copies; and up to 150 copies for higher year programmes and the second cycle. The publishing department tries to offer the textbooks at an affordable price for students; around €10 for the first year textbooks, and around €15 for higher years. In order for the textbooks to be available at the student friendly prices, the authors usually charge no fees for the first editions. Only after a reprint, when there is no cost of reviews, proofreading, and design, the authors get some compensation.

JOURNALS

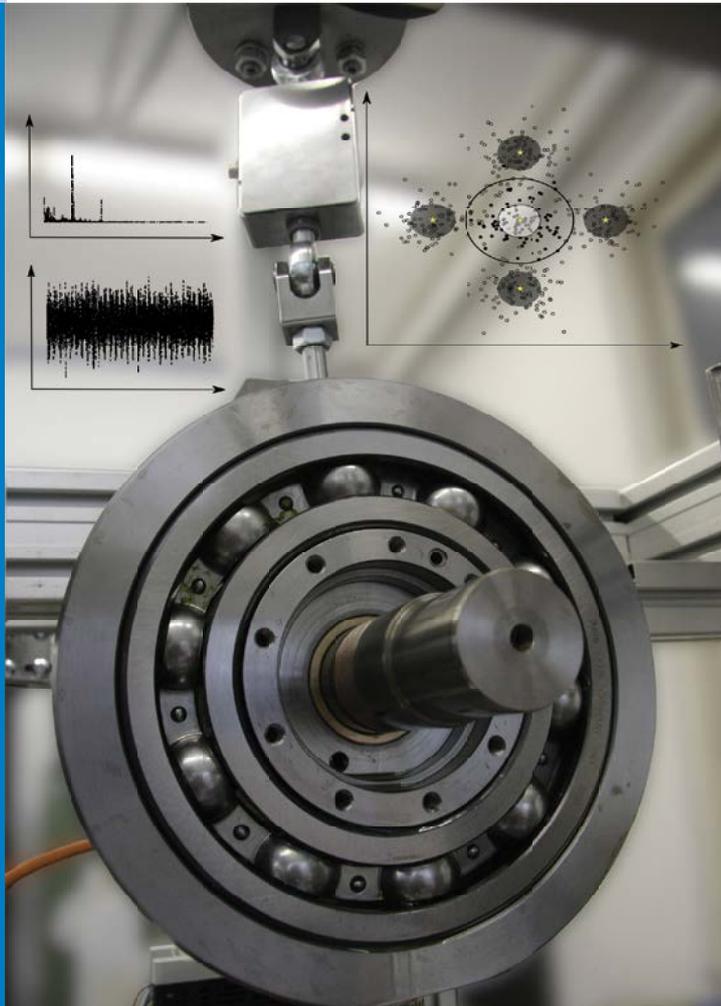
Strojniški vestnik – Journal of Mechanical Engineering

The scientific international journal publishes original and (mini)review articles covering the concepts of materials science, mechanics, kinematics, thermodynamics, energy and environment, mechatronics and robotics, fluid mechanics, tribology, cybernetics, industrial engineering and structural analysis. The journal follows new trends and progress proven practice



Strojniški vestnik

Journal of Mechanical Engineering



no. **4**
year **2020**
volume **66**

in the mechanical engineering and also in the closely related sciences as are electrical, civil and process engineering, medicine, microbiology, ecology, agriculture, transport systems, aviation, and others, thus creating a unique forum for interdisciplinary or multidisciplinary dialogue. The international conferences selected papers are welcome for publishing as a special issue of SV-JME with invited co-editor(s). The Journal is indexed in the WoS Thomson and Scopus databases where it is positioned in the second quarter. The growth of the Journal is evident in the constant increase in the number of citations in WoS.

The SV-JME has been published since 1955; the publishers are the Faculty of Mechanical Engineering of the University of Ljubljana, the Faculty of Mechanical Engineering of the University of Maribor, the Association of Mechanical Engineers of Slovenia, and the Chamber of Commerce and Industry of Slovenia.

The Journal is freely available at <https://www.sv-jme.eu/issues/volume-66-2020/>

Ventil

The scientific and professional journal Ventil publishes articles, dealing with the development and research work at universities, institutes and companies from the field of fluid technics, automatisisation and mechatronics. Its aim is to familiarise with the achievements of Slovene companies, their products, and events, which are connected with the development and production in the relevant fields. It creates new connections between the Slovene industry and the research and development sphere, and among the Slovene and world production, developmental and expert community. It also encourages popularity of fluid technics, automatisisation, and mechatronics, especially among the young people, while it also cultivates the scientific terminology in these fields.

The publishers are the University of Ljubljana, the Faculty of Mechanical Engineering with co-founders GZS-ZKI-FT (Chamber of Commerce and Industry of Slovenia, Chemical Industries Association) and SDFT (Slovene Fluid Technics Association). It has 6 issues per volume in single issues at 1,500 copies each. The technical quality conforms to the international standards, valid in Slovenia. It is also included in the COBBIS, INSPEC and university and library databases (RWTH Aachen – IFAS, TU – Wien, University in Hannover and The British Library). Under its present title Ventil the journal has been published since 1995.

The magazine is freely available at <http://www.revija-ventil.si>.

REVIIJA ZA FLUIDNO TEHNIKO, AVTOMATIZACIJO IN MEHATRONIKO

VENTIL

ISSN 1318 - 7279

Letnik 26 / 2020 / 6 / December

Varjenje
debelostenskih
nerjavnih odkovkov

Testiranje
polimernih zobnikov

Vzdrževanje
hidravličnih naprav

Letalstvo -
Intervju

OPL **rexroth**
A Bosch Company

OPL industrijska avtomatizacija d.o.o.
Dobrave 2, 1236 Trzin, Slovenija
tel.: +386 (0)1 560 22 40
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OMEGA
AIR

STUDY PROGRAMMES

The Faculty of Mechanical Engineering of the University of Ljubljana offers study programmes for all three levels since 1960, which testifies to the strong foundations of its study programmes in Slovenia. Through the years the programmes were adapted to various requirements, changed in accordance with legislation and regulations, and were recently thoroughly renewed in accordance with the Bologna Declaration.



Today, the Faculty of Mechanical Engineering offers the following study programmes:

1ST CYCLE

Professional Study Programme in Mechanical Engineering – Project and Applicative Programme

lasts 3 years and is practice oriented; in the 2nd year it is separated into 5 basic study directions, and in the 3rd year into sub-directions. The graduates acquire the degree of Bachelor of Applied Science in Mechanical Engineering (graduate’s professional degree).

1 st year	2 nd year – directions	3 rd year – sub-directions
Common curriculum	Power, Process and Environmental Engineering - EPO	Power Engineering, Household and Sanitary technology, Process Engineering
	Engineering Design, Machine Operation and Maintenance - SOV	Material Handling and Self-propelled Machines, Vehicle Engineering, Maintenance Management
	Production Engineering - PRS	Production Technologies, Production Management, Welding Technologies
	Mechatronics - MEH	Mechatronics
	Aviation - LET	Airplane pilot/Helicopter pilot, Aircraft Design and Maintenance

Academic Study Programme in Mechanical Engineering – Research and Development Program

lasts 3 years and has no directions. Students acquire theoretical knowledge for continuation of the studies in the 2nd Cycle. Graduates acquire the degree of Bachelor of Science in Mechanical Engineering.

2ND CYCLE

Master's Study Programme in Mechanical Engineering – Development Research Program last 2 years and is divided into 4 basic and 7 interdisciplinary directions. Graduates acquire the degree of Master of Engineering.

Basic directions	Interdisciplinary directions
Machine Design and Mechanics: Mechanics of Materials, Systems and Processes, Engineering Design and Product Development	Traffic Safety Systems, Engineering rheology, Environmental Engineering, Welding, Terotechnology, Engineering pedagogy, Engineering Safety
Power and Process Engineering: Thermal and Process Engineering, Power Engineering	
Production Engineering: Production Technologies and Systems Industrial Engineering	
Mechatronics and Laser Technology	

TRIBOS – Joint Master's Programme in Tribology of Surfaces and Interfaces lasts 2 years and is carried out by four partner European universities. Graduates acquire the degree of Master of Tribology of Surfaces and Interfaces.

3RD CYCLE

Doctoral Study Programme in Mechanical Engineering lasts 4 years and is divided into three basic fields of study. Graduates acquire the degree of Doctor of Science.

Fields

Machine Design and Mechanics Engineering Science
Power and Process Engineering Science
Production Engineering Sciences, Cybernetics and Mechatronics

Interdisciplinary Doctoral Programme in Environmental Protection (coordinated at the level of the University of Ljubljana) lasts 4 years and combines the scientific fields of 13 faculties. Graduates acquire the degree of Doctor of Science.

Interdisciplinary Doctoral Study Programme Biosciences lasts 4 years and is carried out by four members of the University of Ljubljana. Graduates acquire the degree of Doctor of Science.

RESEARCH

The Faculty of Mechanical Engineering of the University of Ljubljana is carrying out its social agenda in the scientific research and applicative developmental fields in order to provide high level of excellence, and to transfer new research findings into the industrial environment.

Research and development activities at the Faculty of Mechanical Engineering include:

- Power and process engineering,
- Design,
- Engine mechanics and maintenance,
- Production engineering,
- Mechatronics,
- Micromechanical systems,
- Automatisations.

The research activities are carried out within the laboratories. The faculty is closely linked with institutes, domestic and foreign companies, and with other organisations from the field of medicine, electrical engineering, chemistry, informational technology and civil engineering. It is venturing outside the boundaries of classic research engineering, since it is reaching into new research fields, which bring higher added value to the society.

Research work is the basis for modern and quality teaching

Our researchers strongly believe that research work is the basis for progressive and quality teaching, therefore taking part in national basic and applicative projects and international projects is a regular practice at the faculty.

Development of young and promising researchers

The faculty pays special attention to the education and development of young and promising students, who are deciding on the career in research through the programme of the Slovenian Research Agency.

The Infrastructure centre for modern engineering

Within the Network of infrastructure centres of the University of Ljubljana (MRIC UL) the faculty has the Infrastructure centre for modern engineering, which offers quality operations, infrastructural support, know-how and cooperation between research groups within research institutions, the Slovene industry and the wider international arena. The Centre uses high-end equipment, which requires highly qualified and specialised staff for its operation and maintenance. The Centre is divided into four sub-units:

- Centre for macromechanical assessments of materials and structures
- Centre for video-diagnostic analysis in process engineering
- Centre for surface diagnostics and lubricants in machine structures
- Centre for informational technologies and support

Highly trained staff, wide networks of researchers and interdisciplinary approach make the Faculty of Mechanical Engineering the largest scientific research institution in mechanical engineering in Slovenia.

Program groups

Within the Slovene Research Agency there are programme groups, which represent research fields established for a longer time period, and are important for Slovenia. The researchers from the Faculty of Mechanical Engineering are involved in the following 14 programme groups:

1. Synergetics of complex systems and processes
2. Mechanics in Engineering
3. Sustainable Polymer Materials and Technologies
4. Engineering design
5. Tribology
6. Development evaluation
7. Modelling in technics and medicine
8. Production systems, laser technologies and materials welding - PLAS
9. Innovative production systems and processes
10. Advanced Manufacturing Technologies for High Quality and Sustainable Production
11. Energy Engineering
12. Heat and Mass Transfer
13. Transient two-phase flows
14. Optodynamics

PRESENTATION OF PROGRAMME GROUPS AND ACTIVITIES OF LABORATORIES



01

MODELLING IN TECHNICS AND MEDICINE

The Modelling in Engineering Sciences and Medicine programme group is based on an interdisciplinary approach and consists of researchers from the Faculty of Mechanical Engineering and the Faculty of Medicine (both University of Ljubljana).

The group's main research activity is modelling of systems related to traffic which involve modelling of mechanical and anatomical structures for investigating systems response to different kinds of excitation. Integrated into commercial software packages and expandable, these developed material and mechanical models are used for predicting the initiation and growth behaviour of damage to metallic and non-metallic materials at diverse monotonic and dynamic loads.

This enables modelling of various types of mechanical and biomechanical systems (human body, vehicles, traffic devices). The group also investigates and updates data and their relationships in traffic databases and develops geoinformation systems designed to determine exposure to traffic accident risk on specific sections of the road network.



Laboratory for Modelling Machine Elements and Structures **LAMEK**

RESEARCH AREAS

Mechanical engineering • Special constructions know-how • Large size bearings • Rolling rotational connections • Combustion processes in internal combustion engines • Vehicles • Traffic accidents

- Machine design • Mechanics of structures and machines • Geometric dimensioning and tolerancing • Expert systems • Tolerance analysis
- Transportation research • Biomechanics • Vehicle engineering
- Measurement in traffic • Traffic accident analysis

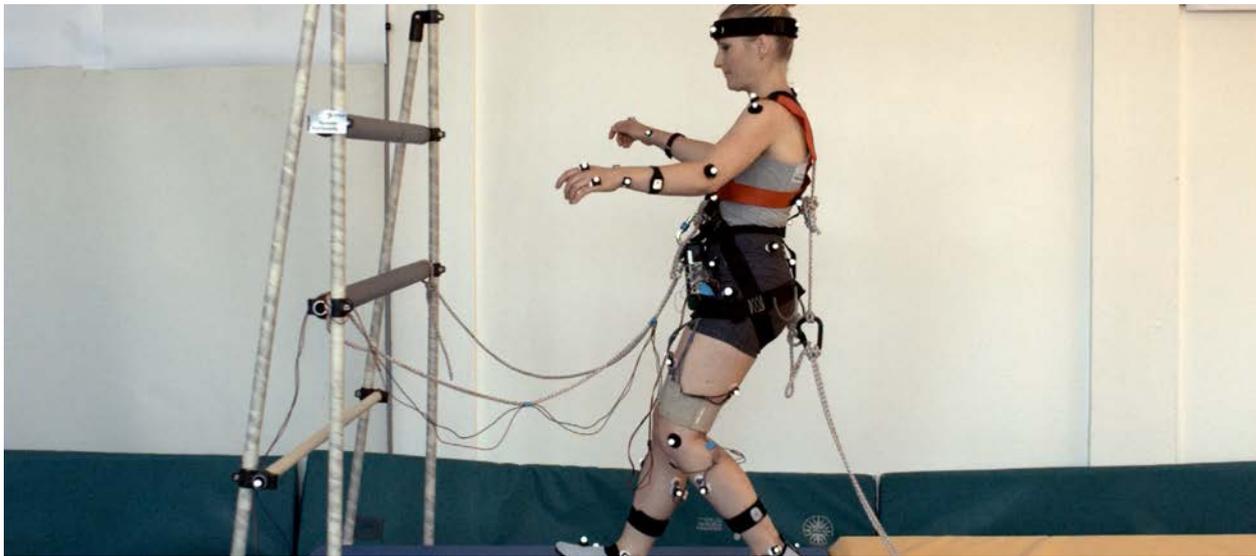
DEPARTMENT HEAD Assist. Prof. Samo Zupan, PhD

DEPARTMENT MEMBERS Assoc. Prof. Robert Kunc, PhD, Assist. Prof. Jovan Trajkovski, PhD, Assist. Prof. Andrej Žerovnik, PhD, Assist. Ana Trajkovski, PhD, Asist. Matej Kranjec, PhD, Assist. Aleksander Novak, Assist. prof. Miha Ambrož, PhD; Assist. Simon Krašna, PhD, Slobodanka Ivanjić Kostrešević, Jernej Korinšek, Luka Roblek, Silva Brenčič

ORIGINAL SCIENTIFIC ARTICLE

TRAJKOVSKI, Ana, HRIBERNIK, Marija, KUNC, Robert, KRANJEC, Matej, KRAŠNA, Simon. Analysis of the mechanical response of damaged human cervical spine ligaments. *Clinical biomechanics*, 2020, vol. 75, p. 1-9.

KRANJEC, Matej, TRAJKOVSKI, Ana, KRAŠNA, Simon, HRIBERNIK, Marija, KUNC, Robert. Material properties of human patellar-ligament grafts from the elderly population. *Journal of the mechanical behavior of biomedical materials*, 2020, vol. 110, p. 1-9.



KRAŠNA, Simon, DJORDJEVIĆ, Srdjan. Estimating the effects of awareness on neck-muscle loading in frontal impacts with EMG and MC sensors. *Sensors*, 2020, vol. 20, no. 14, p. 1-15.

KRANJEC, Matej, KORINŠEK, Jernej, AMBROŽ, Miha, KUNC, Robert. Control system for a tensile-testing device using low-cost hardware and open-source software. *Strojniški vestnik*, 2020, vol. 66, no. 3, p. 155-163.

AMBROŽ, Miha, TRAJKOVSKI, Jovan, KUNC, Robert. Decelerations of passenger vehicles on gravel arrester beds. *Sustainability*, 2020, vol. 12, no. 5, p. 1-13.

BIČEK, Matej, CONNES, Raphaël, OMERVIĆ, Senad, GÜNDÜZ, Aydin, KUNC, Robert, ZUPAN, Samo. The bearing stiffness effect on in-wheel motors. *Sustainability*, 2020, vol. 12, no. 10, p. 1-18.

DOCTORAL DISSERTATIONS

KRANJEC, Matej. Biomechanical model of the human knee at active loading. Mentor Robert Kunc, co-mentor Jože Balažic.

BLAŽ, Janez. System for the management and control of public transport. Mentor Miha Ambrož.

PROJECTS

Company DARS - Testing the deceleration of a passenger car. Robert Kunc. 3.7.2019 – 3.7.2020

EDA - Hybrid Drive Trains. Samo Zupan. 13.12.2019 – 23.1.2021

Horizon 2020 - VIRTUAL - Open access virtual testing protocols for enhanced road users safety. Simon Krašna. 01.06.2018 – 31.05.2022

Company SMM – Research work. Robert Kunc. Ongoing since 1.1.2016

Development of transitions and terminals of road safety barriers. Robert Kunc. September 2019 – September 2020

PATENTS

ŽEROVNIK, Andrej, TUŠEK, Jaka. Hybrid thermal apparatus = Hybride thermische Vorrichtung = Appareil thermique hybride : European patent specification EP 3 542 108 B1, 2020-11-04. Munich: European Patent Office, 2020.

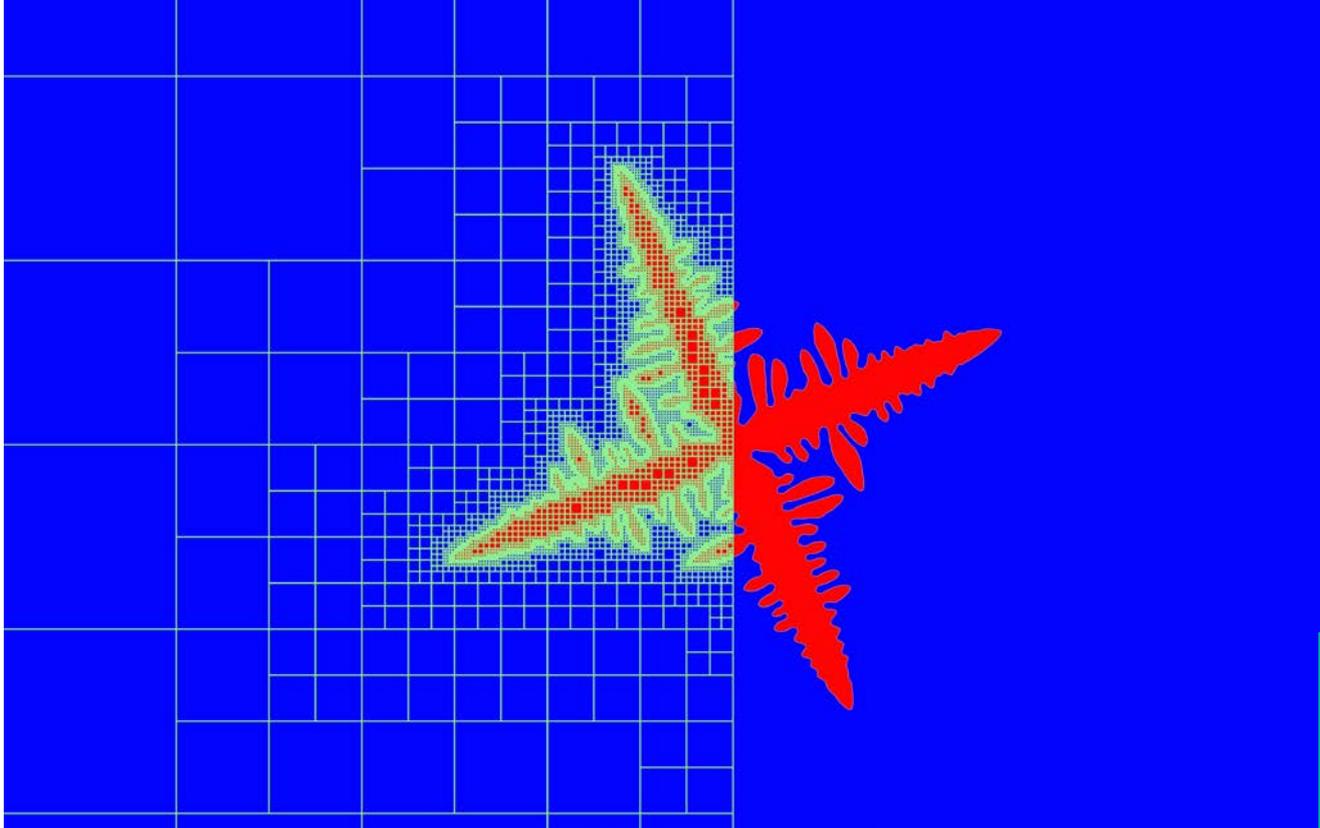
Andrej Voje, Robert Kunc: Podvodni skuter za potapljače. Patent št. 25691. Št. Prijave: P-201800177. Razvrstitev po mednarodni klasifikaciji patentov: B63C 11/00.

02

TRANSIENT TWO-PHASE FLOWS

Key long-term research activities of the programme group Transient two-phase flows are focussed on the following areas:

1. Two-phase flows (gas-liquid, solid-gas) where we want to include also more complex systems with different types of boundaries, moving surfaces (such as stirred vessels, trickle bed reactors and fluidization of solid particles in Wurster chamber) which are frequently used in industry.
2. Investigation of unsteady friction effects on the magnitude and timing of pressure pulses during column separation events in industrial applications.
3. Medical modelling and simulation in fluid-structure interaction studies, for example, for analysing partial upper airway collapse or air stream coupling with soft tissue vibration. The only reasonable methodology leading to a successful scientific development involves a coherent and tight integration of theory, modelling and simulation (TMS) with experiment (E) and the data obtained.
4. Validation of CFD codes where the specific problems are going to be chosen in searching for generic principles of complex fluid dynamics simulation with the aim to range commercial codes of applicability to selected industrial problems.



Laboratory for Fluid Dynamics and Thermodynamics **LFD**T

RESEARCH AREAS

Two-phase flow • Microfluidics • Solidification • Meshless methods
Multiscale and multiphysics • Modelling of materials and processes
• Intelligent systems

DEPARTMENT HEAD Prof. Božidar Šarler, PhD

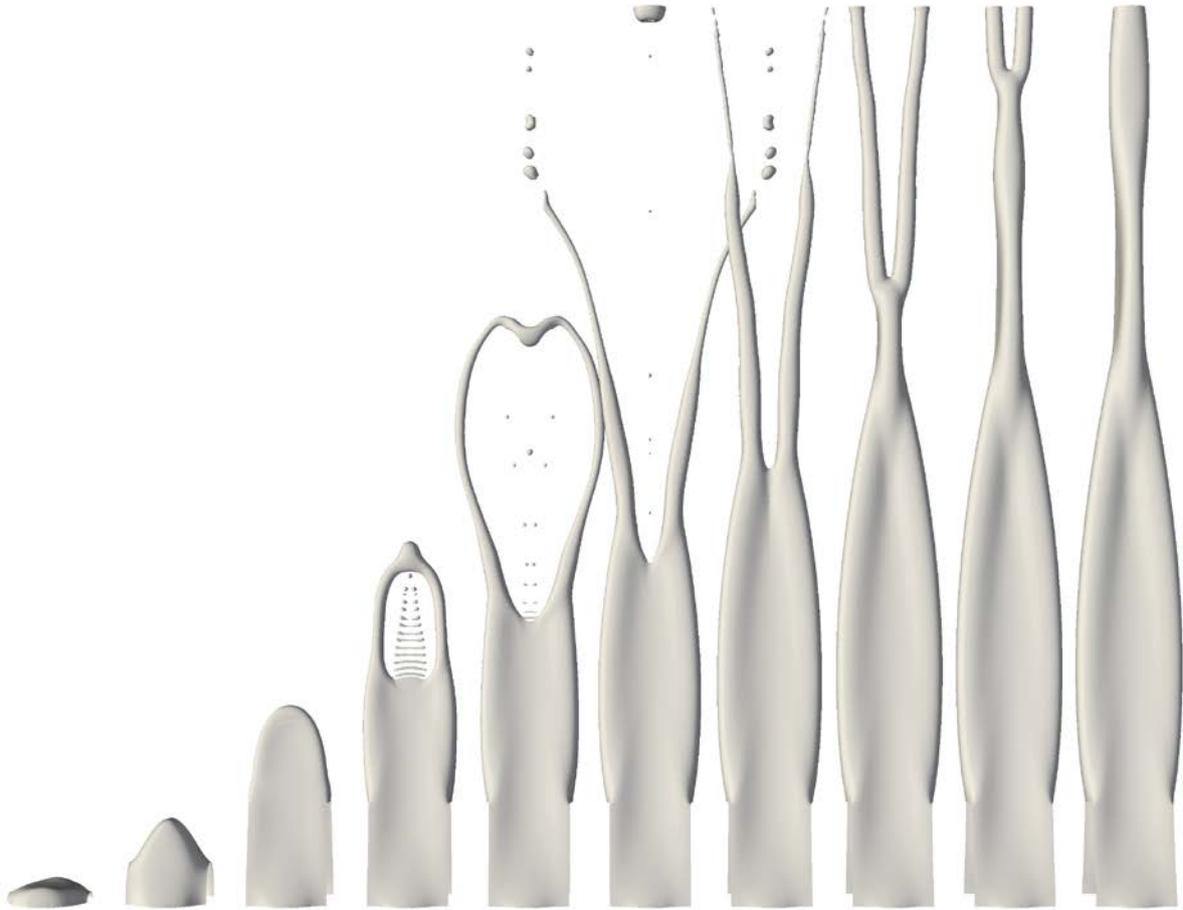
DEPARTMENT MEMBERS Assist. Prof. Anton Bergant, PhD, Assist. Prof. Andrej Bombač, PhD, Assist. Prof. Matjaž Perpar, PhD, Assist. Boštjan Mavrič, PhD, Assist. Jurij Gregorc, PhD, Assist. Zahoor Rizwan, PhD, Assist. Vanja Hatić, PhD, Res. Assoc. Zlatko Rek, PhD, Assist. Umut Hanoglu, PhD, Assist. Katarina Mramor, PhD, Miha Kovačič, PhD, Robert Vertnik, PhD, Assist. Qingguo Liu, PhD, Belšak Grega, Matic Cotič, Rana Khush Bakhat, Assist. Gašper Vuga, Assist. Ajda Kunavar, Assist. Tadej Dobravec, Zdenka Rupič

ORIGINAL SCIENTIFIC ARTICLE

DOBRAVEC, Tadej, MAVRIČ, Boštjan, ŠARLER, Božidar. Reduction of discretisation-induced anisotropy in the phase-field modelling of dendritic growth by meshless approach. *Computational materials science*, 2020, vol. 172, p. 1-12.

PERPAR, Matjaž, REK, Zlatko. Soil temperature gradient as a useful tool for small water leakage detection from district heating pipes in buried channels. *Energy*, 2020, vol. 201, p. 1-13.

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KOVAČIČ, Miha, ŽUPERL, Uroš. Genetic programming in the steelmaking industry. *Genetic programming and evolvable machines*, 2020, vol. 21, p. 99-128.

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KOVAČIČ, Tine, KOVAČIČ, Miha, OVSENIK, Rok, ZURC, Joca. The impact of multicomponent programmes on balance and fall reduction in adults with intellectual disabilities: a randomised trial. *Journal of intellectual disability research*, 2020, vol. 64, part 5, p. 381-394.

ŽUPERL, Uroš, IRGOLIČ, Tomaž, KOVAČIČ, Miha. Minimum depth of milling to obtain the desired surface roughness in multi-layer materials = Minimalna globina frezanja za doseg želeno hrapavosti površine pri večslojnih materialih. *Materiali in tehnologije*, 2020, vol. 54, no. 6, p. 747-753.

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STEINER PETROVIČ, Darja, MANDRINO, Djordje, ŠARLER, Božidar, HORKY, Jelena, OJDANIC, Andrea, ZEHETBAUER, Michael J., ORLOV, Dmytro. Surface analysis of biodegradable Mg-alloys after immersion in simulated body fluid. *Materials*, 2020, vol. 13, no. 7, p. 1-13.

ZAHOOR, Rizwan, REGVAR, Rok, BAJT, Saša, ŠARLER, Božidar. A numerical study on the influence of liquid properties on gas-focused micro-jets. *Progress in computational fluid dynamics*, 2020, vol. 20, no. 2, p. 71-83.

URBANOWICZ, Kamil, DUAN, Huan-Feng, BERGANT, Anton. Transient flow of liquid in plastic pipes. *Strojniški vestnik*, 2020, vol. 66, no. 2, p. 77-90.

KOVAČIČ, Miha, ĐUKIĆ, Goran, GAJŠEK, Brigita, STOPAR, Klemen. CAD based electric transporter path planning and production storage optimization using genetic algorithm - industrial case study. *Tehnički glasnik*, 2020, vol. 14, no. 2, p. 174-179.

PROJECTS

Slovenian Research Agency - Multiphysics and multiscale numerical modelling for competitive continuous casting. Božidar Šarler. 1.7.2018 - 30.6.2021

Slovenian Research Agency. Modelling of trapped air pockets in hydraulic piping systems. Anton Bergant. 1.7.2019 - 30.6.2022

Slovenian Research Agency. Advanced meshless modelling and simulation of multiphase systems. Božidar Šarler 1.7.2019 - 30.6.2022

Slovenian Research Agency. Modelling for thermal control of Plasma Facing Components (PFCs) in fusion reactors 1.3.2020 - 28.2.2022

Slovenian Research Agency. Simulation of hot rolling for topmost steel grades. Umut Hanoglu. 1.9.2020 - 31.8.2023

Company DESY - Innovative methods for imaging with the use of x-ray Free Electron Laser and synchrotron sources. Božidar Šarler. 13.4.2018 - 12.4.2022

SALIHU, Shpetim, KOVAČIČ, Miha, ŽUPERL, Uroš. Investigation and modeling of cutting tool temperature in turning of inconel 625 steel by using taguchi method and long short term memory network. *Proceedings in manufacturing systems*. [Print ed.]. 2020, vol. 15, iss.2, p. 59-64.

PERPAR, Matjaž, REK, Zlatko. Soil temperature gradient as a useful tool for small water leakage detection from district heating pipes in buried channels. *Energy*. 2020, vol. 201, p. 1-13.

03

ENERGY ENGINEERING

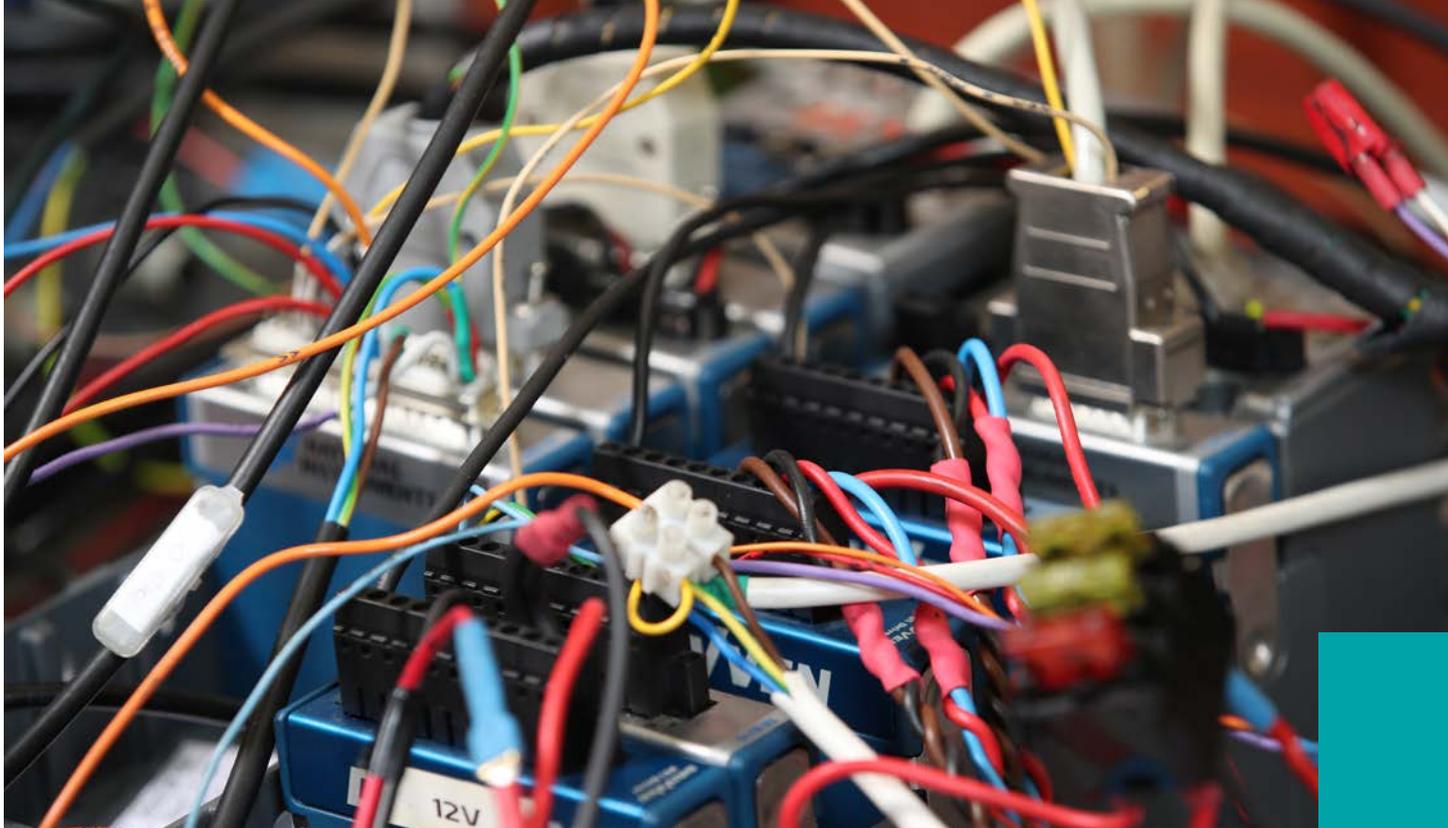
The Energy Engineering research programme is engaged in a wide range of activities:

In the field of internal combustion engines we research advanced designs of engine control and scavenging optimisation. We take part in designing future hybrid, electric and conventional powertrain systems.

In the field of fuel cells and batteries we have been developing next-generation electrochemical models containing nanomaterials.

To achieve high efficiency, durability, economic and environmental sustainability of the use of alternative fuels for, among other things, the research into stationary energy systems, we optimise the performance of systems for cogeneration of heat and electricity.

The research work in the field of turbine machines is concerned with the development of high efficiency and low noise systems. We develop cavitation erosion models. We also study the biological effects of cavitation for medical use and for wastewater treatment.



Laboratory for Internal Combustion Engines and Electromobility LICeM

RESEARCH AREAS

Internal combustion engines • Alternative fuels • Exhaust emission
• Hybrid powertrain systems • Electric vehicles • Fuel cells • Batteries
• Numerical modelling of systems and components

DEPARTMENT HEAD Prof. Tomaž Katrašnik, PhD

DEPARTMENT MEMBERS Assist. Prof. Tine Seljak, PhD, Assist. Ambrož Kregar, PhD, Assist. Samuel Rodman Oprešnik, PhD, Assist. Gregor Tavčar, PhD, Assist. Rok Vihar, PhD, Assist. Anton Žnidarčič, PhD, Chowdhury Haque Amer Amor, PhD, Assist. Klemen Zelič PhD, Assist. Urban Žvar Baškovič, Igor Mele, Andraž Kravos, Ivo Pačnik, Davor Rašić, Assist. Žiga Rosec, Tibaut Tilen, Darja Jeločnik

ORIGINAL SCIENTIFIC ARTICLE

KREGAR, Ambrož, TAVČAR, Gregor, KRAVOS, Andraž, KATRAŠNIK, Tomaž. Predictive system-level modeling framework for transient operation and cathode platinum degradation of high temperature proton exchange membrane fuel cells. *Applied energy*, 2020, vol. 263, p. 1-17.

KRAVOS, Andraž, KREGAR, Ambrož, KATRAŠNIK, Tomaž. Hybrid methodology for efficient on the fly (re)parametrization of proton exchange membrane fuel cells electrochemical model for diagnostics and control applications. *ECS transactions*, 2020, vol. 98, no. 9, p. 13-24.

KREGAR, Ambrož, FRÜHWIRT, Philipp, RITZBERGER, Daniel, JAKUBEK, Stefan, KATRAŠNIK, Tomaž, GESCHEIDT, Georg. Sensitivity based order reduction of a chemical membrane degradation model for low-temperature proton exchange membrane fuel cells. *Energies*, 2020, vol. 13, no. 21, p. 1-16.



ROSEC, Žiga, DIAS, Véronique, CONTINO, Francesco, KATRAŠNIK, Tomaž, SELJAK, Tine. Comparative analysis of bio-intermediates and waste-derived fuels in experimental gas turbine. *Frontiers in mechanical engineering*, 2020, vol. 6, p. 1-14.

TAVČAR, Gregor, KATRAŠNIK, Tomaž. A real time capable quasi 3D system level model of PEM fuel cells. *Fuel cells*, 2020, vol. 20, no. 1, p. 17-32.

KREGAR, Ambrož, KRAVOS, Andraž, KATRAŠNIK, Tomaž. Methodology for evaluation of contributions of Ostwald ripening and particle agglomeration to growth of catalyst particles in PEM fuel cells. *Fuel cells*, 2020, vol. 20, no. 4, p. 487-498.

KRAVOS, Andraž, SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KATRAŠNIK, Tomaž. Operational stability of a spark ignition engine fuelled by low H₂ content synthesis gas: thermodynamic analysis of combustion and pollutants formation. *Fuel*, 2020, vol. 261, p. 1-23.

DIMITRIADIS, Athanasios, SELJAK, Tine, VIHAR, Rok, ŽVAR BAŠKOVIČ, Urban, DIMARATOS, Athanasios, BEZERGIANNI, Stella, SAMARAS, Zissis, KATRAŠNIK, Tomaž. Improving PM-NO_x trade-off with paraffinic fuels. *Fuel*, 2020, vol. 265, p. 1-20.

ROSEC, Žiga, ŽVAR BAŠKOVIČ, Urban, KATRAŠNIK, Tomaž, SELJAK, Tine. Exhaust gas recirculation with highly oxygenated fuels in gas turbines. *Fuel*, 2020, vol. 278, p. 1-12.

ŽNIDARČIČ, Anton, SELJAK, Tine, KATRAŠNIK, Tomaž. Surrogate model for improved simulations of small-scale sludge incineration plants. *Fuel*, 2020, vol. 280, p. 1-15.

KRAVOS, Andraž, RITZBERGER, Daniel, TAVČAR, Gregor, HAMETNER, Christoph, JAKUBEK, Stefan, KATRAŠNIK, Tomaž. Thermodynamically consistent reduced dimensionality electrochemical model for proton exchange membrane fuel cell performance modelling and control. *Journal of power sources*, 2020, vol. 454, p. 1-16.

MELE, Igor, PAČNIK, Ivo, ZELIČ, Klemen, MOŠKON, Jože, KATRAŠNIK, Tomaž. Advanced porous electrode modelling framework based on more consistent virtual representation of the electrode topology. *Journal of the Electrochemical Society*, 2020, vol. 167, no. 6, p. 1-18.

MASELJ, Nik, GATALO, Matija, RUIZ-ZEPEDA, Francisco, KREGAR, Ambrož, JOVANOVIČ, Primož, HODNIK, Nejc, GABERŠČEK, Miran. The importance of temperature and potential window in stability evaluation of supported Pt-based oxygen reduction reaction electrocatalysts in thin film rotating disc electrode setup. *Journal of the Electrochemical Society*, 2020, vol. 167, no. 11, p. 1-8.

KREGAR, Ambrož, RAMŠAK, Anton. Rashba-controlled two-electron spin-charge qubits as building blocks of a quantum computer. *Modern physics letters B*, 2020, vol. 34, no. 19/20, p. 1-11.

KREGAR, Ambrož, RAMŠAK, Anton. Qubit transformations on Rashba ring with periodic potential. *New journal of physics*, 2020, vol. 22, p. 1-15.

FRÜHWIRT, Philipp, KREGAR, Ambrož, TÖRRING, Jens T., KATRAŠNIK, Tomaž, GESCHEIDT, Georg. Holistic approach to chemical degradation of Nafion membranes in fuel cells: modelling and predictions. *PCCP. Physical chemistry chemical physics: a journal of European chemical societies*, 2020, vol. 22, p. 5647-5666.

PATENTS

PERNE, Teos, SELJAK, Tine, ŠETINC, Marko. Naprava za uplinjanje trdnih materialov z vsebnostjo ogljika, s poudarjeno koncentracijo katranov in njihovo katalitsko pretvorbo v ogljikov monoksid in vodik: patent SI 25771 A, 2020-07-31. Ljubljana: Urad republike Slovenije za intelektualno lastnino, 2020.

PERNE, Teos, SELJAK, Tine, ŠETINC, Marko. Postopek uplinjanja trdnih materialov z vsebnostjo ogljika, s poudarjeno koncentracijo katranov in njihovo katalitsko pretvorbo v ogljikov monoksid in vodik: patent SI 25770 A, 2020-07-31. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2020.

PROJECTS

Company AVL List – Research of Liion Battery. Tomaž Katrašnik - 1.1.2020 - 31.12.2020.

Company KPMG – Research. Tomaž Katrašnik - 26.2.2020

COMET K2 Funding Program - K2 Digital Mobility - Context-Embedded Vehicle Technologies. Tomaž Katrašnik. 01.01.2018 – 31.12.2021

ERDF (Smart Specialization) MOZTART - More efficient electric motors with the development of an EXPERT system and new technologies. Tomaž Katrašnik. 1.10.2018 – 30.9.2021

ERDF (Smart Specialization) - NMP - Exploring biomass potential for development of advanced materials and bio-based products. Tomaž Katrašnik. 01.09.2016 – 30.06.2020

FFG (Austria) - CD Labor - CD Laboratory for Innovative Control and Monitoring of Automotive Powertrain Systems. Tomaž Katrašnik. 01.06.2018 – 31.01.2024

Horizon 2020 – OBELICS - Optimization of scalaBle rEaltime modeLs and functlonal testing for e-drive Concepts. Tomaž Katrašnik. 01.10.2017 – 30.09.2020

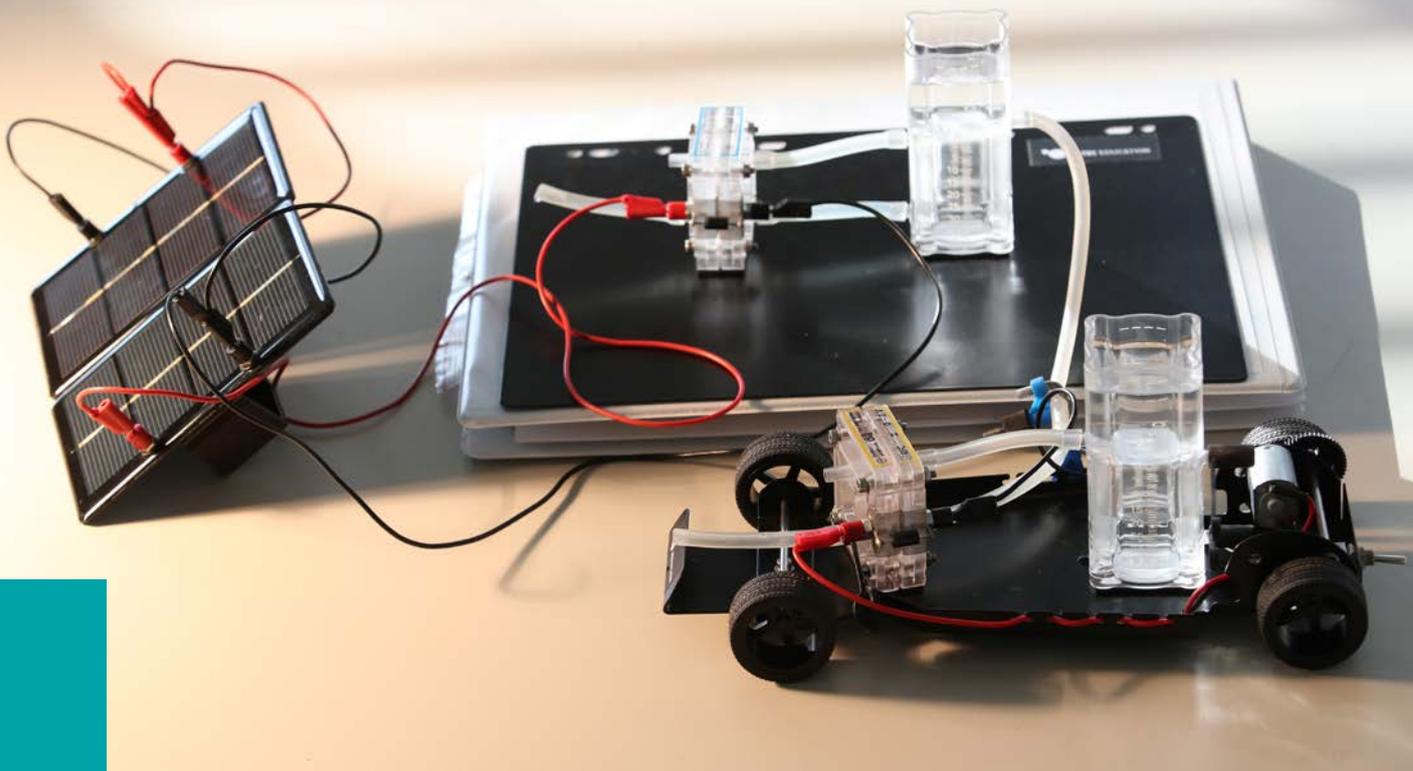
Slovenian Research Agency – Next-generation electrochemical LiFePO4 battery model. Tomaž Katrašnik. 1. 5. 2017 – 30. 4. 2020

Slovenian Research Agency. Zero-footprint combustion for green power generation. Tine Seljak. 1. 7. 2019 – 30. 6. 2021

Slovenian Research Agency. Advanced multi-scale modelling of NMC cathode materials for enhanced next-generation energy storage systems. Tomaž Katrašnik. 1.9.2020 - 31.8.2023

AWARDS AND ACHIEVEMENTS

Andraž Kravos and Ambrož Kregar received an award of the Faculty of Mechanical Engineering for high quality publications.



Laboratory for Heat and Power **LTE**

RESEARCH AREAS

Energy systems • Heat generators • Combustion • Hydrogen technologies • Smart Grids • Life Cycle Assessment • Environmental impacts of energy conversion

DEPARTMENT HEAD Prof. Mihael Sekavčnik, PhD

DEPARTMENT MEMBERS Assoc. Prof. Andrej Senegačnik, PhD, Assist. Prof. Boštjan Drobnič, PhD, Assist. Prof. Mitja Mori, PhD, Res. Assoc. Igor Kuštrin, PhD, Assist. Andrej Lotrič, PhD, Assist. Nejc Mlakar, Assist. Rok Stropnik, Darja Jeločnik

ORIGINAL SCIENTIFIC ARTICLE

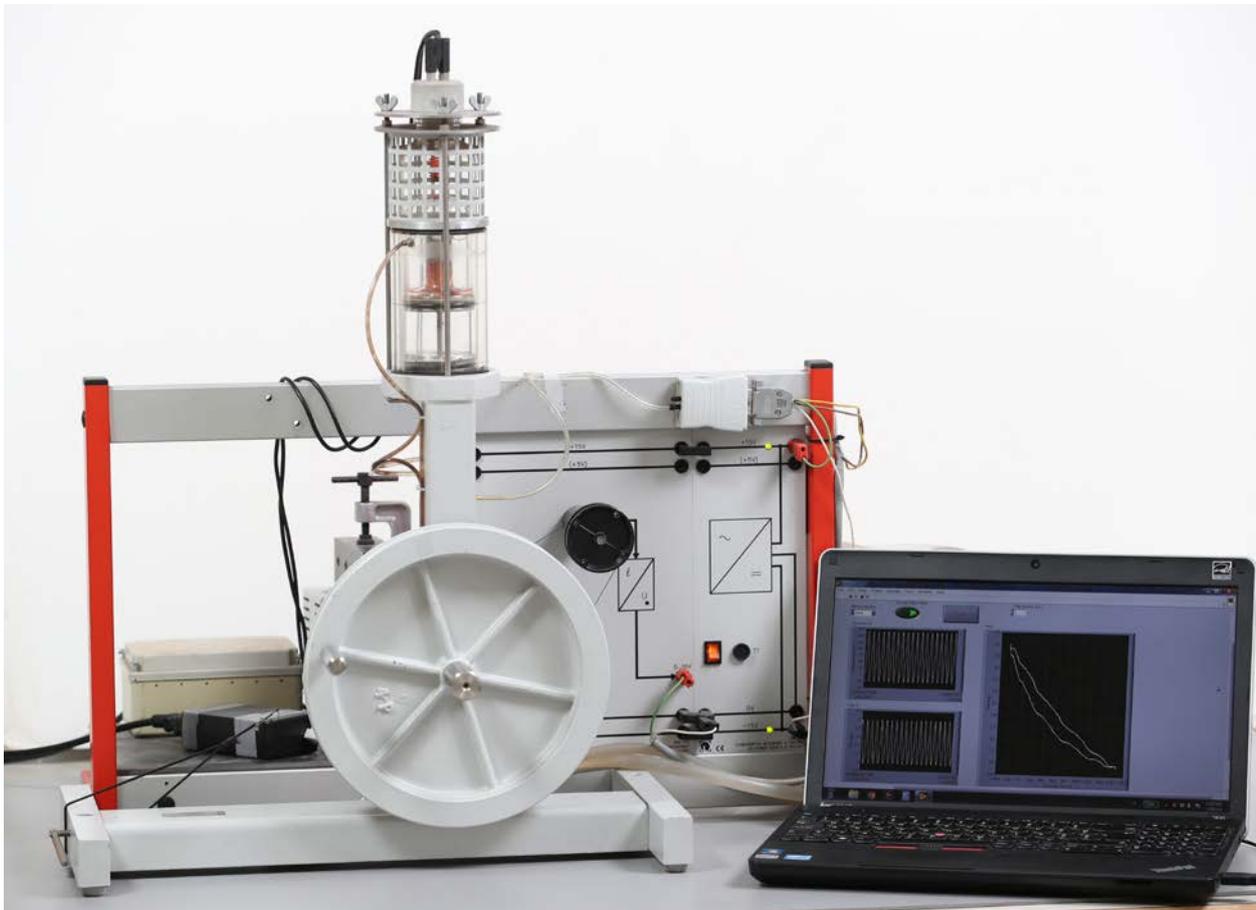
KUŠTRIN, Igor, JURJEVČIČ, Boštjan, SENEGAČNIK, Andrej. An electrostatic measuring technique for monitoring particle size in dilute pneumatic transport. *Thermal science*. 2020, iss. 6, p. 4061-4073.

UNIVERSITY, HIGER EDUCATION OR SHORT-TERM HIGER EDUCATION TEXTBOOK WITH REVIEW

DROBNIČ, Boštjan, SENEGAČNIK, Andrej. *Industrijska energetika: zbirka rešenih nalog s kratkimi teoretičnimi osnovami*. Ljubljana: Fakulteta za strojništvo, 2020.

DOCTORAL DISSERTATION

STROPNIK, Rok. *Life cycle assessment of hydrogen technologies within future energy supply*. Mentor Mihael Sekavčnik.



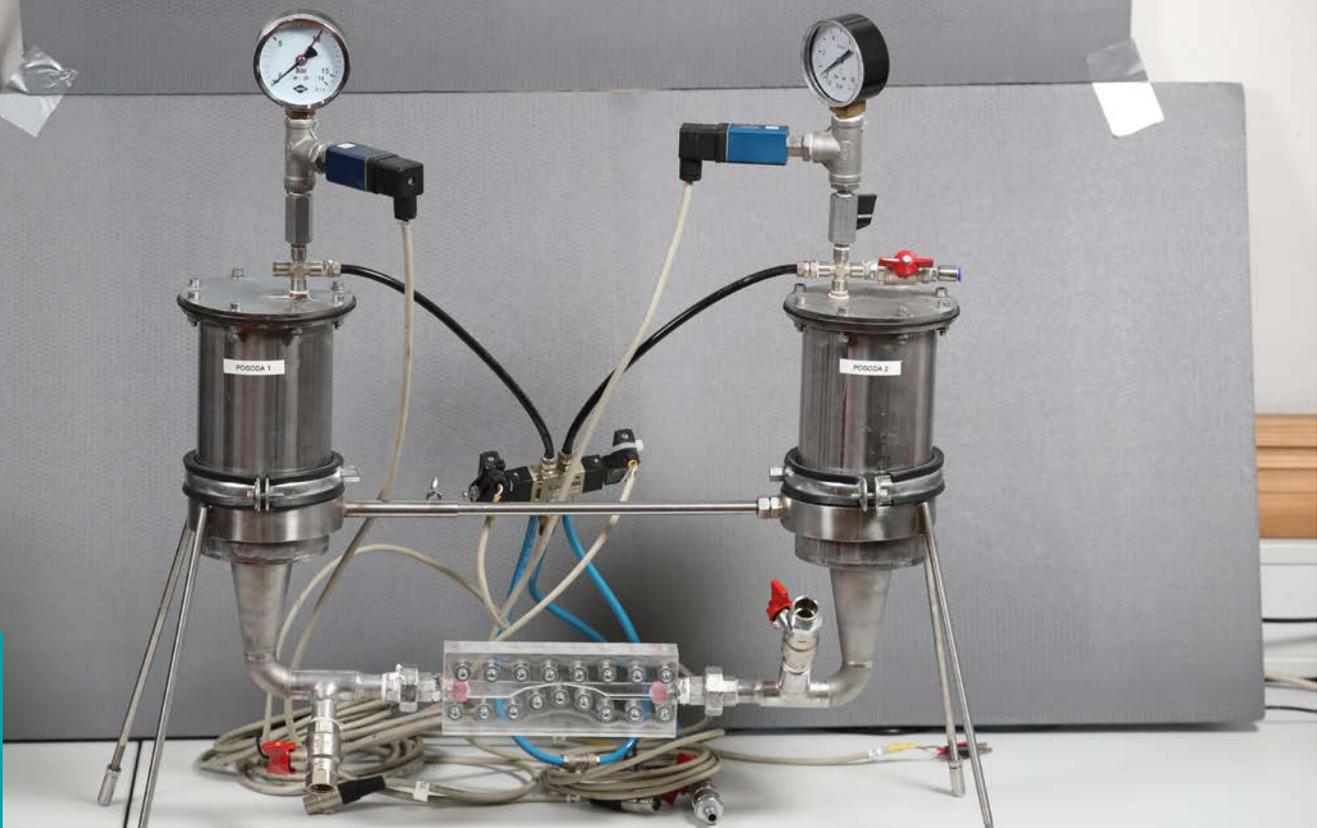
PROJECTS

COST - CA COST Action CA16235 - Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data. Mitja Mori. 05.10.2017 - 04.10.2021

LIFE SUSTAINHUTS - Sustainable Mountain huts in Europe. Mihael Sekavčnik. 01.07.2016 - 30.06.2020

Slovenian Research Agency. Optimization based control of P2G converter connected to hydro power plant. Mihael Sekavčnik. 1.7.2019 - 30.6.2022

Šoštanj Thermal Power Plant - Technical support for the operation of TPP. Mihael Sekavčnik. 1.3.2018 - 28.2.2022



Laboratory for Hydraulic Machines **LVTS**

RESEARCH AREAS

Fluid mechanics • Turbine machines • Computer aided visualisation

DEPARTMENT HEAD Prof. Marko Hočevar, PhD

DEPARTMENT MEMBERS Prof. Matevž Dular, PhD, Assist. Prof. Benjamin Bizjan, PhD, Assist. Prof. Martin Petkovšek, PhD, Assist. Lovrenc Novak, PhD, Assist. Darjan Podbevšek, PhD, Assist. Mojca Zupanc, PhD, Assist. Jurij Gostiša, Assist. Jure Zevnik, MSc Tone Godeša, Assist. Gregor Kozmus, Aleš Malneršič, Matej Sečnik, Assist. Peter Pipp, Assist. Žiga Pandur, Pero Gatarić, Darja Jeločnik

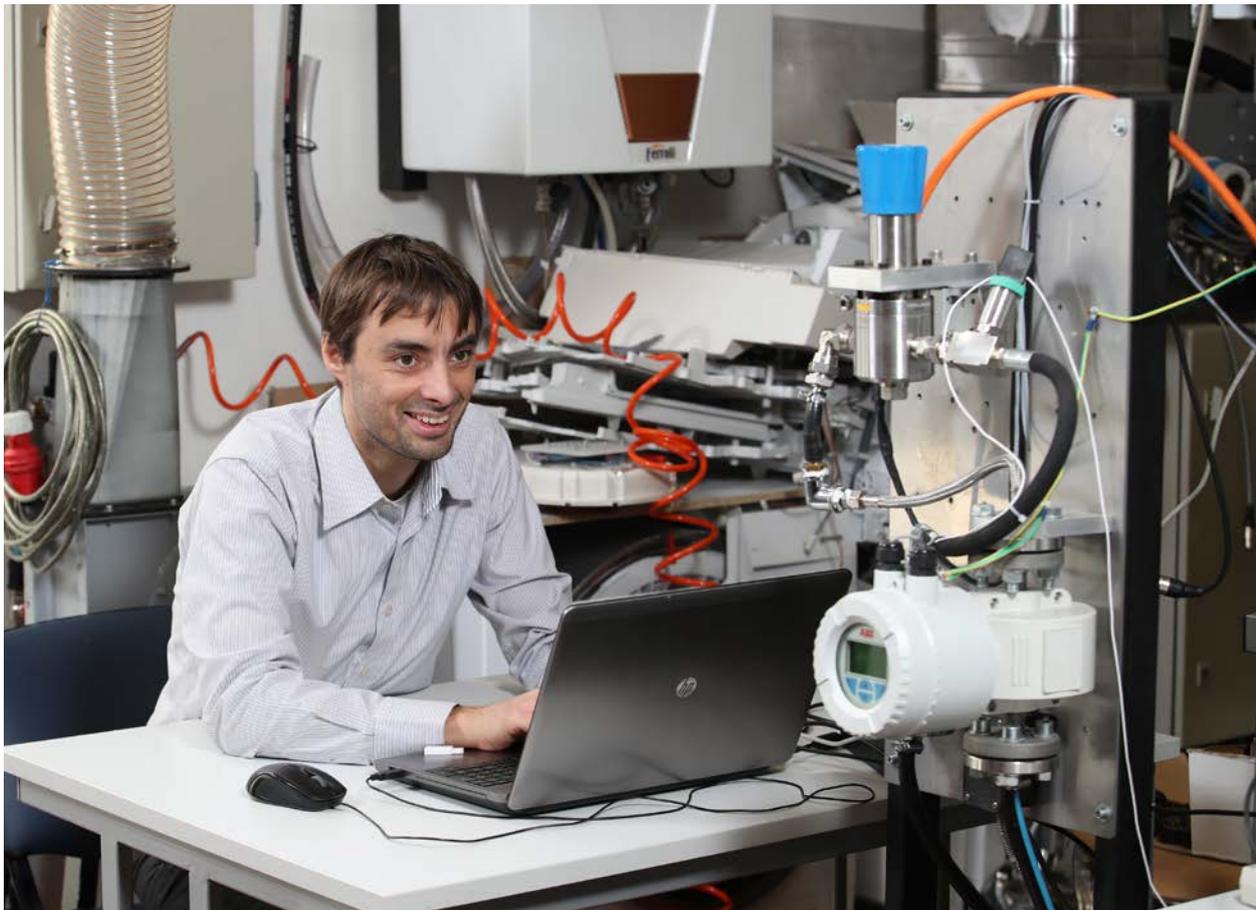
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ZUPANC, Mojca, PETKOVŠEK, Martin, ZEVNIK, Jure, KOZMUS, Gregor, ŠMID, Alenka, DULAR, Matevž. Anomalies detected during hydrodynamic cavitation when using salicylic acid dosimetry to measure radical production. *Chemical engineering journal*, 2020, vol. 396, p. 1-11.

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BILUŠ, Ignacijo, HOČEVAR, Marko, DULAR, Matevž, LEŠNIK, Luka. Numerical prediction of various cavitation erosion mechanisms. *Journal of fluids engineering: Transactions of the ASME*, 2020, vol. 142, no. 4, p. 1-8.

RAK, Gašper, HOČEVAR, Marko, STEINMAN, Franci. Non-intrusive measurements of free-water-surface profiles and fluctuations of turbulent, two-phase flow using 2-D laser scanner. *Measurement science & technology*, 2020, vol. 31, no. 6, p. 1-14.

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KOVAČIČ, Ana, ŠKUFCA, David, ZUPANC, Mojca, GOSTIŠA, Jurij, BIZJAN, Benjamin, KRIŠTOFELC, Nina, SOLLNER DOLENC, Marija, HEATH, Ester. The removal of bisphenols and other contaminants of emerging concern by hydrodynamic cavitation: from lab-scale to pilot-scale. *Science of the total environment*, 2020, vol. 743, p. 1-7.

BIZJAN, Benjamin, ŠIROK, Brane, BLAGOJEVIČ, Marko. Analogue experimental study of fiber formation on two-wheel spinner. *Strojniški vestnik*, 2020, vol. 66, no. 5, p. 279-288.

LIPOLT, Andraž, ŠIROK, Brane, HOČEVAR, Marko, NOVAK, Lovrenc. Convective drying of sewage sludge layer in through-flow. *Strojniški vestnik*, 2020, vol. 66, no. 9, p. 481-493.

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KOSEL, Janez, ŠUŠTARŠIČ, Matej, PETKOVŠEK, Martin, ZUPANC, Mojca, SEŽUN, Mija, DULAR, Matevž. Application of (super)cavitation for the recycling of process waters in paper producing industry. *Ultrasonics Sonochemistry*, 2020, vol. 64, p. 1-11.

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PETKOVŠEK, Martin, HOČEVAR, Matej, GREGORČIČ, Peter. Surface functionalization by nanosecond-laser texturing for controlling hydrodynamic cavitation dynamics. *Ultrasonics Sonochemistry*, 2020, vol. 67, p. 1-10.

ZEVNIK, Jure, DULAR, Matevž. Cavitation bubble interaction with a rigid spherical particle on a microscale. *Ultrasonics Sonochemistry*, 2020, vol. 69, p. 1-13.

SIMUNIČ, Urh, PIPP, Peter, DULAR, Matevž, STOPAR, David. The limitations of hydrodynamic removal of biofilms from the dead-ends in a model drinking water distribution system. *Water research*, 2020, vol. 178, p. 1-13.

SCIENTIFIC MONOGRAPHY

CHEN, Jinpeng, BIZJAN, Benjamin, ŠIROK, Brane. Modelling and application of mineral wool production process. Beijing: Science Publishers, 2020.

PROJECTS

EIP - Introduction of new mechanical and autonomous automated technologies for the sustainable production of grapes. Marko Hočevar. 23.11.2019 – 22.11.2022

ERDF (Smart Specialization) - NMP - Exploring biomass potential for development of advanced materials and bio-based products. Marko Hočevar. 01.09.2016 – 30.06.2020

Horizon 2020 - ERC- CABUM - An investigation of the mechanisms at the interaction between cavitation bubbles and contaminants. Matevž Dular. 01.07.2018 – 30.06.2023

Gorenje d.d. - Development of a fan and independent control of fan and drum of a tumble dryer with heat pump. Marko Hočevar. 1.12.2018 – 31.12.2020

Slovenian Research Agency. Development of new, environment-friendly approaches for plant and human virus inactivation in waters. Matevž Dular. 1.7.2018 – 30.6.2021

Slovenian Research Agency. Cavitation - a solution for microplastics degradation? Martin Petkovšek. 1.7.2019 – 30.6.2022

Slovenian Research Agency. Method for decontamination of sewage sludge and sludge products for their sustainable use as phosphorous fertilizers. Matevž Dular. 1.9.2020 - 31.8.2023

Slovenian Research Agency. Management of brown marmorated stink bug in Slovenia. Tone Godeša. 1.11.2020 - 31.10.2023

AWARDS AND ACHIEVEMENTS

Martin Petkovšek, Jure Zevnik, Benjamin Bizjan and Žiga Pandur received an award of the Faculty of Mechanical Engineering for high quality publications.

Matevž Dular became the recipient of the prestigious »Friedrich Wilhelm Bessel Research Award«.



Laboratory for Pumps, Compressors and Technical Acoustics **LEDSTA**

RESEARCH AREAS

Noise measurement and analysis • Environmental noise • Noise reduction • Identification and parametrisation of sound source • Prediction and modelling of noise propagation • Use of noise as a source of information • Psychoacoustics • Pumps • Ventilators • Compressors • Cavitation

DEPARTMENT HEAD Assoc. Prof. Jurij Prezelj, PhD

DEPARTMENT MEMBERS Assist. Luka Čurović, Assist. Jure Murovec, Tadej Novaković, Zdenka Rupič

ORIGINAL SCIENTIFIC ARTICLE

NOVAKOVIĆ, Tadej, OGRIS, Miha, PREZELJ, Jurij. Validating impeller geometry optimization for sound quality based on psychoacoustics metrics. *Applied acoustics*, 2020, vol. 157, p. 1-6.

MUROVEC, Jure, ČUROVIĆ, Luka, NOVAKOVIĆ, Tadej, PREZELJ, Jurij. Psychoacoustic approach for cavitation detection in centrifugal pumps. *Applied acoustics*, 2020, vol. 165, p. 1-11.

AWARDS AND ACHIEVEMENTS

Tadej Novaković and Jure Murovec received an award of the Faculty of Mechanical Engineering for high quality publications.

04 DEVELOPMENT EVALUATION

In the Development evaluation programme group, we are improving upon the rebmix algorithm for finite mixture parameter estimation and the Dirlik method for fatigue life prediction in the frequency-domain.

We will model the stress-strain states of rubber and rubber composites and their fatigue life. We will improve the energy based method for the durability prediction of thermomechanically loaded components. We will research the lithium-ion batteries. We will improve the models of durability showing a significant break-point in the durability curve. We will research the modelling of the fatigue life of casted parts with inhomogeneities and of parts with a hybrid metal-nonmetal load-carrying structure.

Prediction of the behaviour of structures that are loaded with mechanical loads causing high strain rates in the material will be improved. For wood products, the influence of the probability distribution of occurrence and location of inhomogeneities on the material properties of wood will be determined. The damage initiation and damage propagation periods during fatigue of wood and wood-based composites and hybrids will be investigated.



Laboratory for Machine Elements **LASEM**

RESEARCH AREAS

Machine element • Operational strength • Development evaluations

DEPARTMENT HEAD Prof. Marko Nagode, PhD

DEPARTMENT MEMBERS Assist. Prof. Simon Oman PhD, Assist. Aleš Gosar, PhD, Assist. Ivan Okorn, PhD, Assist. Tadej Kocjan, Assist. Branislav Panić, Boris Šrklec, Silva Brenčič, Assist. Urša Šolinc, PhD

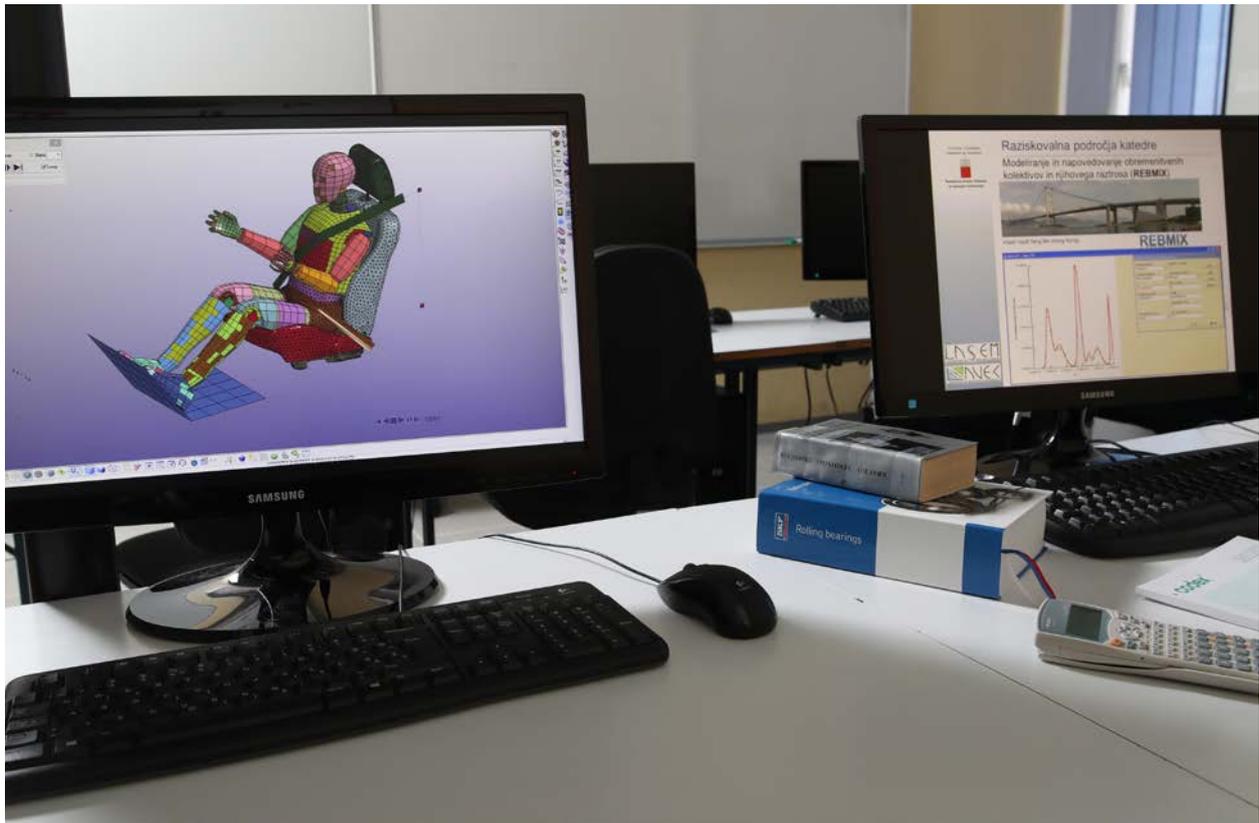
ORIGINAL SCIENTIFIC ARTICLE

PANIĆ, Branislav, KLEMENC, Jernej, NAGODE, Marko. Improved initialization of the EM algorithm for mixture model parameter estimation. *Mathematics*, 2020, vol. 8, no. 3, p. 1-29.

PANIĆ, Branislav, KLEMENC, Jernej, NAGODE, Marko. Optimizing the estimation of a histogram-bin width - application to the multivariate mixture-model estimation. *Mathematics*, 2020, vol. 8, no. 7, p. 1-30.

PANIĆ, Branislav, KLEMENC, Jernej, NAGODE, Marko. Gaussian mixture model based classification revisited: application to the bearing fault classification. *Strojniški vestnik*, 2020, vol. 66, no. 4, p. 215-226.

ŠOLINC, Urša, KLEMENC, Jernej, NAGODE, Marko, ŠERUGA, Domen. A fast and increment independent technique for continuous calculation of the strain energy dissipated during cyclic loading applied to magnesium alloy AZ31. *International journal of fatigue*, 2020, vol. 139, p. 1-11.



DOCTORAL DISSERTATIONS

ŠOLINC, Urša. Wrought magnesium alloy fatigue under cyclic loading, 2020. Mentor Marko Nagode.

BEŠTER, Tomaž. Influence of construction parameters on airspring lifetime, 2020. Mentor Marko Nagode.

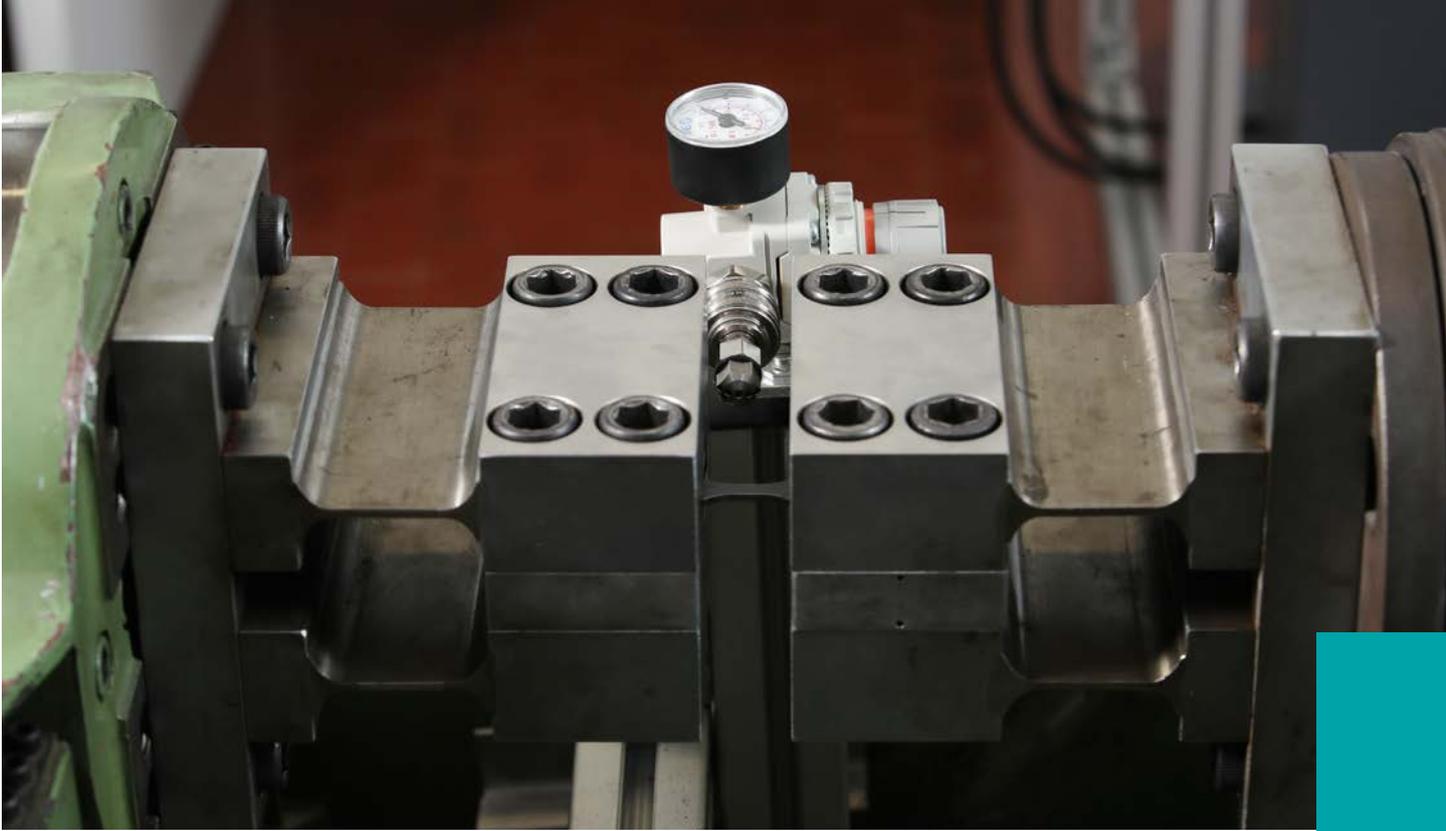
PROJECTS

Company Texas institute of Science. Variable Displacement Modular Axial Piston Pump – design of gas- and sand-separator module. Marko Nagode. 17.6.2019 - 11.11.2020

Company Texas institute of Science. Variable Displacement Modular Axial Piston Pump – design of pump module. Marko Nagode. 18.12.2019 - 31.12.2021

Slovenian Research Agency - Analysis of failures that were detected at technical inspection procedures by using conventional statistical methods and data mining methods. Jernej Klemenc. 1.11.2019 - 31.10.2022

Slovenian Research Agency. Development of multifunctional auxetic cellular structures. Marko Nagode. 1.5.2017 - 30.4.2020



Laboratory for Structure Evaluation **LAVEK**

RESEARCH AREAS

Development • Evaluation • Reliability • Maintainability • Supportability
• Availability • Dependability • Durability • Prediction

DEPARTMENT HEAD Prof. Jernej Klemenc, PhD

DEPARTMENT MEMBERS Assist. Prof. Domen Šeruga, PhD, Assist. Andrej Škrlec, PhD, Assist. Dejan Tomažinčič, Assist. Peter Zobec, Tomaž Bešter, PhD, Assist. Jure Kajbič, Assist. Aljaž Litrop, Silva Brenčič

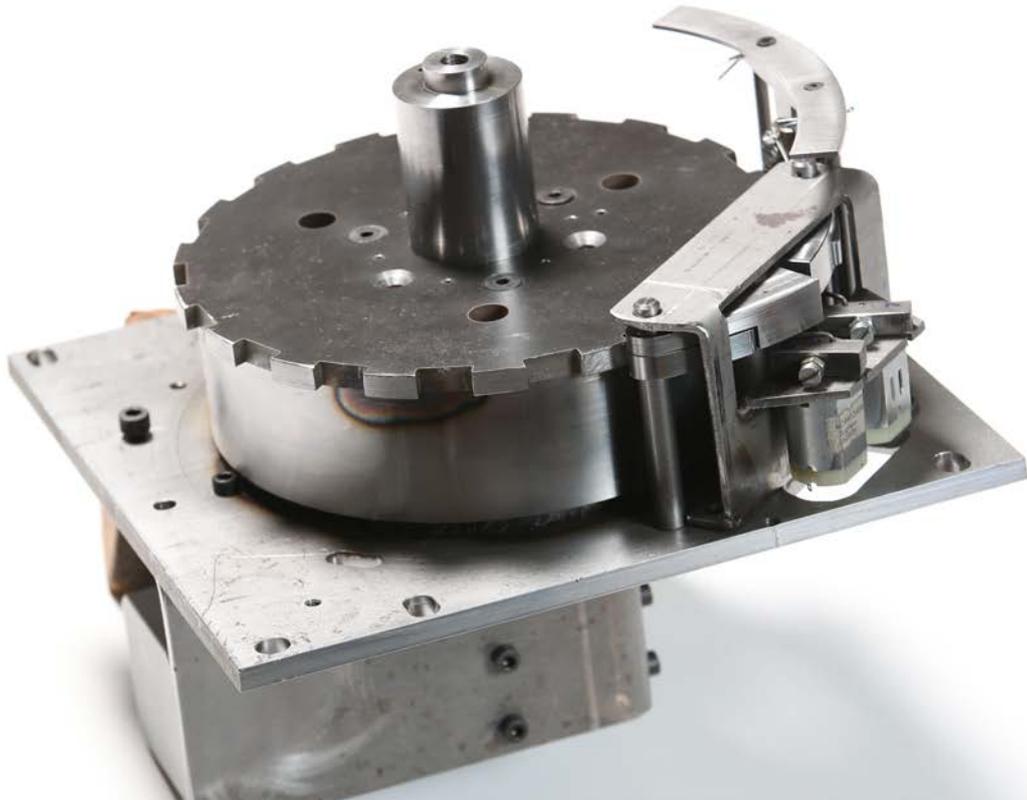
ORIGINAL SCIENTIFIC ARTICLE

ŠERUGA, Domen, KOSMAS, Odysseas, JIVKOV, Andrey P. Geometric modelling of elastic and elastic-plastic solids by separation of deformation energy and Prandtl operators. *International journal of solids and structures*, 2020, vol. 198, p. 136-148.

NEČEMER, Branko, KLEMENC, Jernej, GLODEŽ, Srečko. The computational LCF-analyses of chiral and Re-entrant auxetic structure using the direct cyclic algorithm. *Materials Science & Engineering. A, Structural materials: Properties, Microstructure and Processing*, 2020, vol. 789, p. 1-9.

ŠKRLEC, Andrej, KLEMENC, Jernej. Estimating the strain-rate-dependent parameters of the Johnson-Cook material model using optimisation algorithms combined with a response surface. *Mathematics*, 2020, vol. 8, no. 7, p. 1-18.

TOMAŽINČIČ, Dejan, VESENJAK, Matej, KLEMENC, Jernej. Prediction of static and low-cycle durability of porous cellular structures with positive and negative Poisson's ratios. *Theoretical and Applied Fracture Mechanics*, 2020, vol. 106, p. 1-13.



GLODEŽ, Srečko, KLEMENC, Jernej, ZUPANIČ, Franc, VESENJAK, Matej. High-cycle fatigue and fracture behaviours of SLM AlSi10Mg alloy. Transactions of Nonferrous Metals Society of China, 2020, vol. 30, no. 10, p. 2577-2589.

PATENT

ŠERUGA, Domen, NAGODE, Marko, MALNARIČ, Vili, KLEMENC, Jernej. Priprava za vpetje ploščatega preizkušanca med izvajanjem cikličnega preizkusa mehanske trdnosti materiala: patent SI 25679 A, 2020-01-31. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2020.

DOCTORAL DISSERTATION

BEŠTER, Tomaž. Influence of construction parameters on airspring lifetime. Mentor Marko Nagode.

PROJECTS

Company Texas institute of Science. Variable Displacement Modular Axial Piston Pump - design of gas- and sand-separator module. Jernej Klemenc. 17.6.2019 - 11.11.2020

Company Texas institute of Science. Variable Displacement Modular Axial Piston Pump - design of pump module. Jernej Klemenc. 18.12.2019 - 31.12.2021

Slovenian Research Agency - Analysis of failures that were detected at technical inspection procedures by using conventional statistical methods and data mining methods. Jernej Klemenc. 1.11.2019 - 31.10.2022

Slovenian Research Agency. Development of multifunctional auxetic cellular structures. Jernej Klemenc. 1.5.2017 - 30.4.2020

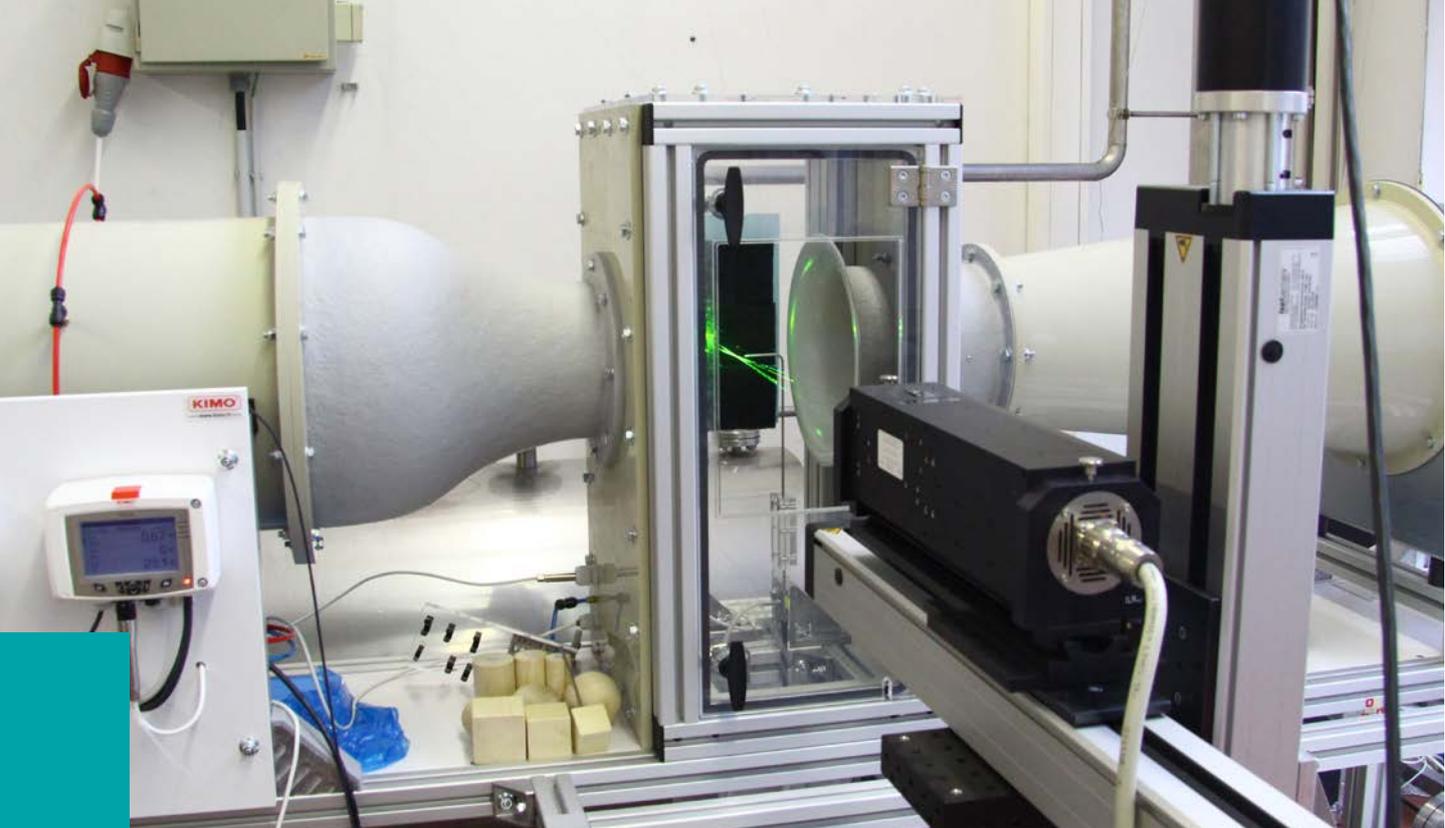
05

HEAT AND MASS TRANSFER

We conduct research and development of systems for the supply and use of energy for heating, cooling, air-conditioning and process engineering with emphasis on renewable energy sources and efficient use of energy.

We are engaged in advanced mechanisms of heat transfer and heat transport, a part of which includes boiling research in microstructures. We are involved in exergoeconomic optimisation of the entire energy supply chain. We research and develop alternative magnetocaloric and electrocaloric cooling technologies for real applications in the domain of conventional refrigerators with inclusion of thermal diodes and switches.

We conduct research of thermal response of cities with natural building elements and integration into buildings' envelope. We study the impact of cooling loads of buildings on electricity consumption and thermal comfort in buildings with inclusion of thermal storage. Research results are verified with measurements conducted in laboratories and on real systems for which innovative measuring methods and meters are being developed.



Laboratory for Measurements in Process Engineering LMPS

RESEARCH AREAS

- Metrology • Measurements of temperature, pressure and fluid flow rate
- Development of measuring equipment and measurement methods
 - Calibration

DEPARTMENT HEAD Assoc. Prof. Jože Kutin, PhD

DEPARTMENT MEMBERS Assist. Prof. Gregor Bobovnik, PhD, Assist. Prof. Andrej Svete, PhD, Marjan Pohl, Peter Sambol, Francisco Javier Hernandez Castro, Assist. Primož Žibret, Zdenka Rupič, Katja Tajč

ORIGINAL SCIENTIFIC ARTICLE

BOBOVNIK, Gregor, KUTIN, Jože. Correlation of the leakage flow rate with pressure changes in a clearance-sealed piston prover. *Flow measurement and instrumentation*, 2020, vol. 74, p. 1-7.

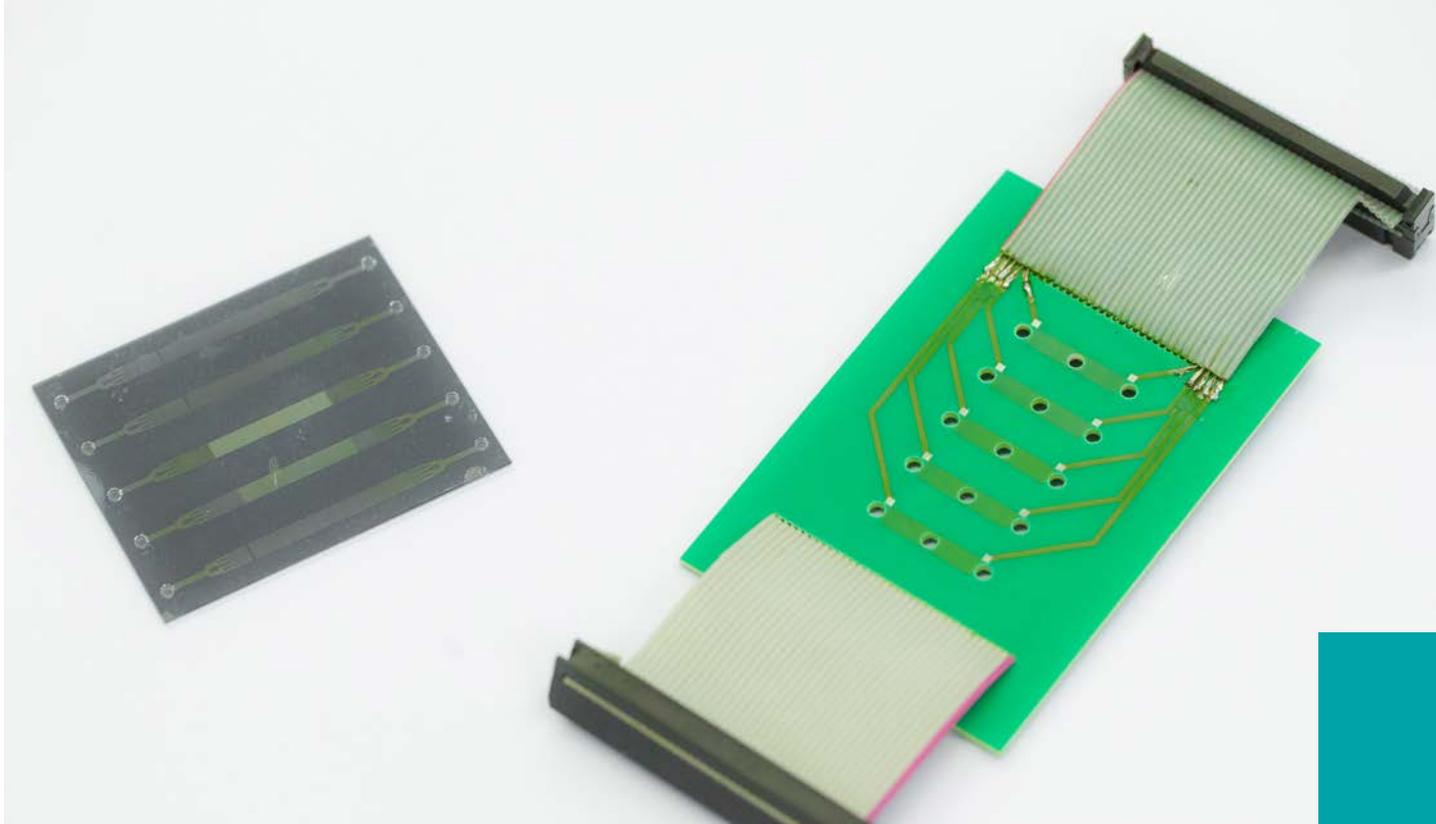
SVETE, Andrej, KUTIN, Jože. Experimental validation of an improved mathematical model for pneumatic pressure measurement systems with connecting tubes. *Measurement science & technology*, 2020, vol. 31, no. 1, p. 1-10.

SVETE, Andrej, KUTIN, Jože. Characterization of a newly developed diaphragmless shock tube for the primary dynamic calibration of pressure meters. *Metrologia*, 2020, vol. 57, no. 5, p. 1-12.

BOBOVNIK, Gregor, ARHAR, Klara, KUTIN, Jože. Validacija merilnega sistema za merjenje pretoka plina z laminarnim tokovnim elementom. *Ventil: revija za fluidno tehniko in avtomatizacijo*, 2020, vol. 26, no. 1, p. 32-37.

AWARDS AND ACHIEVEMENTS

Laboratory LMPS received the Special Recognition award from Chamber of Commerce and Industry of Slovenia for outstanding development and innovation cooperation of the economy, science and health in the development of prototypes of the Slovenian respirator as members of the FEspirator group.



Laboratory for Heating Technology **LTT**

RESEARCH AREAS

Heat and mass transfer • Thermal engineering • Applied thermodynamics • Process engineering • Biotechnology • Environmental protection technologies

DEPARTMENT HEAD Prof. Iztok Golobič, PhD

DEPARTMENT MEMBERS Assist. Prof. Matevž Zupančič, PhD, Assist. Anže Sitar, PhD, Assist. Ivan Sedmak, PhD, Assist. Matic Može, Assist. Jure Berce, Mattia Bucci, Armin Hadžić, Zdenka Rupič

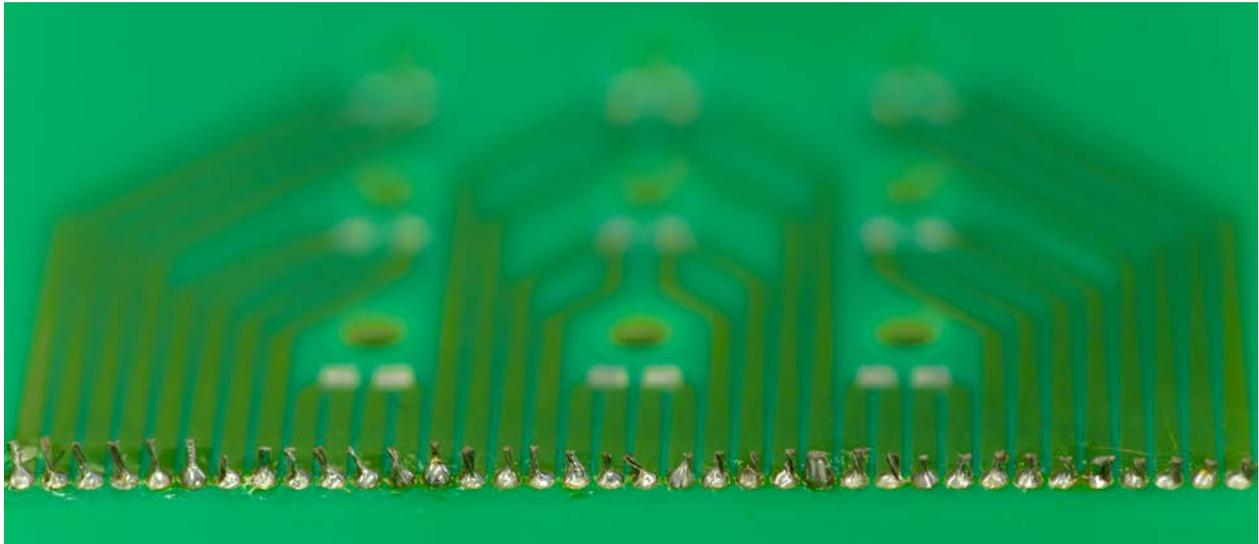
ORIGINAL SCIENTIFIC ARTICLE

MOŽE, Matic, SENEGAČNIK, Matej, GREGORČIČ, Peter, HOČEVAR, Matej, ZUPANČIČ, Matevž, GOLOBIČ, Iztok. Laser-engineered microcavity surfaces with a nanoscale superhydrophobic coating for extreme boiling performance. *ACS applied materials & interfaces*, 2020, vol. 12, no. 21, p. 24419-24431.

MOŽE, Matic, ZUPANČIČ, Matevž, GOLOBIČ, Iztok. Investigation of the scatter in reported pool boiling CHF measurements including analysis of heat flux and measurement uncertainty evaluation methodology. *Applied thermal engineering*, 2020, vol. 169, p. 1-18.

MOŽE, Matic, NEMANIČ, Aljaž, POREDOS, Primož. Experimental and numerical heat transfer analysis of heat-pipe-based CPU coolers and performance optimization methodology. *Applied thermal engineering*, 2020, vol. 179, p. 1-14.

MOŽE, Matic. Effect of boiling-induced aging on pool boiling heat transfer performance of untreated and laser-textured copper surfaces. *Applied thermal engineering*, 2020, vol. 181, p. 1-14.



RAMŠAK, Matjaž, ZADRAVEC, Matej, RAVNIK, Jure, ILJAŽ, Jurij, AVANZO, M., KOČEVAR, K., IRMAN, Špela, CEGNAR, Mateja, GOLOBIČ, Iztok, SITAR, Anže, HRIBERŠEK, Matjaž. Numerical and experimental modeling of lyophilization of lactose and mannitol water solutions in vials. *Computational thermal sciences*, 2020, vol. 12, no. 5, p. 401-415.

SITAR, Anže, MOŽE, Matic, CRIVELLARI, Michele, SCHILLE, Jörg, GOLOBIČ, Iztok. Nucleate pool boiling heat transfer on etched and laser structured silicon surfaces. *International journal of heat and mass transfer*, 2020, vol. 147, p. 1-12.

FERJANČIČ, Klemen, MOŽE, Matic, KRIŽAN, Peter, BOBIČ, Miha, GOLOBIČ, Iztok. Subcooled critical heat flux on laser-textured stainless-steel ribbon heaters in pool boiling of FC-72. *International journal of heat and mass transfer*, 2020, vol. 159, p. 1-16.

MOŽE, Matic, ZUPANČIČ, Matevž, GOLOBIČ, Iztok. Pattern geometry optimization on superbiphilic aluminum surfaces for enhanced pool boiling heat transfer. *International journal of heat and mass transfer*, 2020, vol. 161, p. 1-13.

BOBIČ, Miha, GJEREK, Bojan, GOLOBIČ, Iztok, BAJSIČ, Ivan. Dynamic behaviour of a plate heat exchanger: Influence of temperature disturbances and flow configurations. *International journal of heat and mass transfer*, 2020, vol. 163, p. 1-13.

ZAKŠEK, Peter, ZUPANČIČ, Matevž, GREGORČIČ, Peter, GOLOBIČ, Iztok. Investigation of nucleate pool boiling of saturated pure liquids and ethanol-water mixtures on smooth and laser-textured surfaces. *Nanoscale and microscale thermophysical engineering*, 2020, vol. 24, no. 1, p. 29-42.

PROJECTS

Company Danfoss Trata. Development of smart heating station components for the DOM 24H project. Iztok Golobič. 4.12.2020-4.2.2022

Company Plinovodi. Preparation of a study on the impact of renewable gases, including hydrogen, on the materials and elements of the transmission piping system. Iztok Golobič. 11.8.2020 - 31.12.2021

Slovenian Research Agency. Laser micro and nano structuring for development of biomimetic metallic surfaces with unique properties (LaMiNaS). Peter Gregorčič. 1.7.2019 - 30.6.2022

Slovenian Research Agency. Enhanced boiling heat transfer utilising hierarchical functionalized surfaces (eHEATs). Matevž Zupančič. 1.9.2020 - 31.8.2023



Laboratory for Refrigeration and District Energy LAHDE

RESEARCH AREAS

Heat and Mass Transfer • Refrigeration • Caloric energy conversion
• Heat pumps • Thermal control devices • District energy

DEPARTMENT HEAD Prof. Andrej Kitanovski, PhD

DEPARTMENT MEMBERS Assist. Jure Mencinger, PhD, Assist. Prof. Jaka Tušek, PhD, Assist. Dall'Olio Stefano, PhD, Assist. Primož Poredoš, PhD, Assist. Urban Tomc, PhD, Assist. Boris Vidrih, PhD, Assist. Uroš Plaznik, PhD, Assist. Parham Kabirifar, PhD, Assist. Žiga Ahčin, Assist. Katja Klinar, Assist. Luka Lorbek, Assist. Nada Petelin, Assist. Luka Porenta, MSc Miha Bobič, Simon Bogič, Jan Cerar, Simon Nosan, Assist. Katja Vozel, Anja Kuhelj, Darja Jeločnik

ORIGINAL SCIENTIFIC ARTICLE

KITANOVSKI, Andrej. Energy applications of magnetocaloric materials. *Advanced energy materials*, 2020, vol. 10, no. 10, p. 1-34.

PORENTA, Luka, KABIRIFAR, Parham, ŽEROVNIK, Andrej, ČEBRON, Matjaž, ŽUŽEK, Borut, DOLENEC, Matej, BROJAN, Miha, TUŠEK, Jaka. Thin-walled Ni-Ti tubes under compression: ideal candidates for efficient and fatigue-resistant elastocaloric cooling. *Applied materials today*, 2020, vol. 20, p. 1-9.

POREDOŠ, Primož, TOMC, Urban, PETELIN, Nada, VIDRIH, Boris, FLISAR, Uroš, KITANOVSKI, Andrej. Numerical and experimental investigation of the energy and exergy performance of solar thermal, photovoltaic and photovoltaic-thermal modules based on roll-bond heat exchangers. *Energy conversion and management*, 2020, vol. 210, p. 1-21.

KALIZAN, Jan, TUŠEK, Jaka. Caloric Micro-Cooling: numerical modelling and parametric investigation. *Energy conversion and management*, 2020, vol. 225, p. 1-11.

LORBEEK, Luka, KUHELJ, Anja, DULAR, Matevž, KITANOVSKI, Andrej. Two-phase flow patterns in adiabatic refrigerant flow through capillary tubes. *International journal of refrigeration*, 2020, vol. 115, p. 107-116.

KLINAR, Katja, MUÑOZ ROJO, Miguel, KUTNJAK, Zdravko, KITANOVSKI, Andrej. Toward a solid-state thermal diode for room-temperature magnetocaloric energy conversion. *Journal of applied physics*, 2020, vol. 127, no. 23, p. 1-10.

DEL DUCA, Manuel Gesù, TUŠEK, Jaka, MAIORINO, Angelo, FULANOVIĆ, Lovro, BRADEŠKO, Andraž, PLAZNIK, Uroš, MALIČ, Barbara, APREA, Ciro, KITANOVSKI, Andrej. Comprehensive evaluation of electrocaloric effect and fatigue behavior in the 0.9Pb (Mg₁/3Nb₂/3) O₃-0.1PbTiO₃ bulk relaxor ferroelectric ceramic. *Journal of applied physics*, 2020, vol. 128, no. 10, p. 1-9.

NATAF, Guillaume F., ROMANINI, Michela, VIVES, Eduard, ŽUŽEK, Borut, PLANES, Antoni, TUŠEK, Jaka, MOYA, Xavier. Suppression of acoustic emission during superelastic tensile cycling of polycrystalline Ni 50.4 Ti 49.6. *Physical review materials*, 2020, vol. 4, no. 9, p. 1-9.

NAVICKAITE, Kristina, PENZEL, Michael, BAHL, Christian Robert Haffenden, ENGELBRECHT, Kurt, TUŠEK, Jaka, MARTIN, André, ZINECKER, Mike, SCHUBERT, Andreas. CFD-simulation assisted design of elastocaloric regenerator geometry. *Sustainability*, 2020, vol. 12, no. 21, p. 1-16.

PATENTS

ŽEROVNIK, Andrej, TUŠEK, Jaka. Hybrid thermal apparatus = Hybride thermische Vorrichtung = Appareil thermique hybride: European patent specification EP 3 542 108 B1, 2020-11-04. Munich: European Patent Office, 2020.

KITANOVSKI, Andrej, TOMC, Urban, KLINAR, Katja, VALENTINČIČ, Joško, MAJDIČ, Franc, SABOTIN, Izidor, MENCINGER, Jure. Metoda prenosa toplote v združeni strukturi toplotnega regeneratorja in izvedba toplotnega regeneratorja: patent SI 25712 A, 2020-03-31. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2020.

PROJECTS

Gorenje d.d. - Development of methods for self-adaptive control and management of heat flows in household appliances. Andrej Kitanovski. 1.3.2019 – 31.7.2020

Gorenje d.d. - Development of thermal processes in household appliances. Andrej Kitanovski. 22.2.2017-21.2.2020

Gorenje d.d. - Development of thermal processes in household appliances. Andrej Kitanovski. 23.2.2020-21.2.2022

Horizon 2020 - ERC SUPERCOOL - Superelastic Porous Structures for Efficient Elastocaloric Cooling. Jaka Tušek. 01.01.2019 – 31.12.2023

KPMG – Reseach – Andrej Kitanovski. 26.2.2020

Slovenian Research Agency. Multicaloric cooling. Andrej Kitanovski. 1.7.2018 – 30.6.2021

Slovenian Research Agency. Digital microfluidics in magnetocaloric refrigeration. Urban Tomc. 1.7.2018 – 30.6.2020

Slovenian Research Agency. Electrocaloric elements for active cooling of electronic circuits. Kitanovski Andrej. 1.7.2019 - 30.6.2022

Slovenian Research Agency. MagBoost: Magnetocaloric booster micro-heat pump for district heating system. Andrej Kitanovski. 1.9.2020 - 31.8.2023

AWARDS AND ACHIEVEMENTS

Katja Klinar and Luka Porenta received an award of the Faculty of Mechanical Engineering for high quality publications.



Laboratory for Heating, Sanitary, Solar and Air Conditioning Engineering **LOSK**

RESEARCH AREAS

Heat and mass transfer in buildings and building installations • Indoor environment • Ventilation • Air conditioning • Efficient use of energy • Environment protection (air) • Sanitary engineering • Alternative systems • Modelling

DEPARTMENT HEAD Assoc. Prof. Uroš Stritih, PhD

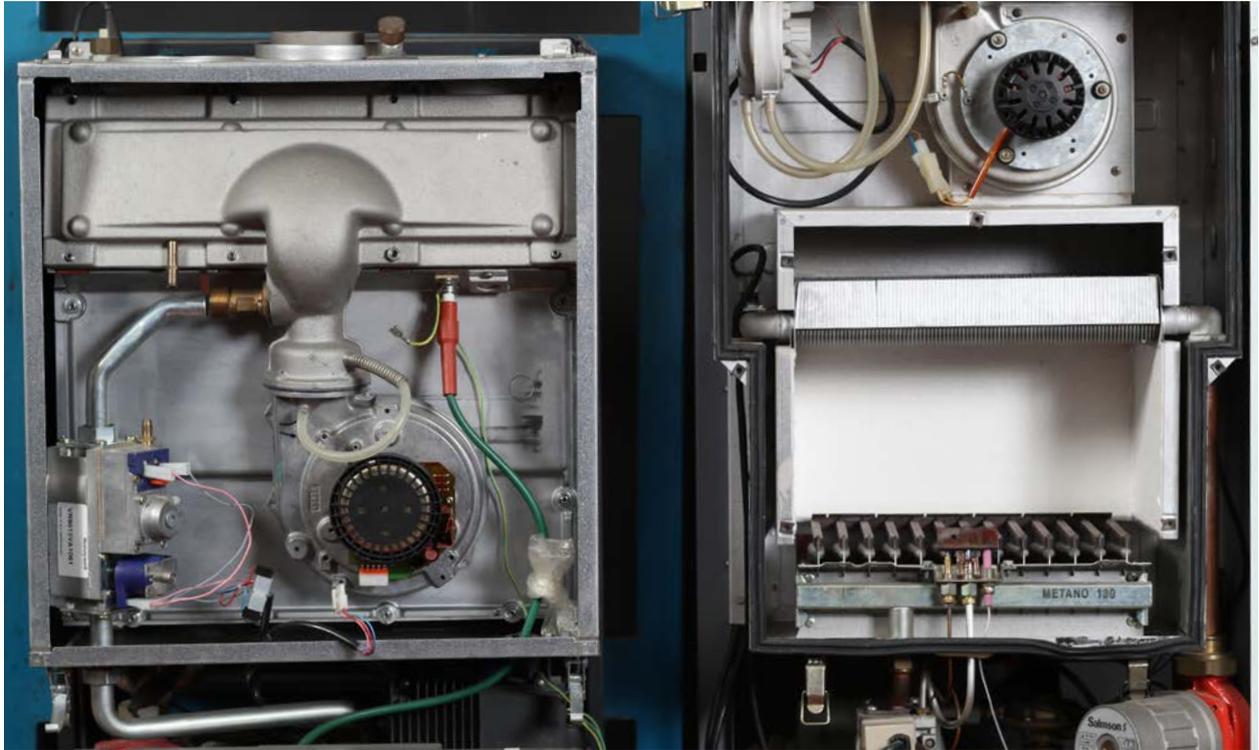
DEPARTMENT MEMBERS Assoc. Prof. Matjaž Prek, PhD, Assist. Eneja Osterman, PhD, Assist. Rok Koželj, Assist. Žiga Lampret, Assist. Eva Zavrl, PhD, Darja Jeločnik

ORIGINAL SCIENTIFIC ARTICLE

ZAVRL, Eva, ZUPANC, Gašper, STRITIH, Uroš, DOVJAK, Mateja. Overheating reduction in lightweight framed buildings with application of phase change materials. *Strojniški vestnik*. 2020, vol. 66, no. 1, p. 3-14.

DOBEIC, Martin, BUTALA, Vincenc, PREK, Matjaž, LESKOVŠEK, Jan, ŠVEGELJ, Žiga. Fundamentals of odour assessment in Slovenia. *Strojniški vestnik*. 2020, vol. 66, no. 11, p. 642-654.

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PROJECTS

Horizon 2020 - HEART - Holistic Energy and Architectural Retrofit Toolkit. Uroš Stritih.
01.10.2017 - 30.09.2021

KPMG - Reseach - Uroš Stritih. 26.2.2020



Laboratory for Sustainable Technologies in Buildings **LOTZ**

RESEARCH AREAS

Engineering sciences • Energy engineering • Renewable sources and technologies

DEPARTMENT HEAD Prof. Sašo Medved, PhD

DEPARTMENT MEMBERS Assoc. Prof. Ciril Arkar, PhD, Assist. MSc Suzana Domjan, Assist. Tej Žižak, Darja Jeločnik

ORIGINAL SCIENTIFIC ARTICLE

ARKAR, Ciril, ŽIŽAK, Tej, DOMJAN, Suzana, MEDVED, Sašo. Dynamic parametric models for the holistic evaluation of semi-transparent photovoltaic/thermal façade with latent storage inserts. Applied energy, 2020, vol. 280, p. 1-16.

DOMJAN, Suzana, PETEK, Lenart, ARKAR, Ciril, MEDVED, Sašo. Experimental study on energy efficiency of multi-functional BIPV glazed façade structure during heating season. Energies, 2020, vol. 13, no. 11, p. 1-19.

PROJECTS

Slovenian Research Agency. Development of the prognostic model of exposure to indoor air pollutants in schools and preparation of evidence based measures for planning of efficient natural ventilation of the classrooms. Sašo Medved. 1.11.2019 – 31.10.2021

06 TRIBOLOGY

The Tribology programme group is interdisciplinary and includes 15-20 member from different disciplines: mechanical engineering, physics, chemistry, materials and nanotechnologies.

The group is developing an energy-efficient, sustainable and at the same time more environment-friendly “green” operation of mechanical systems. Linking understanding of tribological and surface processes from nano- to macroscale with the aim of solving industrial problems is the group’s basic goal. The central closely-related areas of work are: contact engineering and surface mechanics, wear-resistant mechanical systems, protective surface coatings, lubrication and surface films, nanotribology, wetting, tribochemistry and adhesion processes, and power-control hydraulic design.

The group is also actively engaged in topography and real contact area models, advanced polymer, electrical and mechatronic contacts tribology, tribology in production processes, polymer gears and automotive applications, and water hydraulics.



Laboratory for tribology and interface nanotechnology **TINT**

RESEARCH AREAS

Wear • Lubrication • Friction • Surface engineering • Nanotribology
• Interface nanotechnology • Maintenance

DEPARTMENT HEAD Prof. Mitjan Kalin, PhD

DEPARTMENT MEMBERS Assist. Prof. Marko Polajnar, PhD, Assist. Prof. Janez Kogovšek, PhD, Assist. Boris Kržan, PhD, Assist. Akbari Somayeh PhD, Assist. Arshad Muhammad Shahid, PhD, Assist. Blaž Brodnik Žugelj, PhD, Assist. Lucija Čoga, PhD, Assist. Jure Jerina, PhD, Assist. Marko Soderžnik, PhD, Assist. Urban Klanjšček, Assist. Sebastjan Matkovič, Assist. Hamouda Karim, Assist. Siddiqui Muhammad Shoaib Naseem, Franc Kopač, Assist. Petra Jan, Prashant Gangwani, Pedro Martins Ferreira, Irfan Nadeem, Jožica Sterle

ORIGINAL SCIENTIFIC ARTICLE

KUS, Maja, KALIN, Mitjan. Additive chemical structure and its effect on the wetting behaviour of oil at 100°C. *Applied Surface Science*, 2020, vol. 506, p. 1-11.

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KORENT, Matic, KOMELJ, Matej, ŠTURM, Sašo, ŽUŽEK ROŽMAN, Kristina, KOBE, Spomenka, ŽAGAR, Kristina, SODERŽNIK, Marko. Magnetic properties and microstructure evolution of hot-deformed Nd-Fe-B magnets produced by low-pressure spark-plasma sintering. *Journal of Magnetism and Magnetic Materials*, 2020, vol. 515, p. 1-13.



TORRES, Hector, ROJACZ, Harald, ČOGA, Lucija, KALIN, Mitjan, RODRÍGUEZ RIPOLL, Manel. Local mechanical and frictional properties of Ag/MoS₂-doped self-lubricating Ni-based laser claddings and resulting high temperature vacuum performance. *Materials & design*, 2020, vol. 186, p. 1-13.

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BRODNIK ŽUGELJ, Blaž, KALIN, Mitjan. Submicron-scale experimental analyses of the multi-asperity contact behaviour of various steels, an aluminium alloy and a polymer. *Tribology international*, 2020, vol. 141, p. 1-8.

ARSHAD, Muhammad Shahid, KOVAČ, Janez, CRUZ, Sandra, KALIN, Mitjan. Physicochemical and tribological characterizations of WDLC coatings and ionic-liquid lubricant additives: potential candidates for low friction under boundary-lubrication conditions. *Tribology international*, 2020, vol. 151, p. 1-10.

PATENT

MCGUINNESS, Paul J., SODERŽNIK, Marko, ŽAGAR, Kristina, KOCJAN, Andraž, KOBE, Spomenka. Method of manufacturing fully dense Nd-Fe-B magnets with enhanced coercivity and gradient microstructure = Verfahren zur Herstellung von völlig dichten Nd-Fe-B-Magneten mit erhöhter Koerzitivität und Gradient-Mikrostruktur = Procédé de fabrication d'aimants Nd-Fe-B totalement denses à microstructure à gradient et coercivité améliorée: European patent specification EP 2 869 311 B1, 2020-06-24. Munich: European Patent Office, 2020.

SCIENTIFIC MONOGRAPHY

BASU, Bikramjit, KALIN, Mitjan, KUMAR, B. V. Manoj. Friction and wear of ceramics: principles and case studies. Hoboken (N.J.): The American Ceramic Society: J. Wiley & Sons, cop. 2020.

PROJECTS

COMET – Competence Centers for Excellent Technologies - XTribology Excellence Center of Tribology. Mitjan Kalin. 01.04.2015 – 31.03.2020

Erasmus + (Erasmus Mundus) - TRIBOS+ - Joint European Master on Tribology of Surfaces and Interfaces. Mitjan Kalin. 01.09.2018 – 31.08.2024

Horizon 2020 – GreenTRIBOS. Mitjan Kalin. 01.01.2020 - 31.12.2023

M-era.Net – GreenCOAT - Green high-performance and low-friction interfaces tailored by the reactivity of novel DLC coatings and ionic liquids. Mitjan Kalin. 01.08.2017 – 31.07.2020

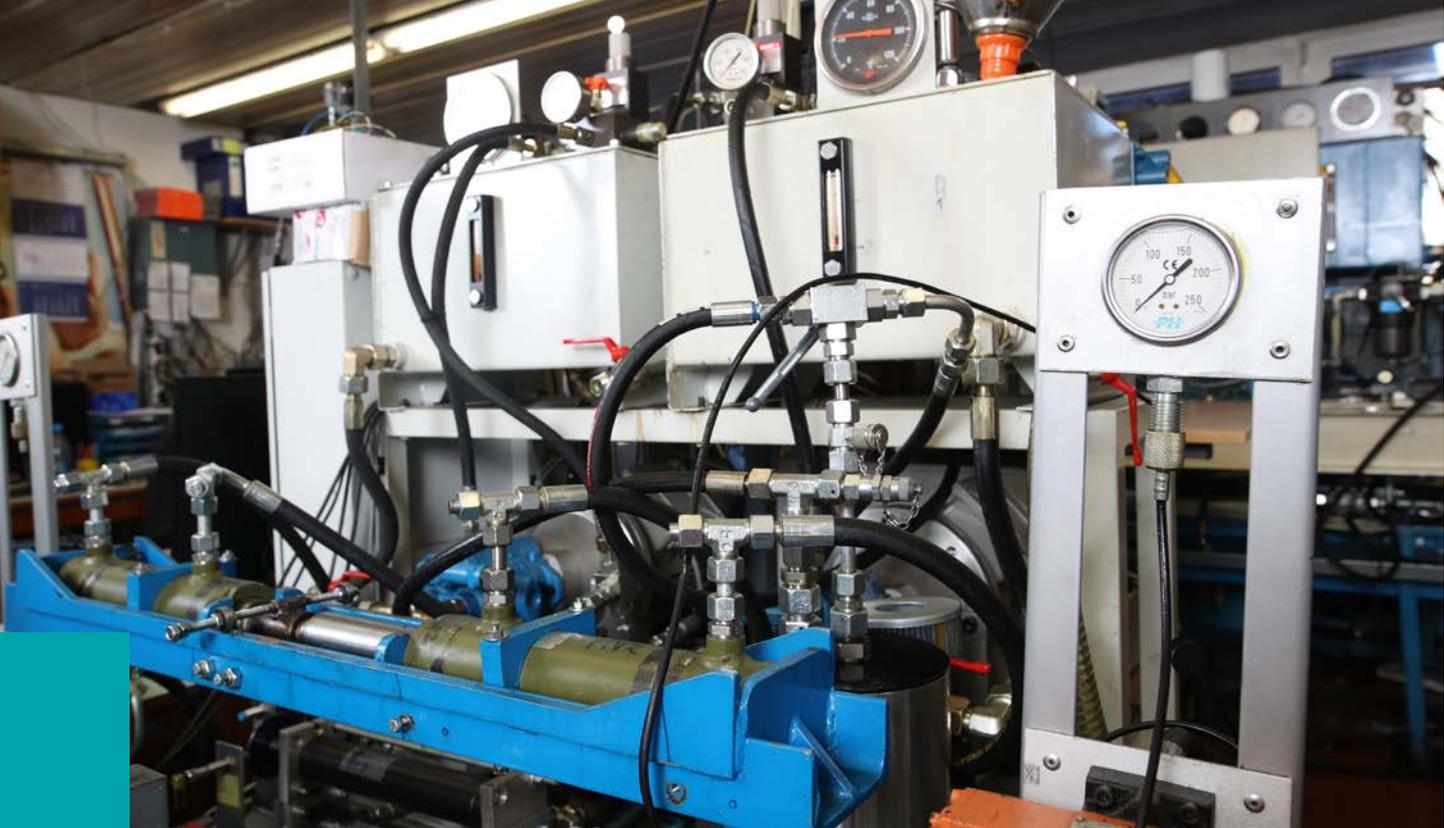
Slovenian Research Agency. Nano-engineered Green lubrication technology for sustainable high-performance stamping. Mitjan Kalin. 1.7.2018 – 30.6.2021

Slovenian Research Agency. Novel design of EHL contacts by employing solid-liquid interface phenomena. Marko Polajnar. 1.7.2019 – 30.6.2021

Slovenian Research Agency. Tribological surface design with advanced metal additive manufacturing – TriboADAM. Mitjan Kalin. 1.9.2020 - 31.8.2023

AWARDS AND ACHIEVEMENTS

Mitjan Kalin become the Congress Ambassador of Slovenia for the year 2020.



Laboratory for Fluid Power and Controls **LFT**

RESEARCH AREAS

Fluid power • Oil and water hydraulics • Numerical simulations
• Hydraulic components and systems • Control • Component and system development • Durability tests • Diagnostics in hydraulics

DEPARTMENT HEAD Assist. Prof. Franc Majdič, PhD

DEPARTMENT MEMBERS Assist. Ervin Strmčnik, Rok Jelovčan, Nejc Novak, Jožica Sterle

ORIGINAL SCIENTIFIC ARTICLE

MAJDIČ, Franc, PEZDIRNIK, Jože. Notranje puščanje hidravličnih sestavin - fizikalne osnove. Ventil: revija za fluidno tehniko in avtomatizacijo, 2020, vol. 26, no. 5, p. 350-356.

DOCTORAL DISSERTATIONS

STRMČNIK, Ervin. Influential parameters on operating of water orbital hydraulic motor. 2020. Mentor Franc Majdič.

PATENTS

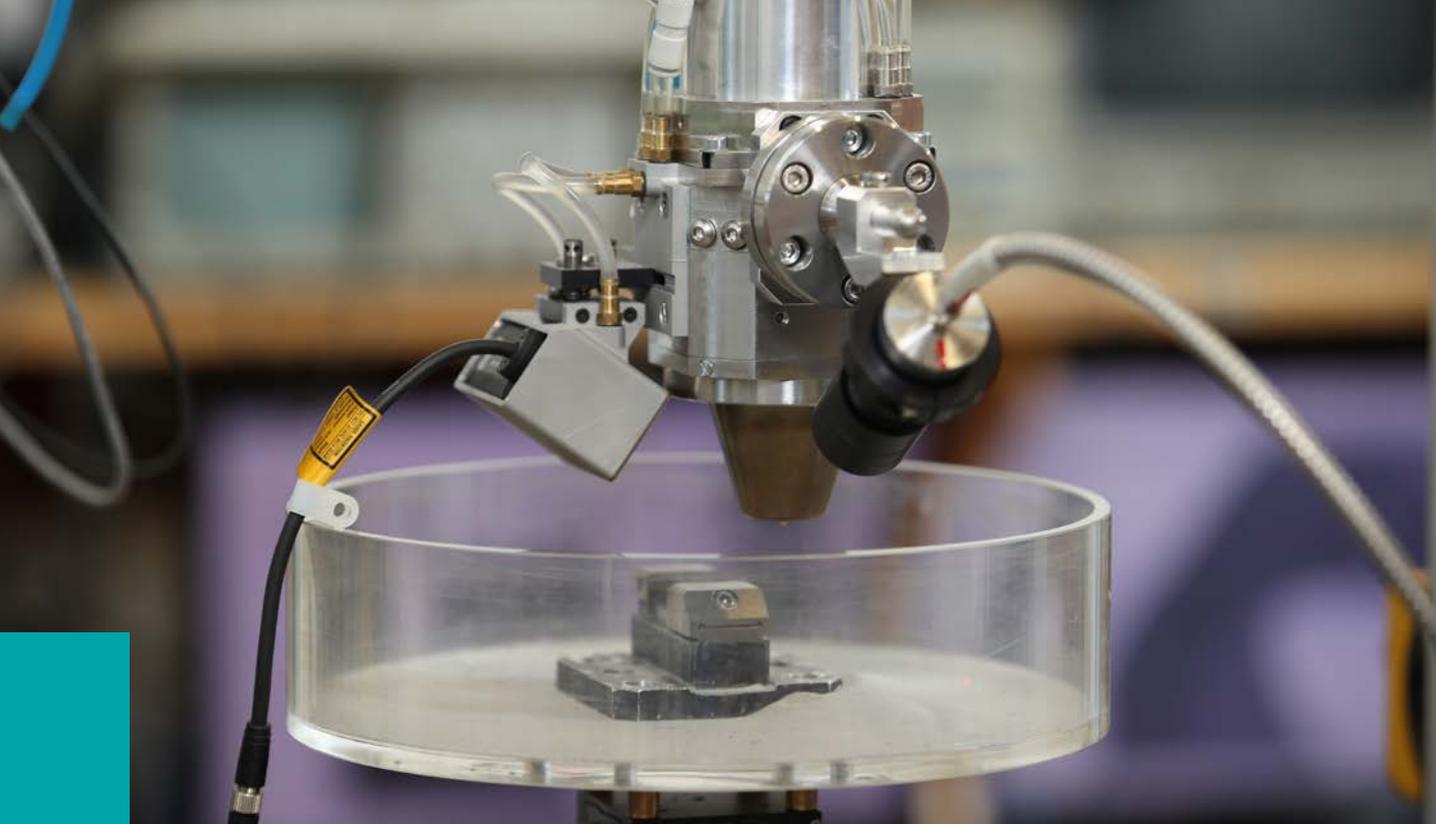
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07

SYNERGETICS OF COMPLEX SYSTEMS AND PROCESSES

Development of new as well as optimisation of existing technologies, systems and processes with complex and time-varying properties requires an understanding of the mutual nonlinear interactions which can often lead to instabilities and even chaos, and are reflected in the corresponding temporal spatial structures.

The main aim of the research programme is to contribute to world science with regards to description and understanding of complex technological systems and processes. Methods of research are based on synergetic approach to complex systems which includes use of advanced methods of probability and statistics, information theory, chaotic dynamics, soft computing, data mining, adaptive empirical modelling, machine learning, methods of optimisation and predictive control. Within the context of the programme, research is conducted in the field of additive technologies using direct laser deposition of materials, in the field of adaptive information systems for automated monitoring, optimisation and control of complex technological systems and processes, and in the field of non-destructive diagnostics of loaded materials and products.



Laboratory for Synergetics **LASIN**

RESEARCH AREAS

- Synergetics • Technology driven physics • Additive manufacturing
- Direct laser deposition • Empirical modelling and industrial diagnostics
 - Optimisation and predictive control

DEPARTMENT HEAD Prof. Edvard Govekar, PhD

DEPARTMENT MEMBERS Assist. Prof. Primož Potočnik, PhD, Assist. Andrej Jeromen, PhD, Matjaž Kotar, Assist. Jaka Peternel, Assist. Ana Vidergar, Jaka Simončič, Marta Ilešič / Teja Pirnat

ORIGINAL SCIENTIFIC ARTICLE

VENKATESH, Ragunanth, VOLOSHIN, Arkady S., EMRI, Igor, BROJAN, Miha, GOVEKAR, Edvard. Digital image correlation based internal friction characterization in granular materials. *Experimental mechanics*, 2020, vol. 60, p. 481-492.

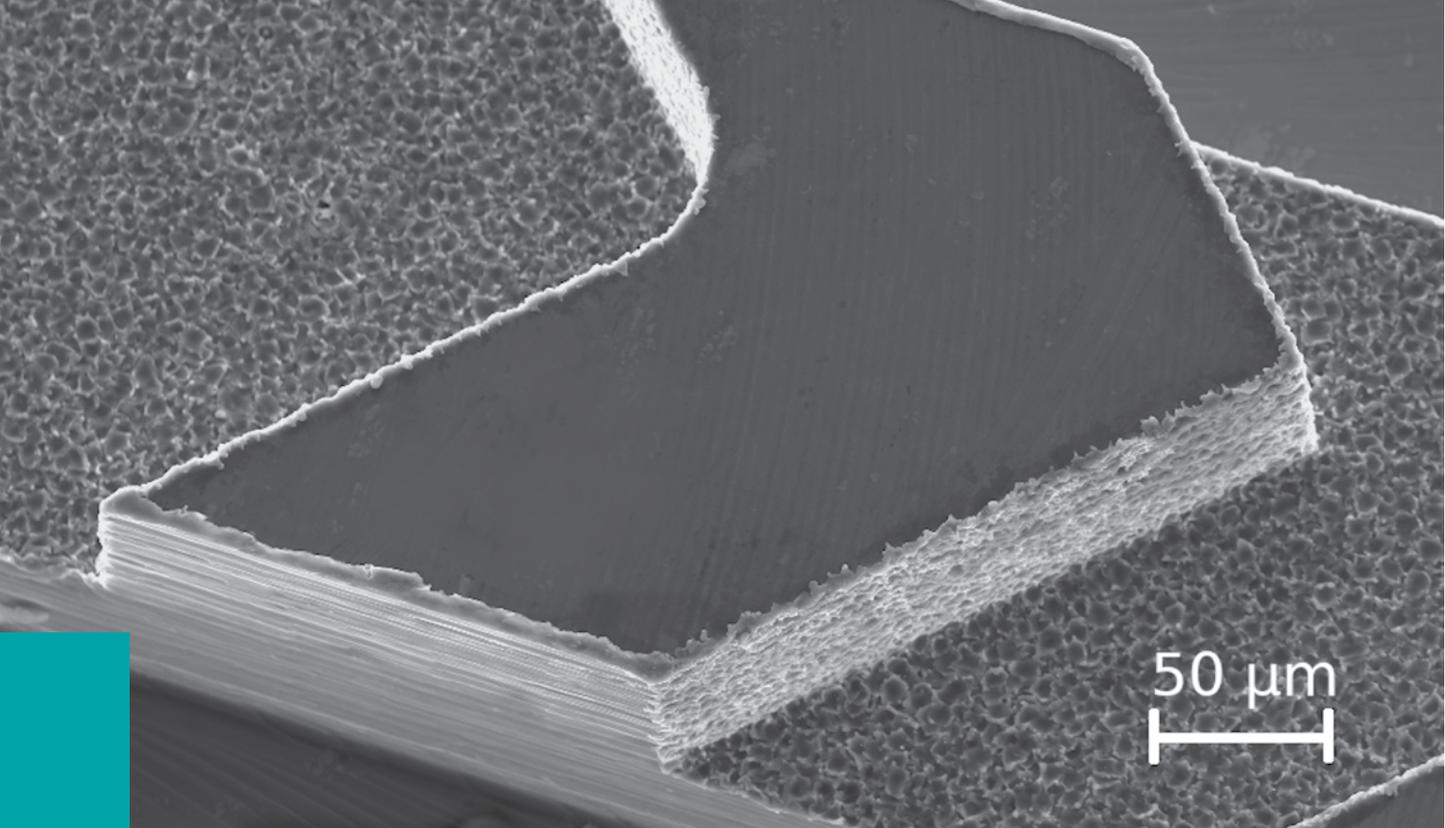
08

INNOVATIVE PRODUCTION SYSTEMS AND PROCESSES

The programme group Innovative manufacturing systems is continuing the research work from previous years with its main focus on the Smart factories concept.

The aim is to increase the efficiency and flexibility of manufacturing systems and processes (MSP), based on the principles of the Digital Factory, LEAN, AGILE and TQM and aligned with the Industry 4.0 guidelines. In constructing self-adjusting mechanisms of MSP with defined roles we are focusing on the development of an intelligent algorithm that would automatically suggest optimization steps and solutions. We will apply the above mentioned technologies, related to the Smart Factories concepts, also in the fields of smart forming tools, IceJet cutting, high-dynamic hydraulic positioning axes, intelligent MSP in the domain of assembly and packaging of the consumer products, etc.

In this way we are keeping pace with the evolution and the prospect of manufacturing systems and processes, which extends from the current state of the so-called LEAN manufacturing, through the paradigm of Manufuture to smart factories and further on to the concept of Remote factory.



Laboratory for Alternative Technologies **LAT**

RESEARCH AREAS

Unconventional machining processes • Additive technologies • Forming and machining of plastic materials and composites • Metrology
• Microtechnologies

DEPARTMENT HEAD Assoc. Prof. Joško Valentinčič, PhD

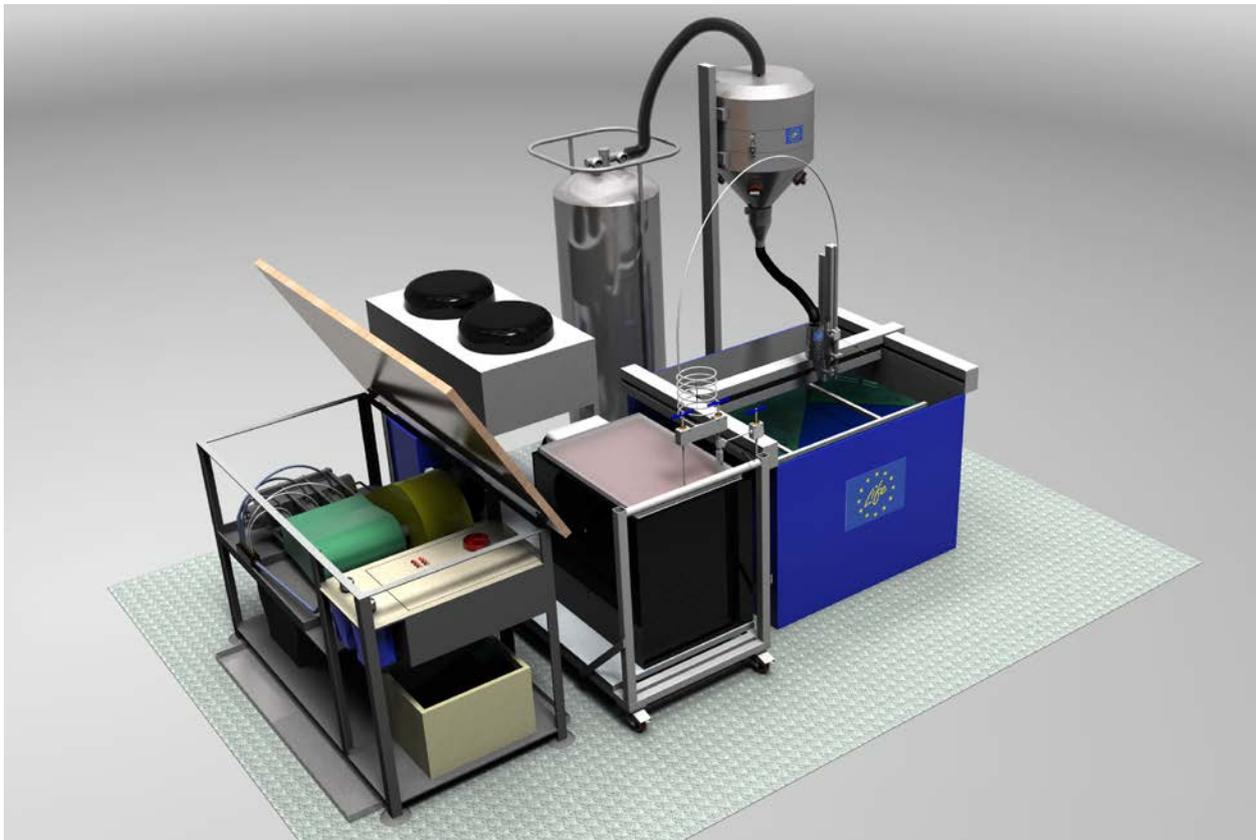
DEPARTMENT MEMBERS Assist. Prof. Andrej Lebar, PhD, Assist. Prof. Henri Orbanić, PhD, Assist. Izidor Sabotin, PhD, Assist. Marko Jerman, PhD, Assist. Suzana Vinetič, Pavel Drešar, Tanja Plestenjak

ORIGINAL SCIENTIFIC ARTICLES

ZEIDLER, Henning, VALENTINČIČ, Joško, JERMAN, Marko, KÜHNEL, Lisa, MÜLLER, Magdalena. Reststoff-Upcycling durch additive Fertigung. Holztechnologie, 2020, vol. 61, no. 3, p. 39-42.

SITAR, Anže, LEBAR, Andrej, CRIVELLARI, Michele, BAGOLINI, Alvise, GOLOBIČ, Iztok. Characterization of oscillations during flow boiling of water in parallel microchannels. Journal of engineering thermophysics, 2020, vol. 29, no. 2, p. 338-347.

VALENTINČIČ, Joško, PRIJATELJ, Miha, JERMAN, Marko, LEBAR, Andrej, SABOTIN, Izidor. Characterization of a custom-made digital light processing stereolithographic printer based on a slanted groove micromixer geometry. Journal of micro- and nano-manufacturing, 2020, vol. 8, p. 1-6.



SABOTIN, Izidor, TRISTO, Gianluca, VALENTINČIČ, Joško. Technical model of micro electrical discharge machining (EDM) milling suitable for bottom grooved micromixer design optimization. *Micromachines*, 2020, vol. 11, no. 6, p. 1-20.

PATENTS

SABOTIN, Izidor, VALENTINČIČ, Joško, PLETERSKI, Matej, JERMAN, Marko, LEBAR, Andrej, DREŠAR, Pavel. An apparatus and a method for loosening a tube section from a tube plate: GB2576062, 2020-12-14. South Wales: Intellectual Property Office, 2020.

VALENTINČIČ, Joško, SABOTIN, Izidor, RESNIK, Matic, DREŠAR, Pavel, MATJAŽ, Nejc, JERMAN, Marko, LEBAR, Andrej, PLETERSKI, Matej. Apparatus and method for cutting an electrically conductive tube = Vorrichtung und verfahren zum schneiden eines elektrisch leitenden Rohres = Appareil et procédé pour couper un tube électriquement conducteur: European patent specification EP 3 603 866 B1, 2020-12-30. München: Europäisches Patentamt, 2020.

AWARDS AND ACHIEVEMENTS

Joško Valentinčič become the Congress Ambassador of Slovenia for the year 2020



Forming Laboratory **LAP**

RESEARCH AREAS

Theory of plasticity • Forming properties of materials • Forming processes
• Biomimetics in forming • Tribology in forming, CARP, CAE, MKE

DEPARTMENT HEAD Assoc. Prof. Tomaž Pepelnjak, PhD

DEPARTMENT MEMBERS Assist. Luka Sevšek, Matjaž Rot, Tanja Plestenjak

ORIGINAL SCIENTIFIC ARTICLE

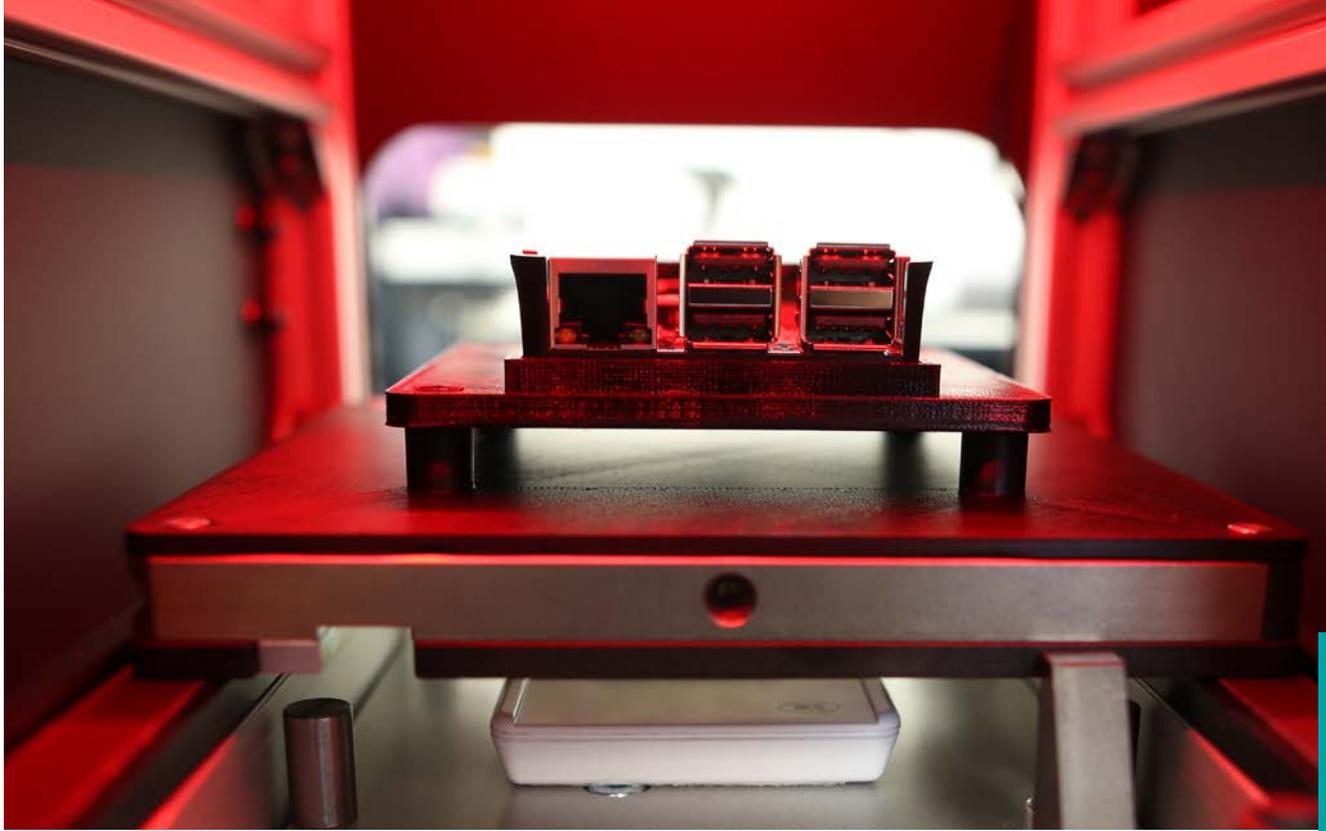
PEPELNJAK, Tomaž, KARIMI, Ako, MAČEK, Andraž, MOLE, Nikolaj. Altering the elastic properties of 3D printed poly-lactic acid (PLA) parts by compressive cyclic loading. *Materials*, 2020, vol. 13, no. 19, p. 1-18.

PROJECTS

COST - CA COST Action CA15216 - European Network of Bioadhesion Expertise: Fundamental Knowledge to Inspire Advanced Bonding Technologies. Tomaž Pepelnjak. 26.02.2016 - 20.10.2020

Ceepus Network CII-HR-0108 Concurrent Product and Technology Development - Teaching, Research and Implementation of Joint Programs Oriented in Production and Industrial Engineering. Tomaž Pepelnjak. Ongoing since 2005

Slovenian Research Agency. Adaptable hardening of austenitic steel surfaces by cryogenic forming processes. Tomaž Pepelnjak. 1.9.2020 - 31.8.2023



Laboratory for Handling, Assembly and Pneumatics **LASIM**

RESEARCH AREAS

Handling and assembly • Industry 4.0, smart factories • Discrete simulation • Production logistics • Production resources • Fluid power • Hydraulic and pneumatic control systems and components • Piezo engineering

DEPARTMENT HEAD Prof. Niko Herakovič, PhD

DEPARTMENT MEMBERS Assist. Prof. Marko Šimic, PhD, Assist. Mihael Debevec, PhD, Assist. Miha Pipan, PhD, Assist. Hugo Zupan, PhD, Assist. Jernej Protner, Assist. Matevž Resman, Edo Adrovič, Assist. Denis Jankovič, Assist. Maja Turk, Rok Živec, Andrej Kos, Tanja Plestenjak

ORIGINAL SCIENTIFIC ARTICLE

TURK, Maja, PIPAN, Miha, ŠIMIC, Marko, HERAKOVIČ, Niko. Simulation-based time evaluation of basic manual assembly tasks. *Advances in production engineering & management*, 2020, vol. 15, no. 3, p. 331-344.

TURK, Maja, PIPAN, Miha, ŠIMIC, Marko, HERAKOVIČ, Niko. A smart algorithm for personalizing the workstation in the assembly process. *Applied sciences*, 2020, vol. 10, no. 23, p. 1-19.

DEBEVEC, Mihael, ŠIMIC, Marko, JOVANOVIĆ, Vukica, HERAKOVIČ, Niko. Virtual factory as a useful tool for improving production processes. *Journal of manufacturing systems*, 2020, vol. 57, p. 379-389.



PROJECTS

Company Kolektor Group- Building Blocks, Tools and Systems for Factories of the Future - Niko Herakovič 1.10.2016-31.3.2020

Company Comnet Global. Implementation of the research and development project of digital models (digital twins) of logistics of the Postal Logistics Centre PLC Ljubljana. Niko Herakovič. 17.9.2020 - 17.6.2021

ERDF - European regional development fond SPS – Building Blocks, Tools and Systems for Factories of the Future (GOSTOP). Niko Herakovič. 01.11.2016 – 30.04.2020

Slovenian Research Agency. Adaptable hardening of austenitic steel surfaces by cryogenic forming processes. Tomaž Pepelnjak. 1.9.2020 - 31.8.2023

Slovenian Research Agency. Stochastic models for logistics of industrial processes. Janez Žerovnik. 1.9.2020 - 31.8.2023

09

ENGINEERING DESIGN

The Engineering design programme group develops basic and applied knowledge needed for the development of new products: design models and methods of innovation, in-depth application of CFX methods, PDM/PLM methods for comprehensive management of information flows in companies, physical/mathematical modelling of polymer gears, and hybrid numerical methods with code development in the field of fusion (ITER) and wider (plasma simulation).

The research was carried out in four basic directions, providing knowledge in the field of design necessary for the innovative development of new products and their implementation. The group has established supercomputing structures in the Slovenian academic environment and is integrated into projects of the supercomputer association PRACE.

Together with domestic and foreign companies (Germany, Japan, China) the group participates in projects in the fields of fusion research (ITER, MSU-USA), auxiliary heart pump (TU Eindhoven and UT Houston) and development of polymer gears and gear trains. The group also implements the model of laboratories, linked to companies.



Laboratory for Engineering Design **LECAD**

RESEARCH AREAS

Engineering design • Computer-aided design • Technical information system • Kansei engineering • Polymer gears research • High-Performance Computing • Big data analysis • Computer-intensive methods and applications • Mathematical optimisation • Plasma sheath transition research • Fusion process simulation • Integrated modelling of fusion

DEPARTMENT HEAD Assoc. Prof. Janez Povh, PhD

DEPARTMENT MEMBERS Jože Tavčar, PhD, Assist. Prof. Janez Benedičič, PhD, Assist. Prof. Leon Kos, PhD, Assist. Prof. Nikola Vukašinović, PhD, Assist. Vanja Čok, PhD, Assist. Ivan Demšar, PhD, Assist. Tomaž Finkšt, PhD, Assist. Janez Rihtaršič, PhD, Assist. Prof. Aleksander Grm, PhD, Assist. Borut Černe, Assist. Pavel Tomšič, PhD, Assist. Damijan Zorko, PhD, Assist. Primož Drešar, Assist. Timotej Hrga, Assist. Dejan Penko, MSc Janez Krek, Mateja Maffi, Luka Sedej, Matjaž Šubelj, Assist. Ivona Vasileska, Assist. Uroš Urbas, Assist. Matic Brank, Assist. Daria Vlah, Alenka Maffi, Gregor Simič, Silva Brenčič

ORIGINAL SCIENTIFIC ARTICLE

MIHELAC, Lorena, POVH, Janez. The impact of the complexity of harmony on the acceptability of music. ACM transactions on applied perception, 2020, vol. 17, no. 1, p. 1-27.

CRNKIĆ, Aladin, POVH, Janez, JAĆIMOVIĆ, Vladimir, LEVNAJIĆ, Zoran. Collective dynamics of phase-repulsive oscillator solves graph coloring problem. Chaos, 2020, vol. 30, p. 1-10.

BERNIK, Rajko, STAJNKO, Denis, DEMŠAR, Ivan. Comparison of the kernel quality of different walnuts (*Juglans regia* L.) varieties shelled with modified centrifugal sheller. *Der Erwerbs-Obstbau: Berichte aus Wissenschaft und Praxis*, 2020, vol. 62, no. 2, p. 213-220.

MIHELAC, Lorena, POVH, Janez. AI based algorithms for the detection of (ir)regularity in musical structure. *International journal of applied mathematics and computer science*, 2020, vol. 30, no. 4, p. 761-772.

VASILESKA, Ivona, KOS, Leon. Time-dependent boundary conditions during ELMs in ITER plasma. *Journal of fusion energy*, 2020, vol. 39, p. 212-220.

PENKO, Dejan, KOS, Leon, BONNIN, Xavier, PINCHES, Simon. Post-processing for ITER scrape-off layer plasma simulations (SOLPS-ITER) in IMAS framework. *Journal of fusion energy*, 2020, vol. 39, no. 5, p. 202-211.

ČERNE, Borut, LORBER, Rebeka, DUHOVNIK, Jože, TAVČAR, Jože. Influence of temperature- and strain rate-dependent viscoplastic properties of polyoxymethylene on the thermo-mechanical response of a steel-polyoxymethylene spur gear pair. *Materials today communications*, 2020, vol. 25, p. 1-14.

ČERNE, Borut, PETKOVŠEK, Martin, DUHOVNIK, Jože, TAVČAR, Jože. Thermo-mechanical modeling of polymer spur gears with experimental validation using high-speed infrared thermography. *Mechanism and machine theory*, 2020, vol. 146, p. 1-22.

KOS, Leon, BRANK, Matic, ANAND, H., PITTS, Richard, VRIES, P. C. de, SNIPES, J. A., NUNES, I., ZABEO, L., GRIBOV, Y. A framework for the assessment and control of ITER main chamber heat loads. *Nuclear fusion*, 2020, vol. 60, no. 3, p. 1-12.

COBURN, Jonathan, THOREN, E., PITTS, Richard, ANAND, H., LEHNEN, M., KOS, Leon, BRANK, Matic, RATYNSKAIA, S., TOLIAS, P. First wall energy deposition during vertical displacement events on ITER. *Physica scripta*, 2020, no. T171, p. 1-6.

TSKHAKAYA, D. D., VASILESKA, Ivona, KOS, Leon, JELIĆ, Nikola, KUHN, S. Time-dependent kinetic theory of the plasma-wall transition layer in a weakly ionized plasma. *Physics of plasmas*, 2020, vol. 27, no. 2, p. 1-15.

DARVAY, Zsolt, ILLÉS, Tibor, POVH, Janez, RIGÓ, Petra Renáta. Feasible corrector-predictor interior-point algorithm for $P^*(k)$ -linear complementarity problems based on a new search direction. *SIAM journal on optimization*, 2020, vol. 30, no. 3, p. 2628-2658.

ČOK, Vanja, VLAH, Daria, ŽAVBI, Roman. An investigation into 2D and 3D shapes perception. *Tehnički vjesnik: znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku*, 2020, vol. 27, no. 1, p. 37-45.

URBAS, Uroš, VUKAŠINOVIĆ, Nikola, DEMŠAR, Ivan. Prehod v celovito opredelitev CAD-modela (MBD). *Ventil: revija za fluidno tehniko in avtomatizacijo*, 2020, vol. 26, no. 1, p. 38-43.

DOCTORAL DISSERTATIONS

ČERNE, Borut. Predictive model for the determination of the thermo-mechanical state of polymer spur gears during running. Mentor Jožef Duhovnik.

DREŠAR, Primož. Development of biofluid pump. Mentor Jožef Duhovnik.

PROJECTS

ERDF (Smart Specialization) – MAPgears - Advanced materials, methodologies and technologies for the development of lightweight power transmission components for drives technology. Jože Tavčar. 01.09.2018 – 31.12.2021

Erasmus + ELPID - E-learning Platform for Innovative Product Development. Nikola Vukašinovič. 01.09.2018 – 31.08.2021

Erasmus + CASProD - Capitals of Smart Product Development. Nikola Vukašinovič. 01.09.2017 – 31.08.2020

Erasmus + SCTrain - Supercomputing knowledge partnership. Pavel Tomšič. 01.12.2020 – 30.11.2023

Horizon 2020 - EXDCI-2 - European eXtreme Data and Computing Initiative – 2. Roman Žavbi. 01.03.2018 – 31.08.2020

Horizon 2020 – EURATOM – EUROfusion - Implementation of activities described in the Roadmap to Fusion during Horizon 2020 through a Joint programme of the members of the EUROfusion consortium. Roman Žavbi. 01.01.2014 – 31.12.2020

Horizon 2020 - PRACE-6IP - PRACE 6th Implementation Phase Project. Janez Povh. 01.05.2019 – 31.12.2021

ITER - IPA Nomination Gregor Simič. Roman Žavbi. 01.03.2020 - 28.02.2021

ITER - Integrated Modelling Analysis Suite (IMAS). Roman Žavbi. 01.01.2020 - 15.11.2022

Ministry of Agriculture, Forestry and Food. Improvement of the process of animal feeding in dairy and meat production, considering climate change and nature conservation (EIP-AVTO). Janez Benedičič. 01.12.2020 – 30.11.2023

National Competence Centres in the framework of EuroHPC (EUROCC)- Pavel Tomšič. 01.09.2020 - 31.08.2022

Slovenian Research Agency. Extending first and second order algorithms for nested classes of optimization problems to solve computationally challenging industrial questions. Janez Povh. 1.11.2017 – 31.10.2020

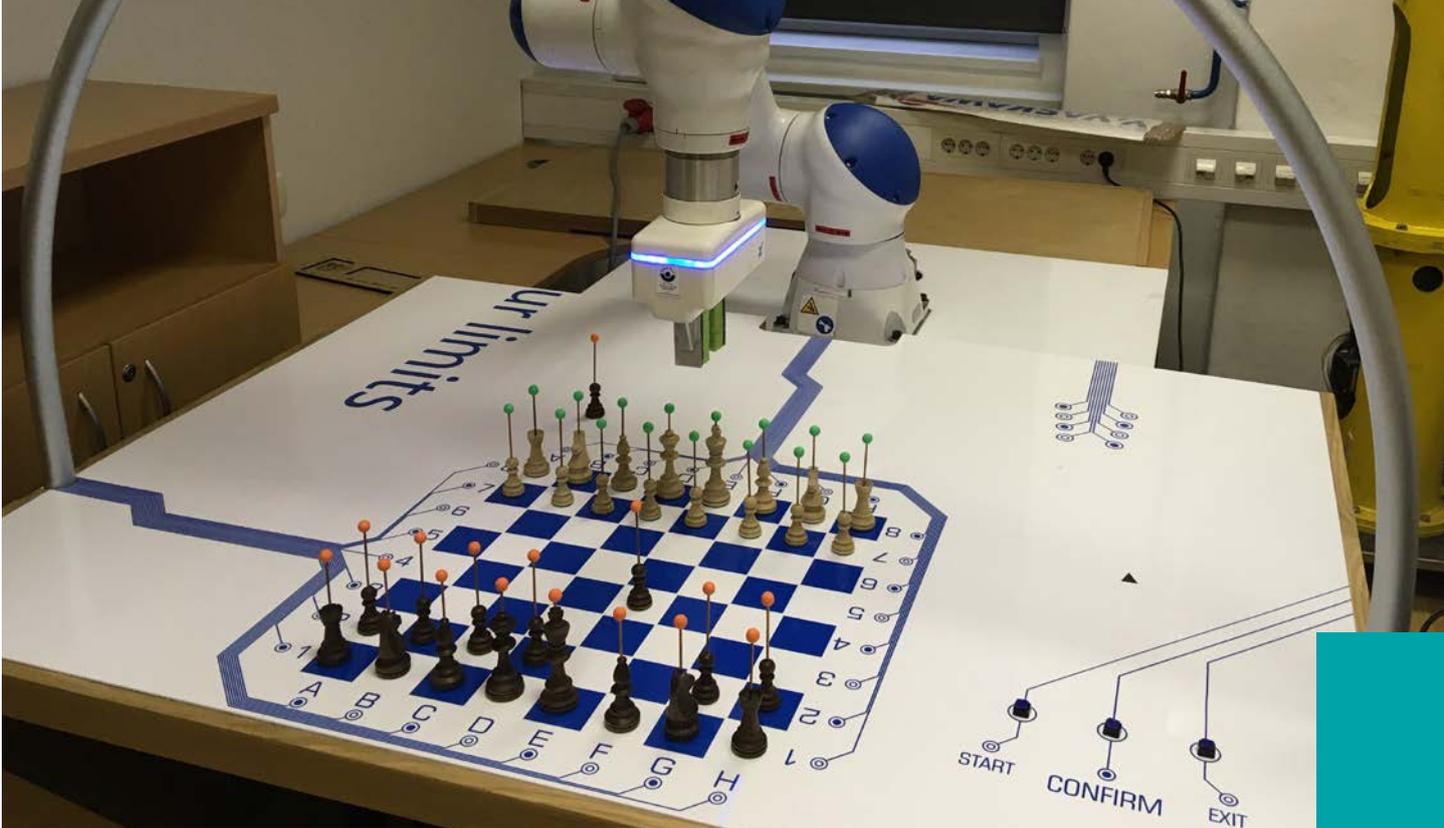
Slovenian Research Agency. Biomedical data fusion by nonnegative matrix tri-factorization. Janez Povh. 01.05.2017-30.04.2020

Slovenian Research Agency. Research collaboration prediction using literature-based discovery approach. Janez Povh. 1.9.2020 - 31.8.2023

Slovenian Research Agency. Stochastic models for logistics of industrial processes. Janez Žerovnik. 1.9.2020 - 31.8.2023

Slovenian Research Agency. Development of sustainable barn construction concepts. Janez Benedičič. 1.11.2020 - 31.10.2022

Slovenian Research Agency. Modelling for thermal control of Plasma Facing Components (PFCs) in fusion reactors. Božidar Šarler. 1.3.2020 - 28.2.2022



Laboratory for Material Handling and Machine Structures **LASOK**

RESEARCH AREAS

Load-bearing structures • Welded structures • Pressure vessels and pipelines • Lifting and transport devices • Development • Optimisation • Evaluation

DEPARTMENT HEAD Assist. Prof. Boris Jerman, PhD

DEPARTMENT MEMBERS Assist. Jurij Hladnik, PhD, MSc Franc Resman, Assist. Luka Bizjak, Silva Brenčič

PROJECTS

Slovenian Research Agency. Warehousing 4.0 – Integration model of robotics and warehouse order-picking systems. Boris Jerman. 1.9.2020 - 31.8.2023

10

MECHANICS IN ENGINEERING

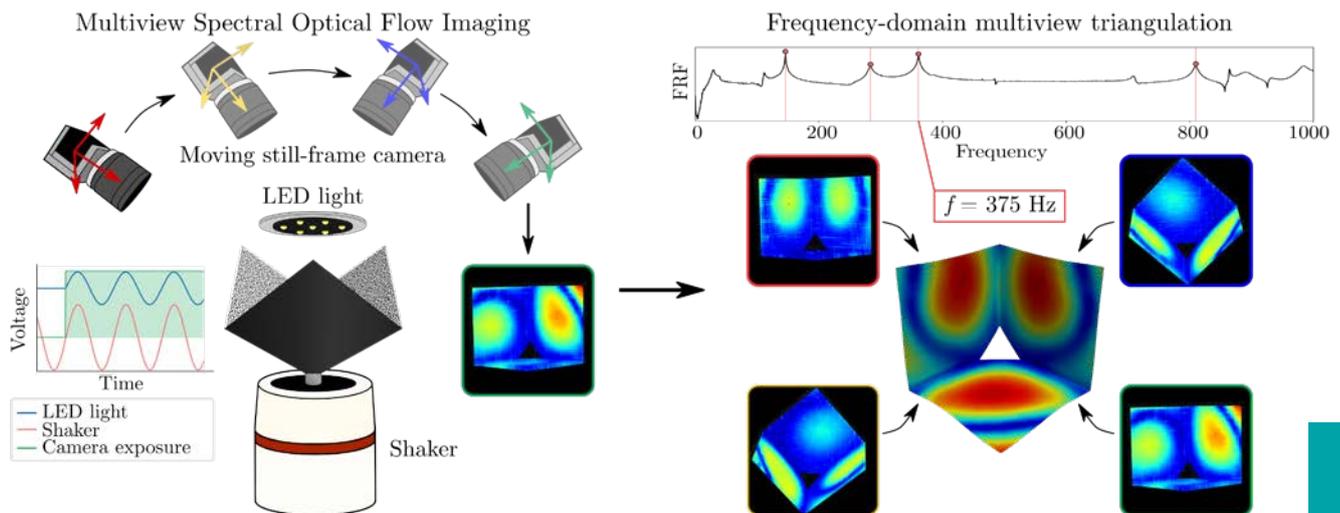
The Mechanics in engineering programme group consists of four laboratories: The Laboratory for Dynamics of Machines and Structures (LADISK), the Laboratory for Numerical Modelling and Simulation (LNMS), the Laboratory for Non-Linear Mechanics (LANEM) and the Laboratory for aeronautics (AEROL).

LADISK: Within the context of flexible multibody system dynamics, the research is focussed on advanced methods of valid nonlinear dynamics modelling of rigid-flexible multibody systems with unilateral contacts or large displacements/deformations. In the field of structural dynamics, the group is focussed on management of vibration fatigue and product noise. Here, the main emphasis is on research into valid models. Research activities are also geared toward smart structures with sensing function and the development of advanced optical methods for identifying dynamic parameters of structures.

LNMS: Long-term research activities are related to the constitutive modelling of the metallic materials response and the development of numerical methods in this field, whereby the numerical aspect of an effective integration of developed algorithms into the FEM programs is crucial. The more complex constitutive models also require the development of algorithms for inverse identification of model parameters.

LANEM: The theory of elasticity and thermoelasticity, geometric and material nonlinearities, stability, fluid mechanics, inelastic deformation, materials with shape memory, characterization of mechanical properties of materials, biomechanics.

AEROL: Development of unmanned aerial vehicles and systems, research into the possibility of controlling unmanned aerial vehicles using cameras and ground landmarks in areas without the GPS signal, aircraft calculation, calculation and measurement of resistance, lift and torque of aerodynamic bodies, measurement of aerodynamic properties and airflow around bodies in the wind tunnel, construction and testing components related to firearms, modelling and mold making for the manufacture of composite parts of unmanned aerial vehicles.



Laboratory for Dynamics of Machines and Structures **LADISK**

RESEARCH AREAS

- Mechanics • Dynamics • Dynamics of machines and structures
- Structural dynamics • Vibration fatigue • Mechanical vibrations
- Nonlinear vibrations • Dynamics of rigid and flexible multibody systems • Structure-borne noise • Signal processing (CWT, HOS)
- Rotor dynamics • Automatic fault detection in mechanical systems
- Dynamics of moving continua • Digital image correlation methods

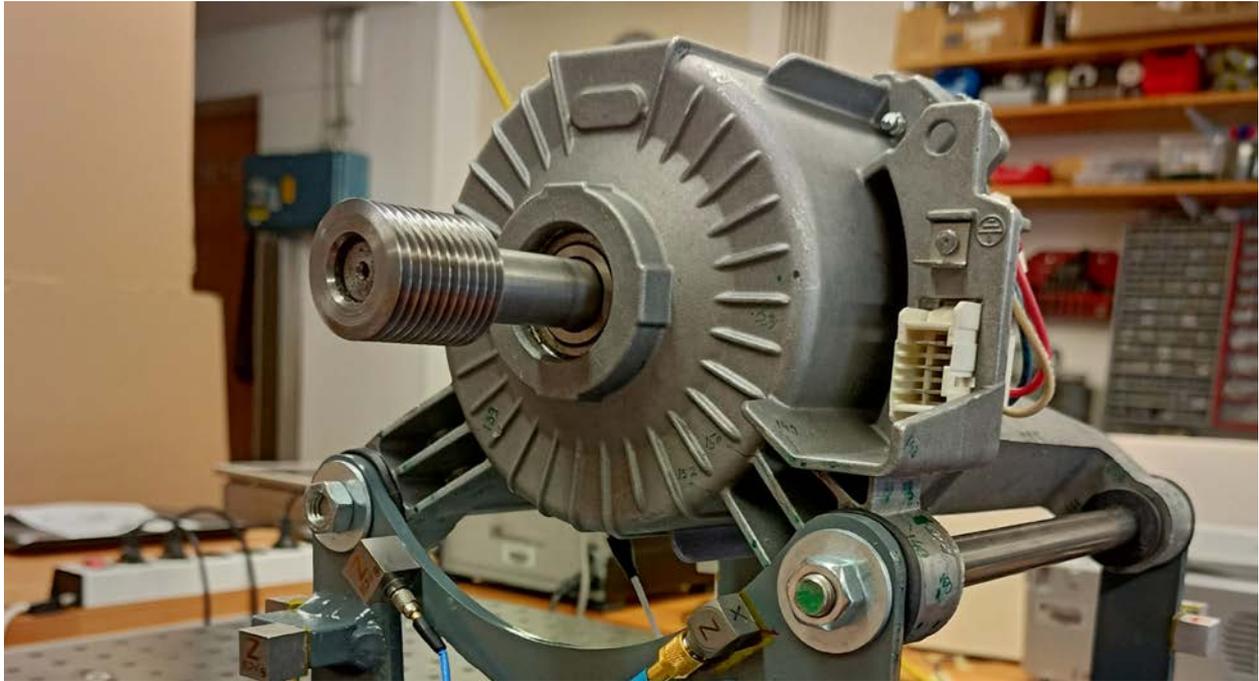
DEPARTMENT HEAD Prof. Miha Boltežar, PhD

DEPARTMENT MEMBERS Prof. Janko Slavič, PhD, Assoc. Prof. Gregor Čepon, PhD, Assist. Prof. Martin Česnik, PhD, Assist. Blaž Starc, PhD, Vitoslav Bratuš, PhD, Aleš Mihelič, PhD, Assist. Tibor Barši Palmič, Assist. Miha Kodrič, Assist. Miha Pogačar, Assist. Domen Gorjup, Assist. Klemen Zaletelj, Assist. Martin Furlan, PhD, Assist. Matic Arh, Luka Kenk, Assist. Domen Ocepek, Assist. Aleš Zorman, Tilen Košir, Teja Pirnat

ORIGINAL SCIENTIFIC ARTICLE

ARH, Matic, SLAVIČ, Janko, BOLTEŽAR, Miha. Experimental identification of the dynamic piezoresistivity of fused-filament-fabricated structures. Additive manufacturing, 2020, vol. 36, p. 1-10.

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BREGAR, Tomaž, HOLEČEK, Nikola, ČEPON, Gregor, RIXEN, Daniel J., BOLTEŽAR, Miha. Including directly measured rotations in the virtual point transformation. *Mechanical systems and signal processing*, 2020, vol. 141, p. 1-21.

LISITANO, Domenico, SLAVIČ, Janko, BONISOLI, Elvio, BOLTEŽAR, Miha. Strain proportional damping in Bernoulli-Euler beam theory. *Mechanical systems and signal processing*, 2020, vol. 145, p. 1-15.

VIRTANEN, Pauli, SLAVIČ, Janko, GOMMERS, Ralf, OLIPHANT, Travis E., HABERLAND, Matt, REDDY, Tyler, COURNAPEAU, David, BUROVSKI, Evgeni, PETERSON, Pearu, WECKESSER, Warren, et al. SciPy 1.0: fundamental algorithms for scientific computing in Python. *Nature methods*, 2020, vol. 17, p. 261-272.

BARŠI PALMIČ, Tibor, SLAVIČ, Janko, BOLTEŽAR, Miha. Process parameters for FFF 3D-printed conductors for applications in sensors. *Sensors*, 2020, vol. 20, no. 16, p. 1-21.

PROJECTS

Company Dewesoft. Software development for the customer. Miha Boltežar. 30.9.2019 - ongoing project

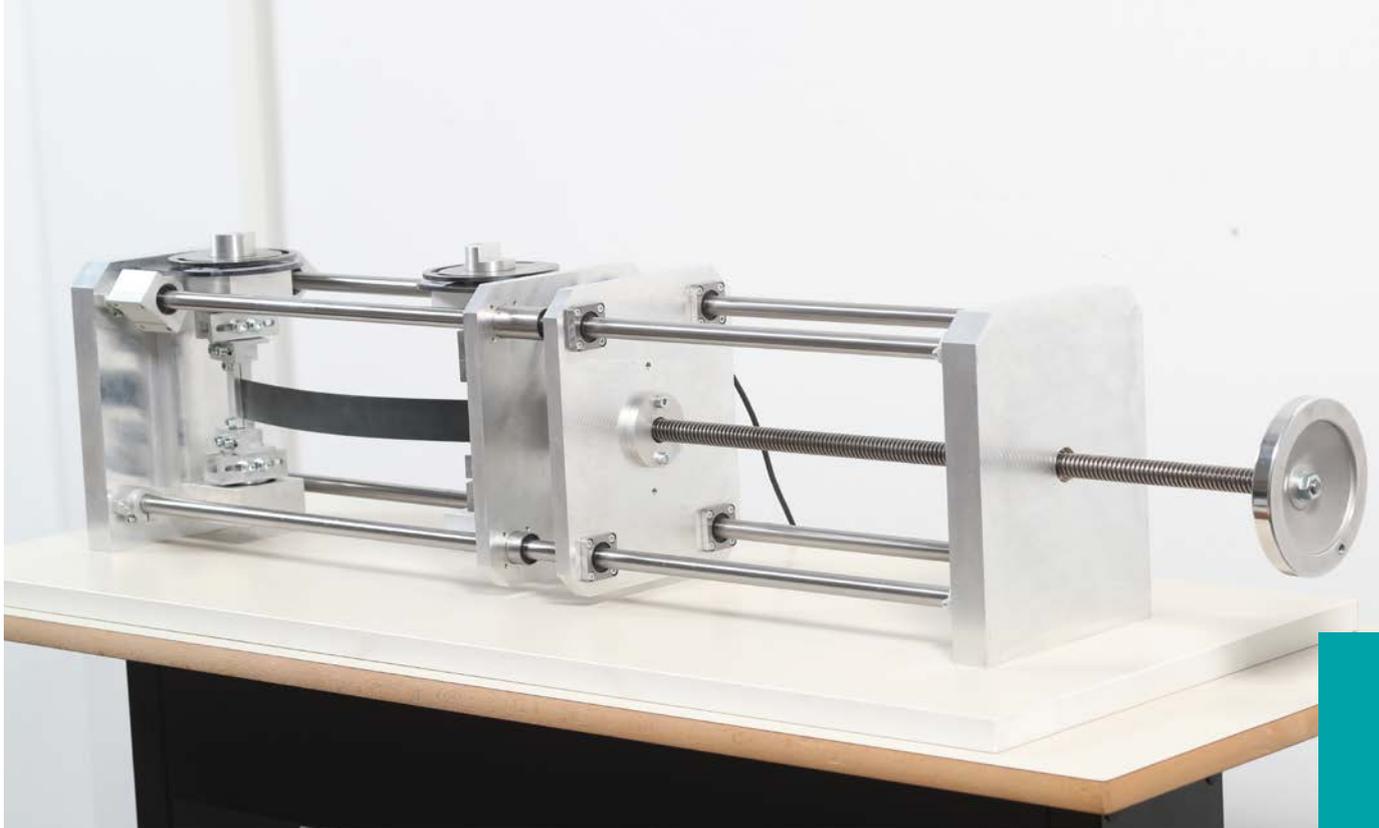
Company Gorenje - Research development cooperation and lease of capacities for numerical analyses and performance of measurements and tests. Miha Boltežar. 27.6.2019-26.6.2021

ERDF (Smart Specialization) MOZTART - More efficient electric motors with the development of an EXPERT system and new technologies. Miha Boltežar. 1.10.2018 - 30.9.2021

Slovenian Research Agency. Hybrid Dynamic Substructuring in the Industry of Home Appliances. Miha Boltežar. 1.7.2019 - 30.6.2022

Slovenian Research Agency. High-speed-camera based high-spatial-density sensing of 3D vibrations with applications in digital-twins and remote sensing. Janko Slavič. 1.7.2019 - 30.6.2022

Slovenian Research Agency. Vision based reduced order modeling approach for operational parameter identification of nonlinear finite element models. Miha Boltežar. 1.1.2020 - 31.12.2023



Laboratory for Non-Linear Mechanics **LANEM**

RESEARCH AREAS

Nonlinear mechanics • Stability • Mechanics of materials • Materials with shape memory

DEPARTMENT HEAD Assist. Prof. Miha Brojan, PhD

DEPARTMENT MEMBERS Assist. Prof. Viktor Šajn, PhD, Assist. Prof. Tomaž Videnič, PhD, Assist. Matjaž Čebtron, PhD, Assist. Matej Bogataj, Assist. Jan Zavodnik, Jonas Trojer, Assist. Tomaž Brzin, Assist. Enej Istenič, Teja Pirnat

ORIGINAL SCIENTIFIC ARTICLE

BRANK, Boštjan, VELDIN, Tomo, LAVRENČIČ, Marko, BROJAN, Miha. A comparison of computational models for wrinkling of pressurized shell-core systems. *International journal of non-linear mechanics*, 2020, vol. 127, p. 1-9.

RAHMANI, Ramin, BROJAN, Miha, ANTONOV, Maksim, PRASHANTH, Konda Gokuldoss. Perspectives of metal-diamond composites additive manufacturing using SLM-SPS and other techniques for increased wear-impact resistance. *International journal of refractory metals & hard materials*, 2020, vol. 88, p. 1-13.

RAHMANI, Ramin, ANTONOV, Maksim, BROJAN, Miha. Lightweight 3D printed Ti6Al4V-AlSi10Mg hybrid composite for impact resistance and armor piercing shielding. *Journal of Materials Research and Technology*, 2020, vol. 9, no. 6, p. 13842-13854.

LAVRENČIČ, Marko, BRANK, Boštjan, BROJAN, Miha. Multiple wrinkling mode transitions in axially compressed cylindrical shell-substrate in dynamics. *Thin-walled structures*, 2020, vol. 150, no. 1, p. 1-12.



LOLIĆ, Damjan, ZUPAN, Dejan, BROJAN, Miha. A consistent finite element formulation for laminated composites with nonlinear interlaminar constitutive law. *Composite structures*. sep. 2020, no. 112445, p. 1-13.

LOLIĆ, Damjan, ZUPAN, Dejan, BROJAN, Miha. A consistent strain-based beam element with quaternion representation of rotations. *Computational mechanics*. May 2020, vol. 65, iss. 5, p. 1397-1415.

BRANK, Boštjan, VELDIN, Tomo, LAVRENČIČ, Marko, BROJAN, Miha. A comparison of computational models for wrinkling of pressurized shell-core systems. *International journal of non-linear mechanics*. [Print ed.]. 2020, p. 1-24. <https://doi.org/10.1016/j.ijnonlinmec.2020.103611>.

RAHMANI, Ramin, BROJAN, Miha, ANTONOV, Maksim, PRASHANTH, Konda Gokuldoss. Perspectives of metal-diamond composites additive manufacturing using SLM-SPS and other techniques for increased wear-impact resistance. *International journal of refractory metals & hard materials*. [Print ed.]. Apr. 2020, vol. 88, str. 1-13.

RAHMANI, Ramin, ANTONOV, Maksim, BROJAN, Miha. Lightweight 3D printed Ti6Al4V-AISi10Mg hybrid composite for impact resistance and armor piercing shielding. *Journal of Materials Research and Technology*. Nov.-Dec. 2020, vol. 9, iss. 6, p. 13842-13854.

LAVRENČIČ, Marko, BRANK, Boštjan, BROJAN, Miha. Multiple wrinkling mode transitions in axially compressed cylindrical shell-substrate in dynamics. *Thin-walled structures*. may 2020, no. 1, 106700, p. 1-12.

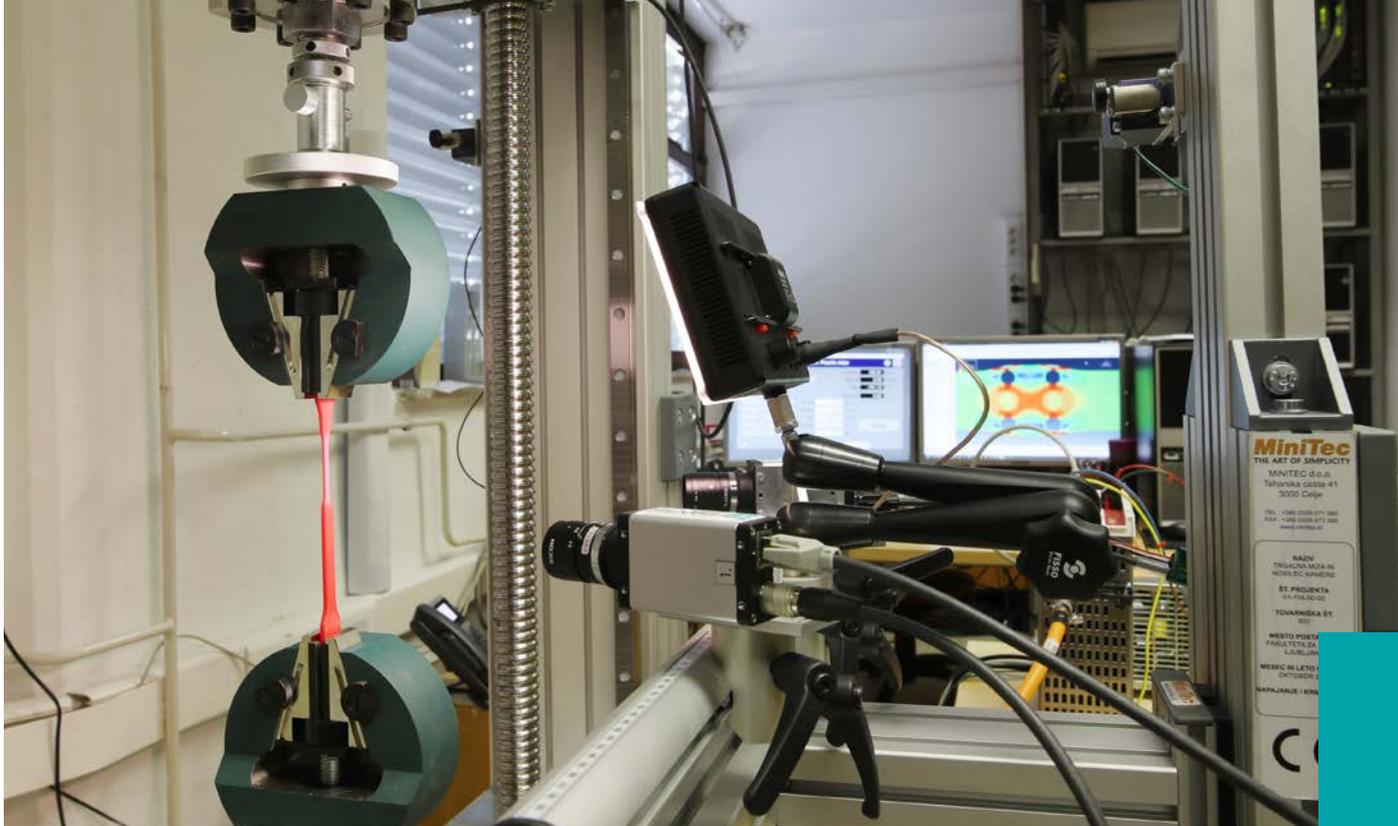
DOCTORAL DISSERTATION

LOLIĆ, Damjan. Finite deformations of three-dimensional composite beams with non-linear contact between layers. Mentor Miha Brojan.

PROJECTS

Slovenian Research Agency. Crystallography of wrinkled elastic surfaces. Miha Brojan. 1.7.2018 – 30.6.2021

Slovenian Research Agency. Development of quasi-periodic deformation patterns in viscoelastic structures. Miha Brojan. 1.9.2020 - 31.8.2023



Laboratory for Numerical Modelling and Simulation LNMS

RESEARCH AREAS

Mechanics • Numerical methods • Computer simulations of technological processes • Modelling of thermomechanical processes
 • Optimisation of products and processes • Nuclear engineering
 • Constitutive modelling • Electromagnetism • Finite element method and boundary element method

DEPARTMENT HEAD Assist. Prof. Miroslav Halilović, PhD

DEPARTMENT MEMBERS Assoc. Prof. Nikolaj Mole, PhD, Assist. Prof. Pino Koc, PhD, Assist. Kristjan Krebelj, PhD, Assist. Primož Rus, PhD, Assist. Prof. Bojan Starman, PhD, Assist. Janez Urevc, PhD, MSc Andrej Kotar, Assist. Štefan Obid, Assist. Tomaž Kastelic, Assist. Andraž Maček, Assist. Matija Nabergoj, Teja Pirnat

ORIGINAL SCIENTIFIC ARTICLE

STARMAN, Bojan, MAČEK, Andraž, RUS, Primož, OBID, Štefan, KRALJ, Aleš, HALILOVIČ, Miroslav. Primary seal deformation in multipane glazing units. Applied sciences, 2020, vol. 10, no. 4, p. 1-20.

STARMAN, Bojan, HALLBERG, Håkan, WALLIN, Mathias, RISTINMAA, Matti, HALILOVIČ, Miroslav. Differences in phase transformation in laser peened and shot peened 304 austenitic steel. International journal of mechanical sciences, 2020, vol. 176, p. 1-18.

MAČEK, Andraž, STARMAN, Bojan, MOLE, Nikolaj, HALILOVIČ, Miroslav. Calibration of advanced yield criteria using uniaxial and heterogeneous tensile test data. *Metals*, 2020, no. 4, vol. 10, p. 1-17.

STARMAN, Bojan, HALLBERG, Håkan, WALLIN, Mathias, RISTINMAA, Matti, MOLE, Nikolaj, HALILOVIČ, Miroslav. Modelling of the mechanical response in 304 austenitic steel during laser shock peening and conventional shot peening. *Procedia manufacturing*, 2020, vol. 47, p. 450-457.

RUS, Primož, UREVC, Janez, STARMAN, Bojan, KLINAR, Dušan, MLADENOVIC, Ana, KOŠIR, Mateja, HALILOVIČ, Miroslav. Izgradnja in krmiljenje pilotne naprave za recikliranje izrabljenega katodnega odpadka iz proizvodnje aluminija. *Ventil: revija za fluidno tehniko in avtomatizacijo*, 2020, vol. 26, no. 2, p. 104-112.

PATENTS

KRALJ, Aleš, ŽNIDARŠIČ, Matjaž, HALILOVIČ, Miroslav, VRH, Marko, ŠTOK, Boris. Building panel as structure of external and inner plate with intermediate insulation space: EP2464799 (B1), 2020-05-06. Munich: European Patent Office, 2020.

KRALJ, Aleš, ŽNIDARŠIČ, Matjaž, HALILOVIČ, Miroslav. Multichamber gas-filled insulated glass unit = Gasgefüllte isolierte Mehrkammerglaseinheit = Unité de verre isolant à plusieurs chambres remplie de gaz: European patent specification EP 3 323 952 B1, 2020-07-08. München: Europäisches Patentamt, 2020.

MAČEK, Andraž, UREVC, Janez, HALILOVIČ, Miroslav. Ureditev razstavljljive in po izbiri tesnjene zveze med drug v drugega vstavljivim moškim in ženskim strojnim delom: patent SI 25741 A, 2020-05-29. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2020.

PROJECTS

Company Nuklearna elektrarna Krško. Independent expert report for Mod. 1005- SI -L and 1010- AF -L. Miroslav Halilovič. 23.8.2019 - 31.3.2020

Company Nuklearna elektrarna Krško. ASME and Safety Related Design Review Analysis of Equipment Suppliers for the BB2 Security Upgrade Project. Miroslav Halilovič. 12.6.2020 - 31.12.2021

EIT KIC RawMaterials - SPL-CYCLE - Closing the loop of the Spent Pot-line (SPL) in Al smelting process. Miroslav Halilovič 01.02.2018 - 31.03.2021

ERDF (Smart Specialization) MOZTART - More efficient electric motors with the development of an EXPERT system and new technologies. Nikolaj Mole. 1.10.2018 - 30.9.2021

AWARDS AND ACHIEVEMENTS

Bojan Starman and Andraž Maček received an award of the Faculty of Mechanical Engineering for high quality publications.



Laboratory for aeronautics **AEROL**

RESEARCH AREAS

Construction mechanics • Special development know-how • Special constructions know-how

DEPARTMENT HEAD Assoc. Prof. Tadej Kosel, PhD

DEPARTMENT MEMBERS Assist. Igor Petrović, PhD, Teja Pirnat

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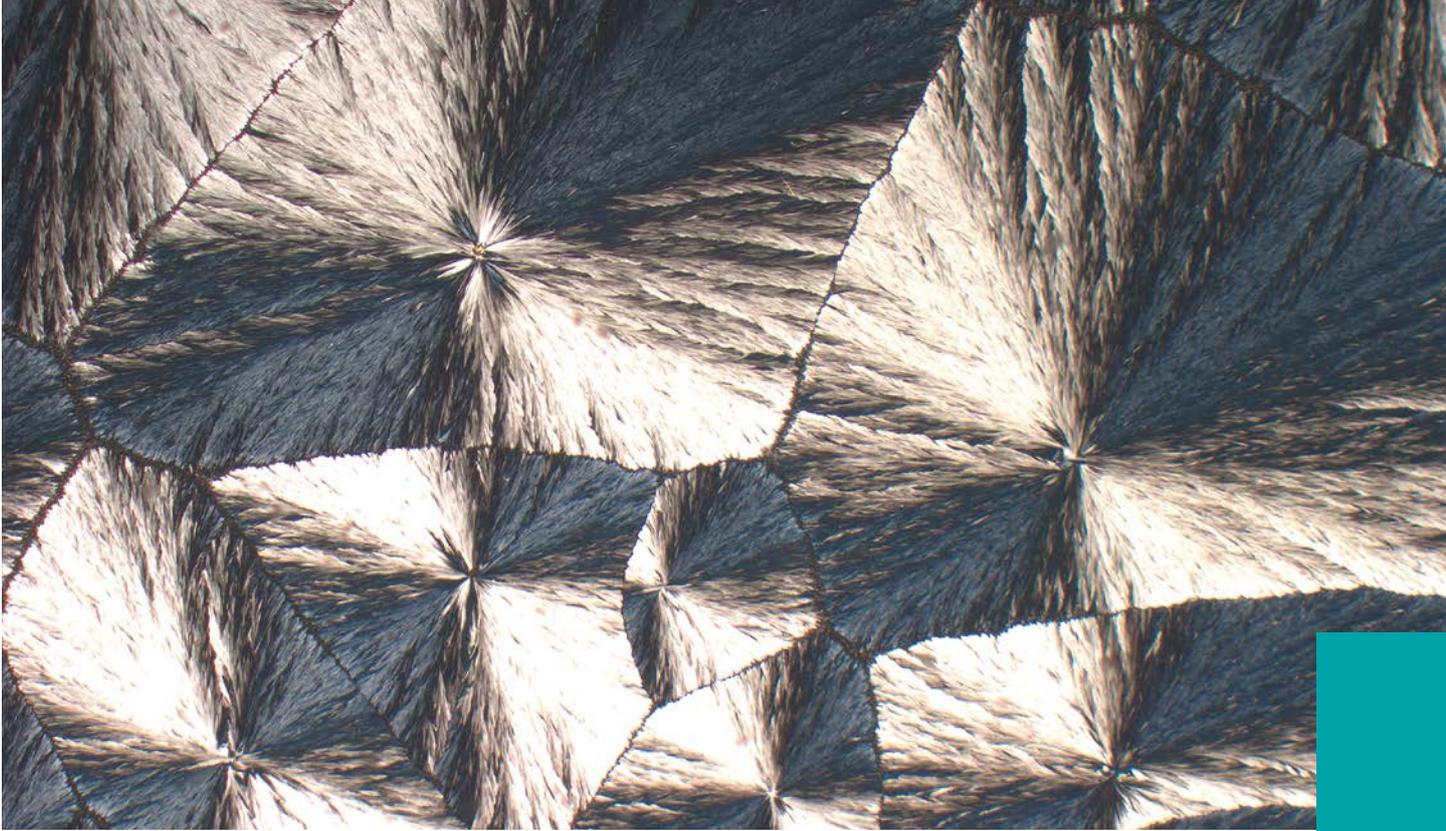
SUSTAINABLE POLYMER MATERIALS AND TECHNOLOGIES

The Sustainable polymer materials and technologies programme group covers basic research on non-linear time-dependent behaviour of polymers and their composites which are regarded as dissipative systems. The programme is divided into three complementary research spheres:

SPHERE 1: Study of the structure-property relationship in polymeric materials (without changing their chemical composition) and the means of controlling their inherent topological structure. This allows us to control their physical properties and, consequently, to fit properties of polymeric materials to a particular application.

SPHERE 2: Development of experimental methods for analyzing dissipative time-dependent behaviour of materials that will allow characterisation and prediction of the durability of products made of polymeric materials.

SPHERE 3: Development of theoretical models and numerical tools which, together with new experimental methods, can be used to predict the mechanical behaviour of polymers and their nano-, micro-, and macrocomposites over a longer period of time.



Laboratory for Experimental Mechanics **LEM**

RESEARCH AREAS

Polymers • Composites • Nanomaterials • Time-dependent behaviour of materials • Experimental mechanics • Modelling of mechanical properties of materials • Technology of polymer processing • Material structure formation

DEPARTMENT HEAD Assist. Prof. Lidija Slemenik Perše, PhD

DEPARTMENT MEMBERS Assist. Alexandra Aulova, PhD, Assist. Marko Bek, PhD, Assist. Mohor Mihelčič, PhD, Assist. Alen Oseli, Król Elžbieta, Assist. Damjan Lolič, PhD, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

BEK, Marko, GONZALEZ-GUTIERREZ, Joamin, KUKLA, Christian, PUŠNIK ČREŠNAR, Klementina, MAROH, Boris, SLEMENIK PERŠE, Lidija. Rheological behaviour of highly filled materials for injection moulding and additive manufacturing: effect of particle material and loading. Applied sciences, 2020, vol. 10, no. 22, p. 1-23.

PUŠNIK ČREŠNAR, Klementina, FRAS ZEMLJIČ, Lidija, SLEMENIK PERŠE, Lidija, BEK, Marko. Effect of wood fiber loading on the chemical and thermo-rheological properties of unrecycled and recycled wood-polymer composites. Applied sciences, 2020, vol. 10, no. 24, p. 1-17.

LOLIČ, Damjan, ZUPAN, Dejan, BROJAN, Miha. A consistent finite element formulation for laminated composites with nonlinear interlaminar constitutive law. Composite structures, 2020, vol. 247, no. 112445, p. 1-13.

LOLIĆ, Damjan, ZUPAN, Dejan, BROJAN, Miha. A consistent strain-based beam element with quaternion representation of rotations. *Computational mechanics*, 2020, vol 65, p. 1397-1412.

OSELI, Alen, VESEL, Alenka, MOZETIČ, Miran, ŽAGAR, Ema, HUSKIĆ, Miroslav, SLEMENIK PERŠE, Lidija. Nano-mesh superstructure in single-walled carbon nanotube/polyethylene nanocomposites, and its impact on rheological, thermal and mechanical properties. *Composites. Part A, Applied science and manufacturing*, 2020, vol. 136, p. 1-10.

OSELI, Alen, BIZJAN, Benjamin, KRÓL, Elżbieta, ŠIROK, Brane, SLEMENIK PERŠE, Lidija. Tensile properties of mineral fibers determined with Sentmanat extensional rheometer. *Construction & building materials*, 2020, vol. 253, p. 1-12.

OSELI, Alen, PRODAN, Ted, SUSIČ, Egon, SLEMENIK PERŠE, Lidija. The effect of short fiber orientation on long term shear behavior of 40% glass fiber reinforced polyphenylene sulfide. *Polymer testing*, 2020, vol. 81, p. 1-12.

RODOŠEK, Mirjana, MIHELČIČ, Mohor, ČOLOVIĆ, Marija, ŠEST, Ervin, ŠOBAK, Matic, JERMAN, Ivan, SURCA, Angelja Kjara. Tailored crosslinking process and protective efficiency of epoxy coatings containing glycidyl-POSS. *Polymers*, 2020, vol. 12, no. 3, p. 1-18.

AULOVA, Alexandra, BEK, Marko, KOSOVICH, Leonid, EMRI, Igor. Needleless electrospinning of PA6 fibers: the effect of solution concentration and electrospinning voltage on fiber diameter. *Strojniški vestnik*, 2020, vol. 66, no. 6, p. 421-430.

RŽEK, Lidija, TUŠAR, Marjan, SLEMENIK PERŠE, Lidija. Modelling rheological characteristics of rejuvenated aged bitumen. *The International journal of pavement engineering*. 2020, p. 1-13.

PROJECTS

Slovenian Research Agency. Development of complex shape multicomponent permanent magnets with the use of advanced 3D printing technology. Spomenka Kobe. 1.7.2019 – 30.6.2022

Slovenian Research Agency. Rheological behavior and mechanical properties for processing of highly filled powder – polymer systems. Lidija Slemenik Perše. 1.11.2018 – 31.10.2021

Slovenian Research Agency. Neural networks for determination of polymer creep response at different temperatures. Alexandra Aulova. 1.7.2019 – 30.6.2021

AWARDS AND ACHIEVEMENTS

Alen Oseli received an award of the Faculty of Mechanical Engineering for high quality publications.

12

ADVANCED MANUFACTURING TECHNOLOGIES FOR HIGH QUALITY AND SUSTAINABLE PRODUCTION

Slovenian industry has a significant impact on the development of economy, employment, innovations and export. A large part of the economy depends on the competitiveness of the manufacturing industry. Thus, the concept of rapid production, innovative machining technologies, manufacturing technology management and the idea of sustainable development are becoming key research areas for increasing the competitiveness of the Slovenian processing industry.

Long-term research content focuses on the development, transfer and research support of high-performance machining technologies (cutting, 3D printing, etc.), including the implementation of sustainable development considerations in manufacturing technologies in response to environmental, social and economic challenges. The focus is not limited to innovations in technology, but also on providing integrated development solutions.

The research domains of the programme group are complementary, and to a certain extent interdisciplinary, comprised of:

- advanced machining processes;
- technology and resource efficiency;
- quality engineering for manufacturing;
- human-centered manufacturing.



Laboratory for Cutting **LABOD**

RESEARCH AREAS

Technology and product planning • Sustainable development of machining processes • Research of machining processes • Development of new machining processes (cryogenic machining, the novel dry machining) • Characterisation of material machinability • High-speed hard milling for the tool industry • Machine tools • Machining process sensors • Reverse engineering • 3D prototype printing • Characterisation of machining surface quality • Product precision and accuracy

DEPARTMENT HEAD Assoc. Prof. Franci Pušavec, PhD

DEPARTMENT MEMBERS Assoc. Prof. Peter Krajnik, PhD, Res. Assoc. Radovan Dražumerič, PhD, Assist. David Homar, PhD, Assist. Awais Ikram, PhD, Assist. Jani Kenda, PhD, Assist. Jaka Dugar, Assist. Matjaž Kern, David Muženič, Vinko Rotar, Luka Sterle, Marija Jeretina

ORIGINAL SCIENTIFIC ARTICLE

HRIBERŠEK, Matija, BERUS, Lucijano, PUŠAVEC, Franci, KLANČNIK, Simon. Empirical modeling of liquefied nitrogen cooling impact during machining Inconel 718. Applied sciences, 2020, vol. 10, no. 10, p. 1-16.

PUŠAVEC, Franci, STERLE, Luka, KALIN, Mitjan, MALLIPEDDI, Dinesh, KRAJNIK, Peter. Tribology of solid-lubricated liquid carbon dioxide assisted machining. CIRP annals, 2020, vol. 69, no. 1, p. 1-4.

KHANNA, Navneet, SHAH, Prassan, AGRAWAL, Chetan, PUŠAVEC, Franci, HEGAB, Hussien. Inconel 718 machining performance evaluation using indigenously developed hybrid machining facilities: experimental investigation and sustainability assessment. *International journal of advanced manufacturing technology*, 2020, vol. 106, p. 4987-4999.

DRAŽUMERIČ, Radovan, BADGER, Jeffrey A., ROININEN, Roope, KRAJNIK, Peter. On geometry and kinematics of abrasive processes: the theory of aggressiveness. *International journal of machine tools & manufacture: Design, research and application*, 2020, vol. 154, p. 1-13.

IKRAM, Awais, MEHMOOD, Muhammad Farhan, SHERIDAN, Richard Stuart, AWAIS, Muhammad, WALTON, Allan, ELDOSOUKY, Anas, ŠTURM, Sašo, KOBE, Spomenka, ŽUŽEK ROŽMAN, Kristina. Particle size dependent sinterability and magnetic properties of recycled HDDR Nd-Fe-B powders consolidated with spark plasma sintering. *Journal of Rare Earths*, 2020, vol 38, no. 1, p. 90-99.

STRAŠEK, Aleksander, PUŠAVEC, Franci, LIKAR, Borut. Open innovation and business performance improvement in strategic business alliances. *Management: journal of contemporary management issues*, 2020, no. 1, vol. 25, p. 133-144.

IKRAM, Awais, AWAIS, Muhammad, SHERIDAN, Richard Stuart, WALTON, Allan, KOBE, Spomenka, PUŠAVEC, Franci, ŽUŽEK ROŽMAN, Kristina. Limitations in the grain boundary processing of the recycled HDDR Nd-Fe-B system ... [et al.]. *Materials*, 2020, vol. 13, no. 16, p. 1-17.

KHANNA, Navneet, PUŠAVEC, Franci, AGRAWAL, Chetan, KROLCZYK, Grzegorz M. Measurement and evaluation of hole attributes for drilling CFRP composites using an indigenously developed cryogenic machining facility. *Measurement: journal of the International Measurement Confederation*, 2020, vol. 154, p. 1-11.

IKRAM, Awais, AWAIS, Muhammad, SHERIDAN, Richard Stuart, WALTON, Allan, KOBE, Spomenka, PUŠAVEC, Franci, ŽUŽEK ROŽMAN, Kristina. Spark plasma sintering as an effective texturing tool for reprocessing recycled HDDR Nd-Fe-B magnets with lossless coercivity. *Metals*, 2020, vol. 10, no. 3, p. 1-17.

DOCTORAL DISSERTATION

GRGURAŠ, Damir. Machining conditions of cryogenic milling using liquid CO₂. Mentor Franci Pušavec.

PROJECTS

EIT Manufacturing hub in Slovenia (SI EIT-M). Franci Pušavec. 15.06.2020 – 31.12.2020

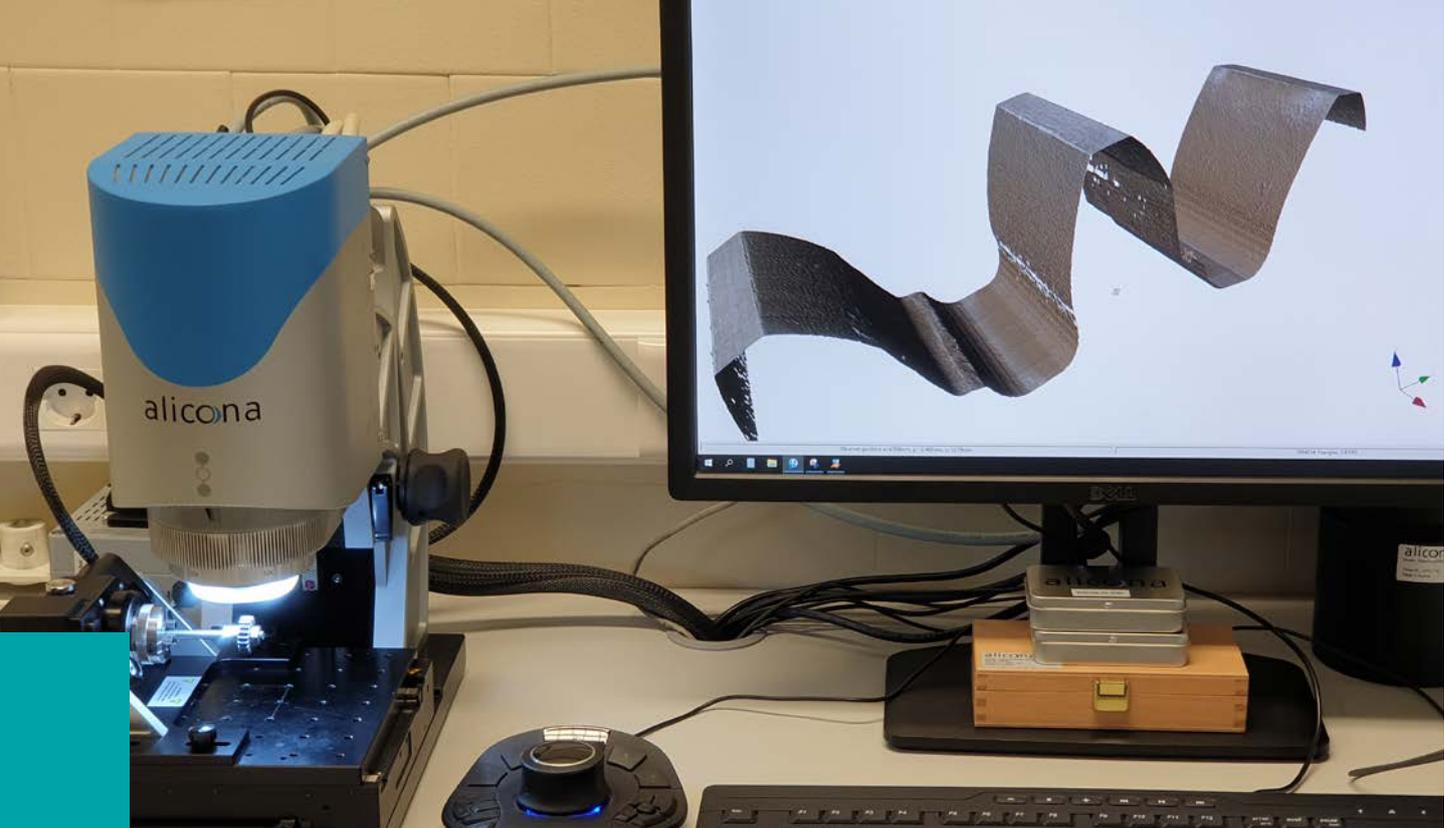
ERASMUS + REACH - Reinforcing Access to Cross Border Employment at Palestinian Higher Education Institutions -PHEIs. Franci Pušavec. 15.11.2019 - 14.11.2022

Slovenian Research Agency. Development and implementation of cryogenic machining into serial production industry for increasing productivity of drilling and milling processes. Franci Pušavec. 1.5.2017 – 30.4.2020

Slovenian Research Agency. Development and implementation of innovative machining technology for machining ZnO based ceramics with defined cutting geometry, in serial production, to increase the quality of varistors as final products. Franci Pušavec. 1.7.2019 – 30.6.2022

AWARDS AND ACHIEVEMENTS

Damir Grguraš and Luka Sterle received Rector's Award for the Best Innovation of the University of Ljubljana for a project entitled ArcLub One. With the same project they became the winners of the EIT Jumpstarter 2020 Grand Final.



Laboratory for Quality Assurance LAZAK

RESEARCH AREAS

Quality planning and control • Quality assurance of processes, products and services • Technology and innovation management • 3D digitisation and reverse engineering • Machine tools precision and accuracy measurement

DEPARTMENT HEAD Assoc. Prof. Davorin Kramar, PhD

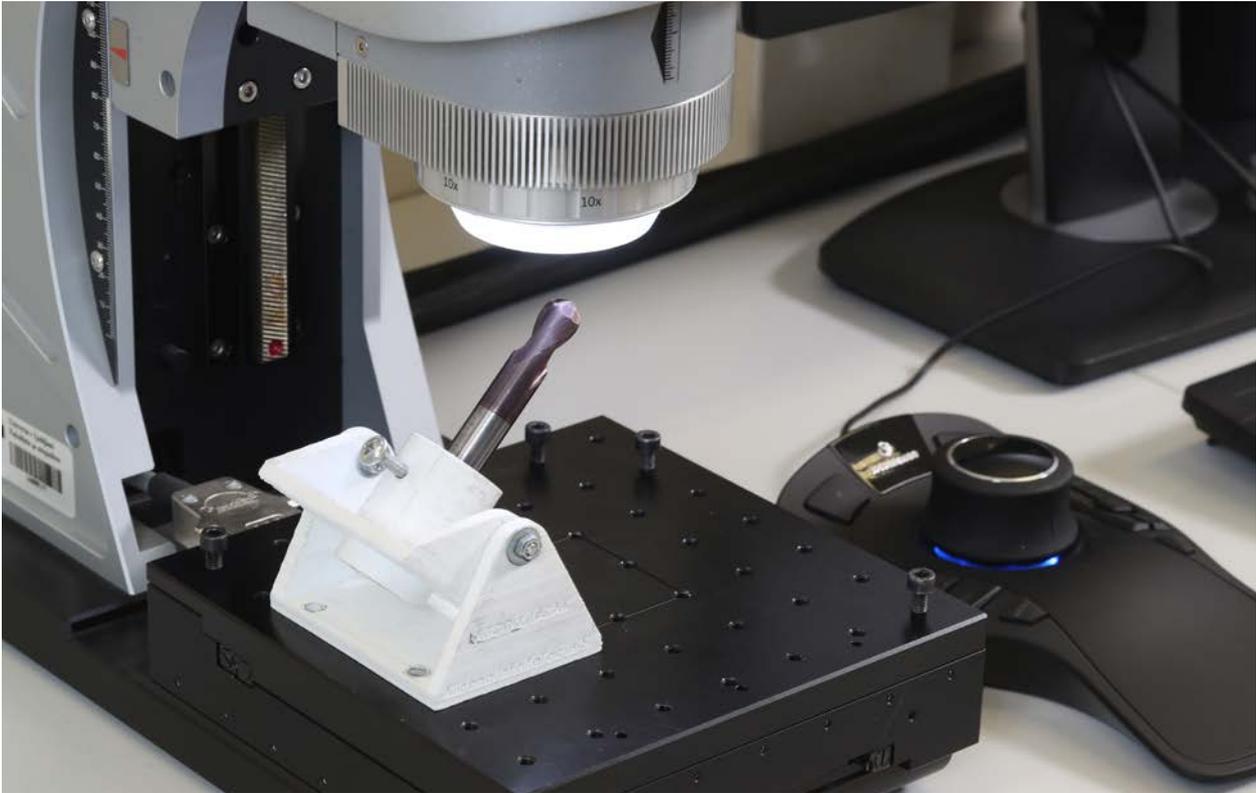
DEPARTMENT MEMBERS Assist. Luka Čerče, PhD, Assist. Damir Grguraš, PhD, Luka Kastelic, David Muženič, Marija Jeretina

ORIGINAL SCIENTIFIC ARTICLE

KRIVOKAPIĆ, Zdravko, VUČUREVIĆ, Radoslav, KRAMAR, Davorin, JOVANOVIĆ, Jelena. Modelling surface roughness in the function of torque when drilling. *Metals*, 2020, vol. 10, no. 3, p. 1-15.

CICA, Djordje, ČALIŠKAN, Halil, PANJAN, Peter, KRAMAR, Davorin. Multi-objective optimization of hard milling using taguchi based grey relational analysis. *Tehnički vjesnik: znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku*, 2020, vol. 27, no. 2, p. 513-519.

SPAIĆ, Obrad, KRIVOKAPIĆ, Zdravko, KRAMAR, Davorin. Development of family of artificial neural networks for the prediction of cutting tool condition. *Advances in production engineering & management*, Jun. 2020, vol. 15, no. 2, p. 164-178.



CICA, Djordje, SREDANOVIĆ, Branislav, TEŠIĆ, Saša, KRAMAR, Davorin. Optimisation of turning parameters for minimising specific cutting energy with use of different cooling/lubricating techniques. International journal of machining and machinability of materials, 2020, vol. 22, no. 2, p. 153-164.

PROJECTS

Slovenian Research Agency. Development and implementation of cryogenic machining into serial production industry for increasing productivity of drilling and milling processes. Franci Pušavec. 1.5.2017 - 30.4.2020

Slovenian Research Agency. Development and implementation of innovative machining technology for machining ZnO based ceramics with defined cutting geometry, in serial production, to increase the quality of varistors as final products. Franci Pušavec. 1.7.2019 - 30.6.2022

AWARDS AND ACHIEVEMENTS

Damir Grguraš and Luka Sterle received Rector's Award for the Best Innovation of the University of Ljubljana for a project entitled ArcLub One. With the same project they became the winners of the EIT Jumpstarter 2020 Grand Final.

13

PRODUCTION SYSTEMS, LASER TECHNOLOGIES AND MATERIALS WELDING - PLAS

The research programme Production systems, laser technologies and materials welding integrates four research fields which are of key importance for the development of modern manufacturing.

The Production systems field focuses on:

- concepts of distributed manufacturing systems, including their structuring and control;
- concurrent product development concepts;
- principles of product-service systems, on-line monitoring and remote control;
- development of mechatronics and cyber-physical systems applications.

The research in the Laser systems field is aimed at:

- Fiber and hybrid laser sources, and pulsed laser sources;
- laser measuring systems for simultaneous 3D shape and color measurement of bodies in real time;
- adaptive control of laser systems based on identification, monitoring and adaptive process control;
- opto-mechatronic systems based on optical elements with free surfaces, electrically focus-tunable lenses and microlens arrays.

Research in the field of Laser machining processes, surface modification and non-destructive testing is geared towards:

- development of new laser machining processes for surface finishing and improvement of mechanical properties;
- optimisation of various laser processes in terms of surface integrity;
- development of a method for non-destructive testing based on monitoring of die-casting process of reinforced polymeric materials using acoustic emission signals;
- testing of glued joints by means of ultrasound.

The Joining of materials section performs the following research:

- analysis of the chemical composition of joining accelerators;
- optimisation of welding parameters and mutual weldability of dissimilar materials;
- repair-welding of tools for extending the in-service tool life, filler materials;
- development of design welding, friction stir welding and other joining technologies;
- applying different materials with high-energy arc procedures.

These topics are highly relevant for advances of manufacturing science as well as for the economic and social development of Slovenia. The research is conducted in a close cooperation with the industry.



Laboratory for Heat Treatment and Materials Testing **LATOP**

RESEARCH AREAS

Heat treatment • Laser surface hardening • Shot peening of surfaces
• Surface integrity • Measurement of residual stresses • Determination of microstructures • Modelling of casting processes • Determination of tool life

DEPARTMENT HEAD Prof. Roman Šturm, PhD

DEPARTMENT MEMBERS Assist. Prof. Zoran Bergant, PhD, Assist. Prof. Tomaž Kek, PhD, Assist. Prof. Uroš Trdan, PhD, Assist. Janez Sušnik, PhD, Assist. Sebastjan Žagar, PhD, Assist. Bor Mojškerc, PhD, Assist. Dunja Ravnikar, PhD, Vane Kralj, Rok Markežič, PhD, Anja Vrhovec, Jan Šmalc, Dušanka Grubor Železnik

ORIGINAL SCIENTIFIC ARTICLE

MARKEŽIČ, Rok, MOLE, Nikolaj, NAGLIČ, Iztok, ŠTURM, Roman. Time and temperature dependent softening of H11 hot-work tool steel and definition of an anisothermal tempering kinetic model. *Materials today communications*, 2020, vol. 22, p. 1-7.

LU, Guoxing, TRDAN, Uroš, ZHANG, Yongkang, DULANEY, Jeff L. The distribution regularity of residual stress on a metal surface after laser shock marking. *Mechanics of materials*, 2020, vol. 143, p. 1-7.

RAVNIKAR, Dunja, TRDAN, Uroš, NAGODE, Aleš, ŠTURM, Roman. Energy density effect of laser alloyed TiB₂/TiC/Al composite coatings on LMZ/HAZ, mechanical and corrosion properties. *Metals*, 2020, no. 3, vol. 10, p. 1-19.



BABIČ, Matej, ŠTURM, Roman. Analiza parametrov laserskega kaljenja na robotski celici. Ventil: revija za fluidno tehniko in avtomatizacijo, 2020, vol. 26, no. 4, p. 282-287.

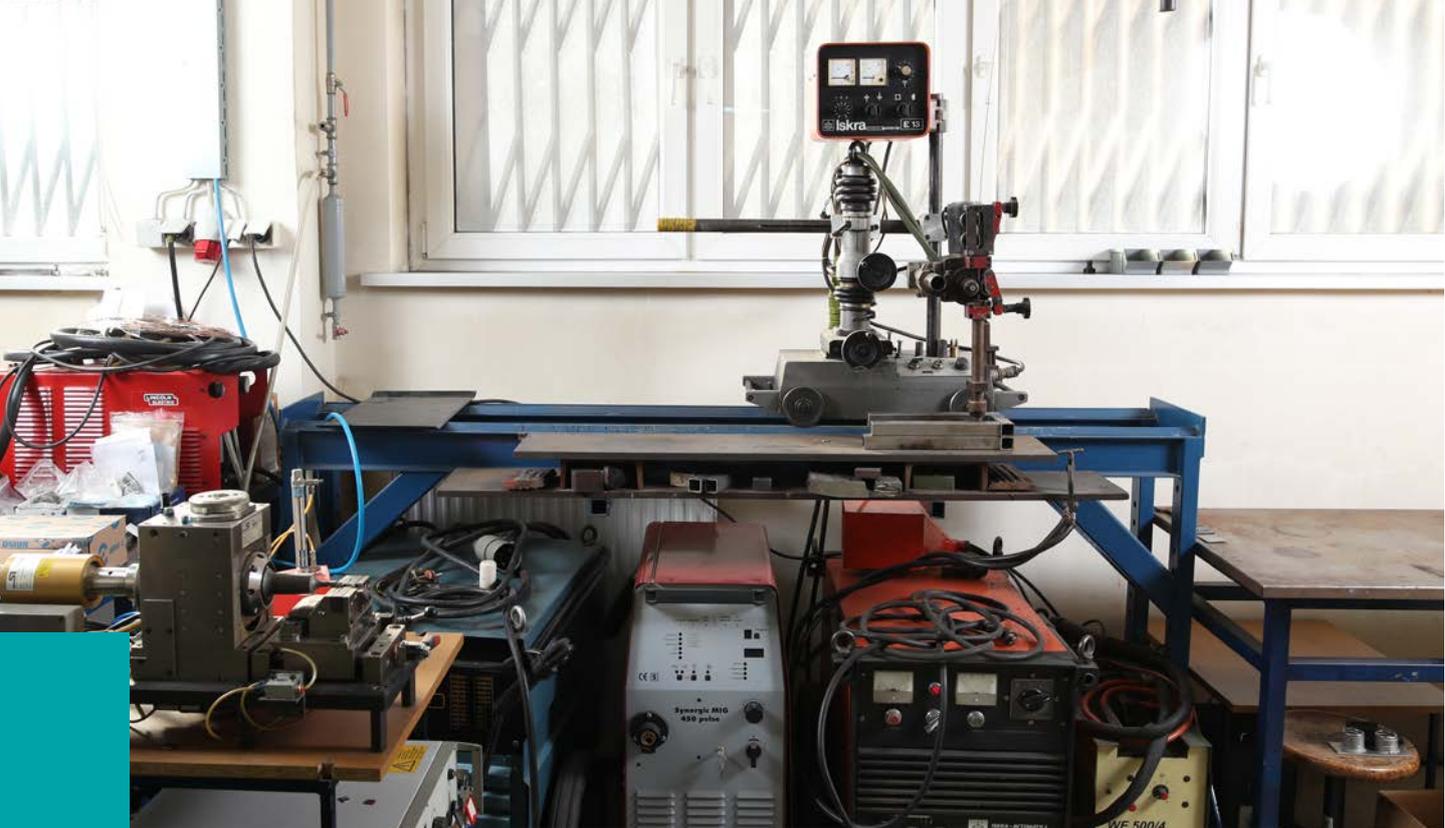
DOCTORAL DISSERTATION

MARKEŽIČ, Rok. Prediction of properties of hot work tool steels under cyclic thermal loading conditions. Mentor Roman Šturm.

PROJECTS

COST - CERTBOND CA18120 - Reliable roadmap for certification of bonded primary structures. Uroš Trdan. 04.04.2019 - 03.04.2023

COST - ODIN Optimising Design for Inspection. Tomaž Kek. 02.10.2019 - 01.10.2023



Laboratory for Welding **LAVAR**

RESEARCH AREAS

Technologies of material joining and assembly (arc welding, laser welding, friction stir welding, resistance welding, ultrasonic welding)

- Technologies of thermal cutting • Wire arc additive manufacturing
- Materials science • Production technologies • Weldability of metallic materials and polymers • Welding machines and devices • Additive and auxiliary welding materials • Chemical and metallurgical processes in welding

DEPARTMENT HEAD Assist. Prof. Damjan Klobčar, PhD

DEPARTMENT MEMBERS Prof. Borut Kosec, PhD, Assist. Matej Pleterski, PhD, Assist. Maja Lindič, Peter Kolar, Andraž Logar, Assist. Aljaž Ščetinec, Ana Lazar, Uroš Klopčič, Dušanka Grubor Železnik

ORIGINAL SCIENTIFIC ARTICLE

IVANIĆ, Ivana, GOJIĆ, Mirko, KOŽUH, Stjepan, KOSEC, Borut. Microstructural and fractographic analysis of CuAlNi shape memory alloy before and after heat treatment. Defect and diffusion forum, 2020, vol. 405, p. 100-106.

KARPE, Blaž, KLOBČAR, Damjan, KOVAČ, Janez, BIZJAK, Milan, KOSEC, Borut, VESKOVIČ BUKUDUR, Stojana. Failure analysis of diesel engine glow plugs. Engineering failure analysis, 2020, vol. 109, p. 1-8.



NAGODE, Aleš, ZUPANČIČ, Katja, ZORC, Matija, ŽUŽEK, Borut, KARPE, Blaž, ŠETINA, Barbara, ZORC, Borut, KOSEC, Borut, BIZJAK, Milan, PAVLIČ, Alenka. Investigating the properties of dental composites = Preiskava lastnosti kompozita za zobne zalivke. *Materiali in tehnologije*, 2020, vol. 54, no. 4, p. 433-437.

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PRIJANOVIČ, Urban, TONKOVIČ-PRIJANOVIČ, Marica, TRDAN, Uroš, PLETERSKI, Matej, JEZERŠEK, Matija, KLOBČAR, Damjan. Remote fibre laser welding of advanced high strength martensitic steel. *Metals*, 2020, vol. 10, no. 4, p. 1-14.

CONRADI, Marjetka, KOCIJAN, Aleksandra, KLOBČAR, Damjan, GODEC, Matjaž. Influence of laser texturing on microstructure, surface and corrosion properties of Ti-6Al-4V. *Metals*, 2020, vol. 10, no. 11, p. 1-9.

ZORC, Borut, ZORC, Matija, KOSEC, Borut, NAGODE, Aleš. Influence of laser texturing on microstructure water-filter housings on the destructive pressure, crack-initiation, propagation conditions and fracture toughness of styrene-acrylonitrile. *Polymers*, 2020, vol. 12, no. 2, p. 1-22.

PLETERSKI, Matej, ZORKO, Domen, KLOBČAR, Damjan. Uporabnost vodotopnega papirja za zaščito korena zvarke. *Ventil: revija za fluidno tehniko in avtomatizacijo*, 2020, vol. 26, no. 3, p. 180-185.

PLETERSKI, Matej, VAJDIČ, Janez, KLOBČAR, Damjan. Varjenje debelostenskih nerjavnih odkovkov v ozki reži: po postopku elektroobločnega varjenja pod praškom. *Ventil: revija za fluidno tehniko in avtomatizacijo*, 2020, vol. 26, no. 6, p. 430-435.

PROJECTS

COST - CERTBOND CA18120 - Reliable roadmap for certification of bonded primary structures. Damjan Klobčar. 04.04.2019 – 03.04.2023

COST - CA COST Action CA15102; CRM-EXTREME - Solutions for Critical Raw Materials Under Extreme Conditions. Damjan Klobčar. 10.03.2016 – 09.03.2020

Erasmus + APTIME - Additive Process Technology Integration with Management and Entrepreneurship. Damjan Klobčar. 04.10.2019 – 03.10.2022

Slovenian Research Agency. Selective plasma oxidation of FeCrAl alloys for extended-lifetime of glow plugs for diesel engines. Damjan Klobčar. 1.5.2017 – 30.4.2020



Laboratory for Digital Systems and Electrical Engineering **LDSE**

RESEARCH AREAS

Modelling • Simulation • Automation • Hardware • Software

DEPARTMENT HEAD Prof. Janez Diaci, PhD

DEPARTMENT MEMBERS Assist. Prof. Marjan Jenko, PhD, Assist. Tomaž Požrl, PhD, Anja Juriševič, Assist. Nejc Rožman, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

ŠTEFE, Blaž, JENKO, Marjan. Modeling of insulation paper damage in the assembly of a solid slot winding. IEEE access, 2020, vol. 8, p. 27831-27850.

PROJECTS

ERDF - European regional development fond SPS - Building Blocks, Tools and Systems for Factories of the Future (GOSTOP). Janez Diaci. 01.11.2016 - 30.04.2020



Laboratory for Process Automation **LPA**

RESEARCH AREAS

Analysis of control systems • Design of control systems • Optimal control laws • Energy devices and processes

DEPARTMENT HEAD Assoc. Prof. Primož Podržaj, PhD

DEPARTMENT MEMBERS Assist. Prof. Samo Simončič, PhD, Miha Finžgar, PhD, Assist. Marko Corn, PhD, Assist. Žan Pirnar, Matic Kelvišar, Igor Reznichenko, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

MACURA, Miloš, BAN, Helena, CANKAR, Ksenija, FINŽGAR, Miha, FRANGEŽ, Igor. The effect of transcutaneous application of gaseous CO₂ on diabetic chronic wound healing: a double-blind randomized clinical trial. *International wound journal*, 2020, vol. 17, no.6, p. 1-5.

FINŽGAR, Miha, PODRŽAJ, Primož. Feasibility of assessing ultra-short-term pulse rate variability from video recordings. *PeerJ*, 2020, vol. 8, p. 1-26.

DOCTORAL DISSERTATION

FINŽGAR, Miha. Extraction of pulse rate and its variability from video recordings. Mentor Primož Podržaj.

PROJECTS

Erasmus + MAESTRO - Manufacturing Education for a Sustainable fourth Industrial Revolution. Primož Podržaj. 01.09.2019 – 31.08.2022

Erasmus + ICCT - Interactive course for Control Theory. Primož Podržaj. 01.09.2018 – 31.08.2021



Laboratory for Manufacturing Cybernetics and Experimentation **MCE**

RESEARCH AREAS

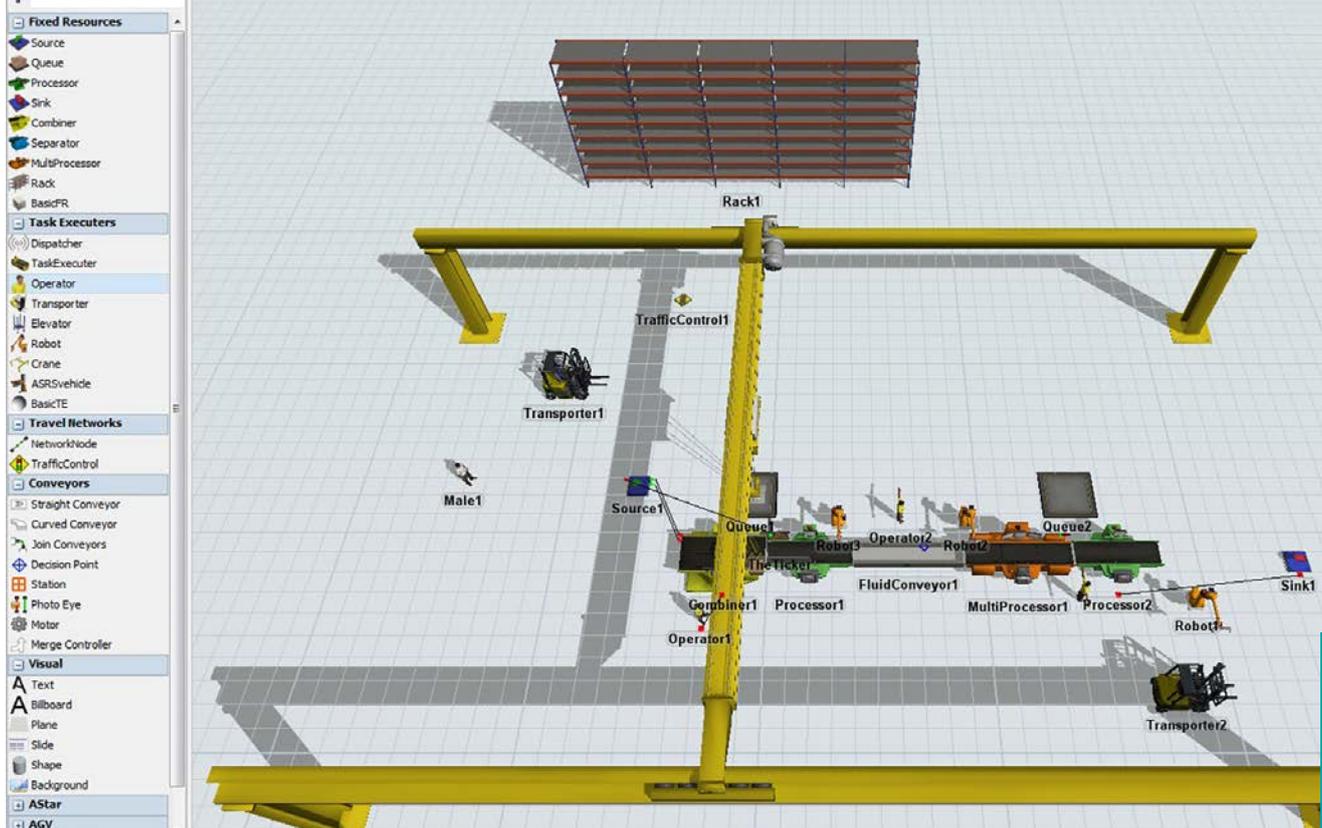
Quality • Computer integrated manufacturing • Adaptive control
• Machine vision • Internet of Things • Mechatronics • Biologically inspired robotics

DEPARTMENT HEAD Assist. Prof. Drago Bračun, PhD

DEPARTMENT MEMBERS Assist. Luka Selak, PhD, Assist. Gašper Škulj, PhD, Assist. Nejc Kozamernik, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

KOZAMERNIK, Nejc, BRAČUN, Drago, KLOBČAR, Damjan. WAAM system with interpass temperature control and forced cooling for near-net-shape printing of small metal components. International journal of advanced manufacturing technology, 2020, vol. 110, no. 7/8, p. 1955-1968.



Laboratory for Manufacturing Systems and Production Process Planning **LAPS**

RESEARCH AREAS

Production systems • Production planning and control • Logistics of material and information flows • Work and time studies • Project management • Concurrent engineering • Operational research

DEPARTMENT HEAD Assoc. Prof. Janez Kušar, PhD

DEPARTMENT MEMBERS Assist. Prof. Tomaž Berlec, PhD, Assist. Lidija Rihar, PhD, Tadeja Kavčič, Assist. Tena Žužek, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

ŽUŽEK, Tena, RIHAR, Lidija, BERLEC, Tomaž, KUŠAR, Janez. Standard project risk analysis approach. Business systems research journal: international journal of the Society for Promotion of Business Information Technology (BIT), 2020, vol. 11, no. 2, p. 149-158.

ŽUŽEK, Tena, KUŠAR, Janez, RIHAR, Lidija, BERLEC, Tomaž. Agile-concurrent hybrid: a framework for concurrent product development using scrum. Concurrent engineering: research and applications, 2020, vol. 28, no. 4, p. 1-10.

JORDAN, Eva, BERLEC, Tomaž, RIHAR, Lidija, KUŠAR, Janez. Simulation of cost driven value stream mapping. International journal of simulation modelling, 2020, vol. 19, no. 3, p. 458-469.

ŽUŽEK, Tena, GOSAR, Žiga, KUŠAR, Janez, BERLEC, Tomaž. Adopting agile project management practices in non-software SMEs: a case study of a Slovenian medium-sized manufacturing company. Sustainability, 2020, vol. 12, no. 21, p. 1-17.



Laboratory for control and manufacturing systems **LAKOS**

RESEARCH AREAS

Mechatronics • Robotics • Flexible manufacturing systems
 • Computer-integrated manufacturing • Distributed control
 • Multi-agent systems • Reinforcement learning • Engineering informatics • Manufacturing data analytics

DEPARTMENT HEAD Assist. Prof. Rok Vrabič, PhD

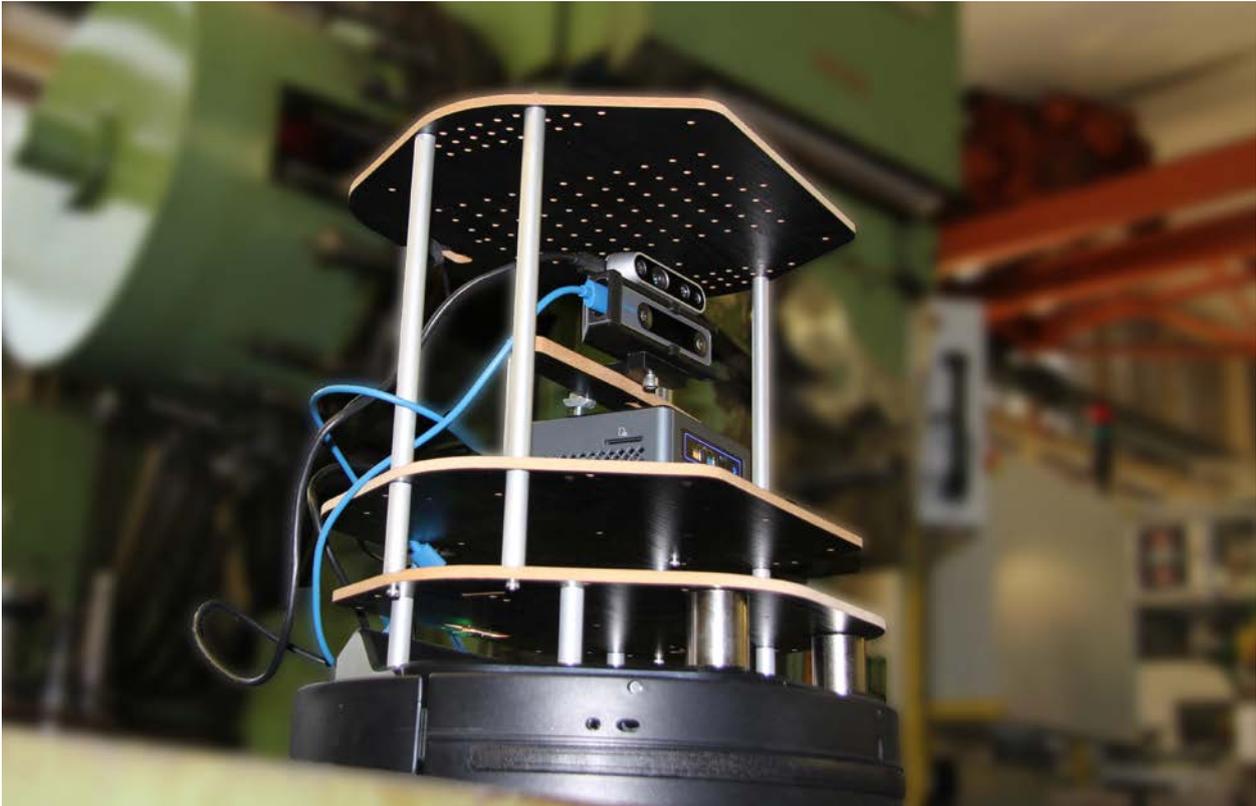
DEPARTMENT MEMBERS Assist. Dominik Kozjek, PhD, Assist. Andreja Malus, Dominik Rupert, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

AMO, Iñigo Fernández del, ERKOYUNCU, John, VRABIČ, Rok, FRAYSSINET, Romain, VAZQUEZ REYNEL, Cristina, ROY, Rajkumar. Structured authoring for AR-based communication to enhance efficiency in remote diagnosis for complex equipment. *Advanced engineering informatics: the science of supporting knowledge-intensive activities*, 2020, vol. 145, p. 1- 17.

ERKOYUNCU, John Ahmet, AMO, Iñigo Fernández del, ARIANSYAH, Dedy, BULKA, Dominik, VRABIČ, Rok, ROY, Rajkumar. A design framework for adaptive digital twins. *CIRP annals*, 2020, vol. 69, no. 1, p. 145-148.

MALUS, Andreja, KOZJEK, Dominik, VRABIČ, Rok. Real-time order dispatching for a fleet of autonomous mobile robots using multi-agent reinforcement learning. *CIRP annals*, 2020, vol. 69, no. 1, p. 397-400.



KOZJEK, Dominik, VRABIČ, Rok, RIHTARŠIČ, Borut, LAVRAČ, Nada, BUTALA, Peter. Advancing manufacturing systems with big-data analytics: a conceptual framework. *International journal of computer integrated manufacturing*, 2020, vol. 33, no. 2, p. 169-188.

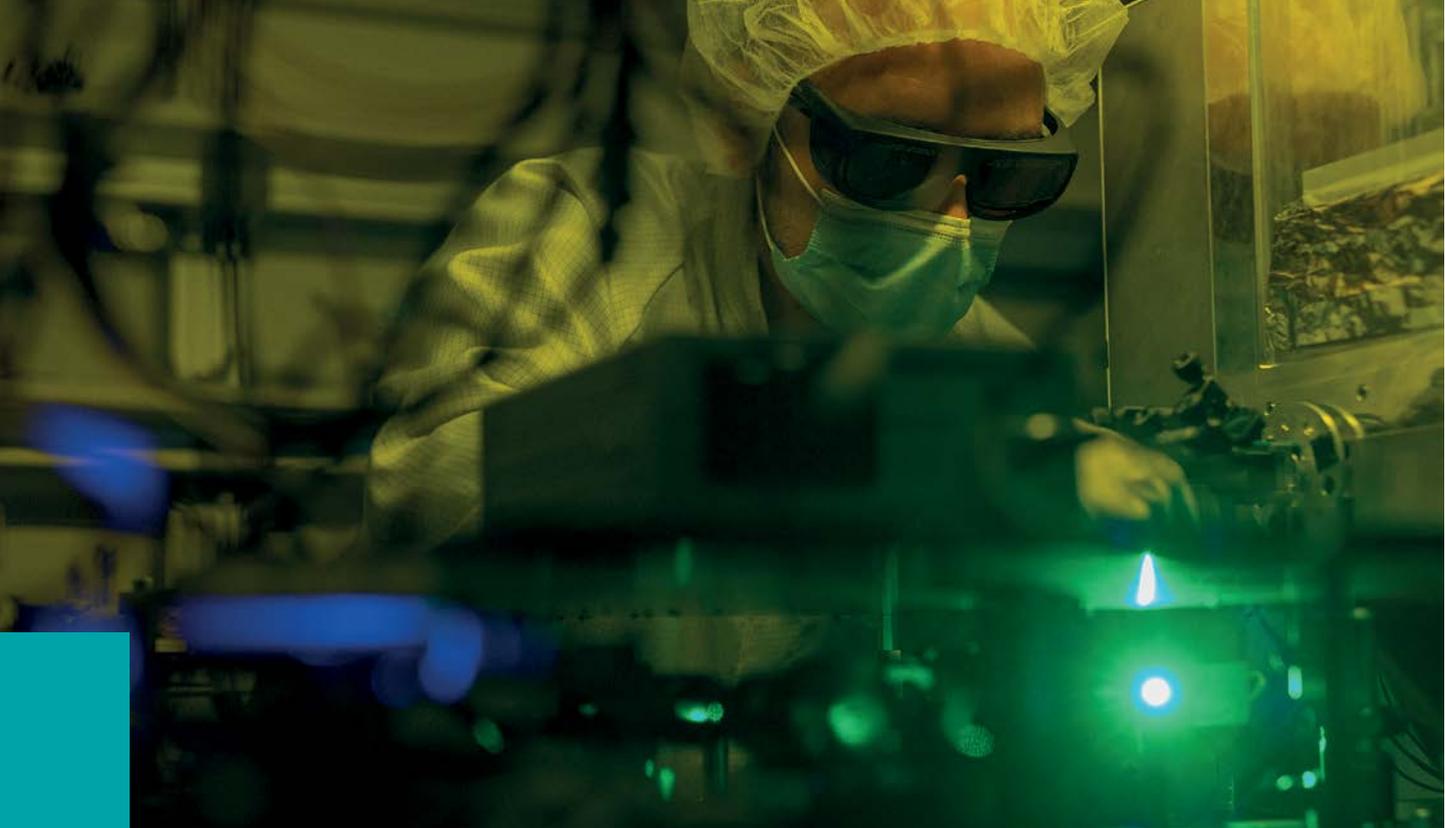
HOZDIĆ, Elvis, KOZJEK, Dominik, BUTALA, Peter. A cyber-physical approach to the management and control of manufacturing systems. *Strojniški vestnik*, 2020, vol. 66, no. 1, p. 61-70.

PROJECTS

Erasmus + REACH - Reinforcing access to cross border employment at Palestinian higher education institutions-PHEIs. Rok Vrabič. 15.11.2019 - 14.11.2022

ERDF - European regional development fond SPS - Building Blocks, Tools and Systems for Factories of the Future (GOSTOP). Rok Vrabič. 01.11.2016 - 30.04.2020

Horizon 2020 - ROSIN ROS-Industrial quality-assured robot software components. Rok Vrabič. 01.01.2020 - 31.12.2020



Laboratory for photonics and laser systems **FOLAS**

RESEARCH AREAS

Laser sources • Fiber and hybrid lasers • Photonics • Optical fiber processing • Laser transfer printing • Laser micro- and nano-processing
• Laser treatment and diagnostic in medicine • Rapid photography
• Laser interferometric methods • Optodynamics

DEPARTMENT HEAD Assoc. Prof. Rok Petkovšek, PhD

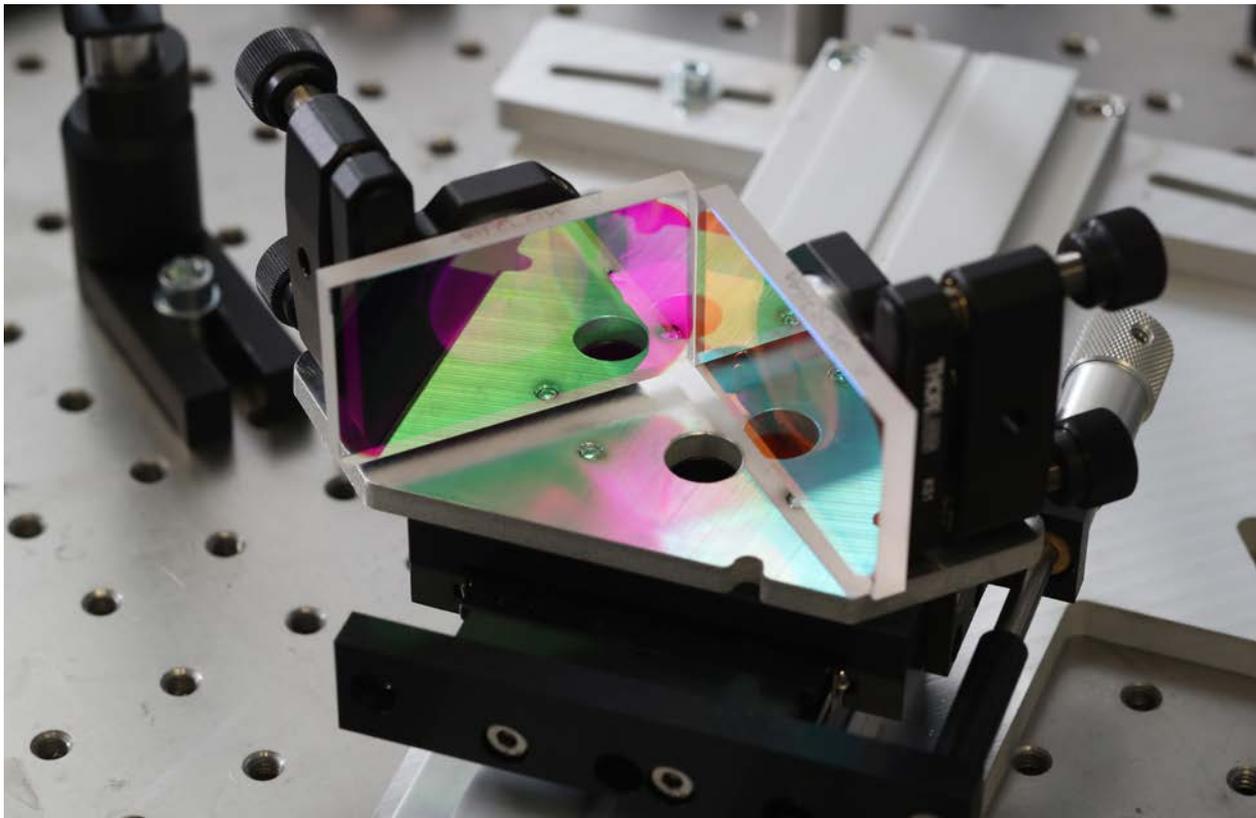
DEPARTMENT MEMBERS Assist. Prof. Vid Agrež, PhD, Assist. Prof. Tomaž Požar, PhD, Assist. Darja Horvat, PhD, Assist. Žiga Lokar, PhD, Assist. Jaka Mur, PhD, Assist. Jaka Petelin, PhD, Assist. Uroš Orthaber, PhD, Marko Šajn, PhD, Assist. Luka Černe, PhD, Assist. Jernej Jan Kočica, Assist. Peter Šušnjar, PhD, Assist. Matevž Marš, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

POŽAR, Tomaž, PIRC, Žan, SUSIČ, Egon, PETKOVŠEK, Rok. Simplified detection of cavitation threshold in control valves. Applied acoustics, 2020, vol. 165, p. 1-6.

PODLIPEC, Rok, MUR, Jaka, PETELIN, Jaka, ŠTRANCAR, Janez, PETKOVŠEK, Rok. Two-photon retinal theranostics by adaptive compact laser source. Applied physics. A, Materials science & processing, 2020, vol. 126, no. 6, p. 1-9.

HORVAT, Darja, POŽAR, Tomaž, STARMAN, Bojan, HALILOVIČ, Miroslav, PETKOVŠEK, Rok. Pressure wave focusing effects following laser medical procedures in human eyes. Applied physics. A, Materials science & processing, 2020, vol. 126, no. 6, p. 1-9.



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ŠUŠNJAR, Peter, JONES, Travis, TREBINO, Rick, PETKOVŠEK, Rok. Crystal-configuration considerations for higher-sensitivity picosecond-pulse SHG FROG. *IEEE journal of quantum electronics*, 2020, vol. 56, no. 2, p. 1-8.

JONES, Travis, ŠUŠNJAR, Peter, PETKOVŠEK, Rok, TREBINO, Rick. High-sensitivity, simple frequency-resolved-optical-gating device. *IEEE journal of quantum electronics*, 2020, vol. 56, no. 3, p. 1-6.

FLIZIKOWSKI, G. A. S., ANGHINONI, B., ROHLING, J. H., BELANÇON, M. P., MENDES, R. S., BAESSO, Mauro L., MALACARNE, L. C., POŽAR, Tomaž, BIALKOWSKI, Stephen Edward, ASTRATH, Nelson Guilherme Castelli. Influence of edge effects on laser-induced surface displacement of opaque materials by photothermal interferometry. *Journal of applied physics*, 2020, vol. 128, no. 4, p. 1-10.

MUR, Jaka, MIKELJ, Aljaž, PODOBNIK, Boštjan, PETKOVŠEK, Rok. Precision fabrication of flexible microfluidic circuits using direct laser rapid prototyping solution. *Journal of micromechanics and microengineering*, 2020, vol. 30, no. 11, p. 1-8.

FLIZIKOWSKI, G. A. S., CAPELITO, O. A., CAMARGO, V. G., ANGHINONI, B., BAESSO, Mauro L., MALACARNE, Luis Carlos, BELANÇON, M. P., POŽAR, Tomaž, ASTRATH, Nelson Guilherme Castelli. Laser induced thermoelastic surface displacement in solids detected simultaneously by photothermal mirror and interferometry. *Optics express*, 2020, vol. 28, no. 5, p. 7116-7124.

ČERNE, Luka, PETELIN, Jaka, PETKOVŠEK, Rok. Femtosecond CPA hybrid laser system with pulse-on-demand operation. *Optics express*, 2020, vol. 28, no. 6, p. 7875-7888.

AGREŽ, Vid, POŽAR, Tomaž, PETKOVŠEK, Rok. High-speed photography of shock waves with an adaptive illumination. *Optics letters*, 2020, vol. 45, no. 6, p. 1547-1550.

ORTHABER, Uroš, ZEVIK, Jure, PETKOVŠEK, Rok, DULAR, Matevž. Cavitation bubble collapse in a vicinity of a liquid-liquid interface: basic research into emulsification process. *Ultrasonics Sonochemistry*, 2020, vol. 68, p. 1-15.

PATENT

AGREŽ, Vid, PETELIN, Jaka, PETKOVŠEK, Rok, VREČKO, Andrej. Enostaven laser z izboljšanim črpalnim sistemom za proizvodnjo laserskih pulzov na zahtevo: patent SI 25838 A, 2020-10-30. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2020.

DOCTORAL DISSERTATIONS

ČERNE, Luka. Ultrashort pulsed hybrid laser for high precision industrial processing. Mentor Rok Petkovšek.

ŠUŠNJAR, Peter. Highly-sensitive characterization of ultrashort laser pulses. Mentor Rok Petkovšek.

PROJECTS

ERDF - European regional development fund SPS – Building Blocks, Tools and Systems for Factories of the Future (GOSTOP). Rok Petkovšek. 01.11.2016 – 30.04.2020

LPKF - Laser micro-machining processes. Rok Petkovšek. 1.7.2017 – 30.6.2020

Slovenian Research Agency. Ultrashort pulses on demand. Rok Petkovšek. 1.7.2018 – 30.6.2021

Slovenian Research Agency – Spatial and temporal shaping of laser light for minimally invasive ophthalmic procedures. Tomaž Požar. 1.7.2018 – 30.6.2021

Slovenian Research Agency. High power highly adaptable fiber lasers for the industrial applications. Vid Agrež. 1.5.2017 – 30.4.2020

AWARDS AND ACHIEVEMENTS

Jaka Mur and Uroš Orthaber received an award of the Faculty of Mechanical Engineering for high quality publications.

14

OPTODYNAMICS

Optodynamics explores the dynamic aspects of light-to-substance interaction, which are the basis of most laser machining processes and laser-based medical interventions. Since optodynamic responses are an important source of information on the interaction between light and matter, their simultaneous detection and analysis can provide effective control over all laser processes.

The recent discovery of the programme group's researchers on characteristics of mechanical waves induced due to reflection of light is the basis for an important progress in resolving the dilemmas regarding the momentum of light in transparent media. Basic research into optodynamics leads to new applied research.

The programme also enables the development of new approaches in research on:

- laser-induced mass transfer;
- manipulation of nanoparticles;
- microfluidics;
- laser micro- and nanoprocessing;
- laser-based non-destructive testing and its transfer into practice.

The program is also oriented towards the further development and optimisation of new, more efficient and safer medical laser systems. The results of the programme are closely related to the Master's and Doctoral education programs at Faculty of Mechanical Engineering.



Laboratory for Laser Techniques **LASTEH**

RESEARCH AREAS

- Laser measuring methods • Laser triangulation • Fiber-optic sensors
- Fast photography • Interferometry • Laser machining processes
- Laser micro and nano structuring • Adaptive control of laser processes
- Medical laser procedures • Optodynamics

DEPARTMENT HEAD Assoc. Prof. Matija Jezeršek, PhD

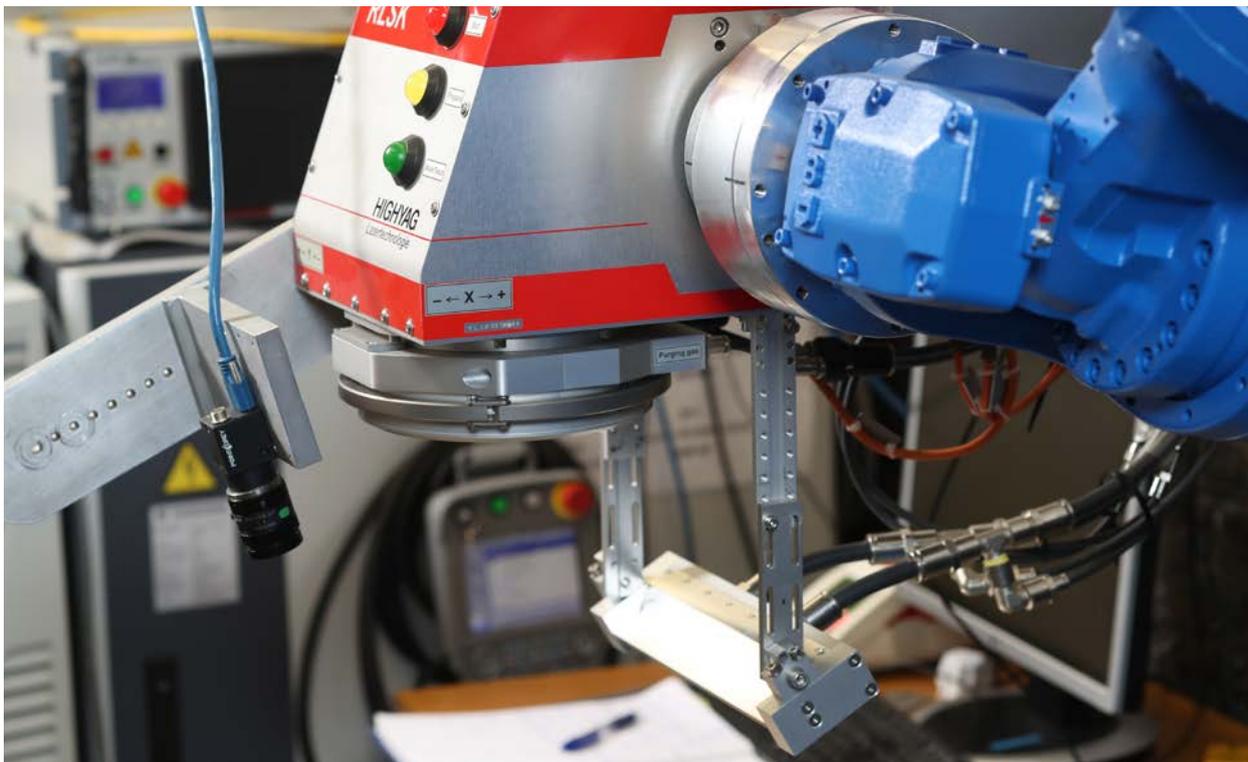
DEPARTMENT MEMBERS Assoc. Prof. Peter Gregorčič, PhD, Assist. Aleš Babnik, PhD, Assist. Urban Pavlovčič, PhD, Assist. Ladislav Grad, PhD, Assist. Nejc Lukač, PhD, Assist. Luka Hribar, Assist. Daniele Vella, PhD, Assist. Jure Košir, Assist. Matjaž Kos, Assist. Matej Senegačnik, Gaia Kravanja, Jasna Gornik

ORIGINAL SCIENTIFIC ARTICLE

SENEGAČNIK, Matej, JEZERŠEK, Matija, GREGORČIČ, Peter. Propulsion effects after laser ablation in water, confined by different geometries. Applied physics. A, Materials science & processing, 2020, vol. 126, no. 2, p. 1-12.

PAVLOVČIČ, Urban, RAK, Gašper, HOČEVAR, Marko, JEZERŠEK, Matija. Ranging of turbulent water surfaces using a laser triangulation principle in a laboratory environment. Journal of hydraulic engineering, 2020, vol. 146, no. 8, p. 1-10.

Matija Jezeršek, Nejc Lukač, Matjaž Lukač, "Measurement of simulated debris removal rates in an artificial root canal to optimize laser-activated irrigation parameters", Lasers surg. med., p. 1-7, 2020.



SEDOVA, Anastasiya, VIŠIĆ, Bojana, VELLA, Daniele, VEGA MAYORAL, Victor, GADERMAIER, Christoph, DODIUK, Hanna, KENIG, Samuel, TENNE, Reshef, GVISHI, Raz, BAR, Galit. Silica aerogels as hosting matrices for WS₂ nanotubes and their optical characterization. *Journal of Materials Science*, 2020, vol. 55, p. 7612-7623.

LUKAČ, Matjaž, LUKAČ, Nejc, JEZERŠEK, Matija. Characteristics of bubble oscillations during laser-activated irrigation of root canals and method of improvement. *Lasers in surgery and medicine*, 2020, vol. 52, no. 9, p. 907-915.

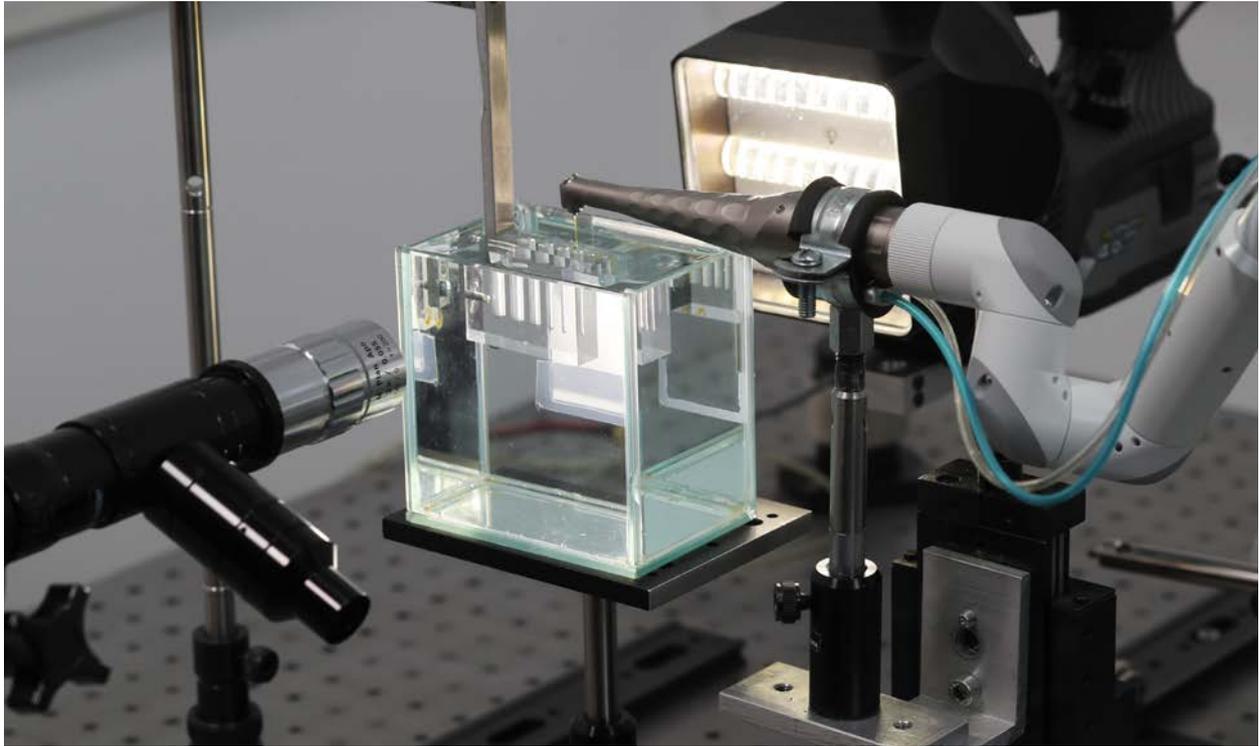
LINARDY, Eric, YADAV, Dinesh, VELLA, Daniele, VERZHBITSKIY, Ivan, WATANABE, Kenji, TANIGUCHI, Takashi, PAULY, Fabian, TRUSHIN, Maxim, EDA, Goki. Harnessing exciton-exciton annihilation in two-dimensional semiconductors. *Nano letters*, 2020, vol. 20, no. 3, p. 1647-1653.

JEZERŠEK, Matija, LUKAČ, Nejc, LUKAČ, Matjaž, TENYI, Ana, OLIVI, Giovanni, FIDLER, Aleš. Measurement of pressures generated in root canal during Er:YAG laser-activated irrigation. *Photobiomodulation, photomedicine, and laser surgery*, 2020, vol. 38, no. 10, p. 625-631.

KOŠIR, Jure, VELLA, Daniele, JEZERŠEK, Matija. Non-contact monitoring of the depth temperature profile for medical laser scanning technologies. *Scientific reports*, 2020, vol. 10, f. 1-10.

BOŽIČ, Alex, KOS, Matjaž, JEZERŠEK, Matija. Power control during remote laser welding using a convolutional neural network. *Sensors*, 2020, vol. 20, no. 22, p. 1-15.

HOČEVAR, Matej, ŠETINA, Barbara, GODEC, Matjaž, KONONENKO, Veno, DROBNE, Damjana, GREGORČIČ, Peter. The interaction between the osteosarcoma cell and stainless steel surface, modified by high-fluence, nanosecond laser pulses. *Surface & coatings technology*, 2020, vol. 394, p. 1-12.



PATENT

JEZERŠEK, Matija, MOŽINA, Janez, DIACI, Janez, KOSLER, Hubert. System and method for laser processing = Verfahren und Vorrichtung zur Laserbearbeitung = Système et procédé de traitement laser: European patent specification EP 3 124 163 B1, 2020-04-22. Munich: European patent office, 2020.

DOCTORAL DISSERTATION

POGAČAR, Marko. Adaptive laser surface treatment for absolute position marks on steel measuring rod. Mentor Matija Jezeršek.

PROJECTS

Company Fotona - Research and development of laser medical systems. Matija Jezeršek. 1.9.2018 – 1.9.2021

ERDF - European regional development fund SPS – Building Blocks, Tools and Systems for Factories of the Future (GOSTOP). Matija Jezeršek. 01.11.2016 – 30.04.2020

Slovenian Research Agency. Laser-induced subsurface microdestruction of tissue (LasDes). Matija Jezeršek. 1.7.2019 – 30.6.2022

Slovenian Research Agency. Combined multispectral and thermographic imaging for screening and monitoring of small joint arthritis. Matija Jezeršek. 1.5.2017 – 30.4.2020

Slovenian Research Agency. Laser micro and nano structuring for development of biomimetic metallic surfaces with unique properties (LaMiNaS). Peter Gregorčič. 1.7.2019 – 30.6.2022

Slovenian Research Agency. New Conventional and Additive Manufactured Biodegradable Fe-Mn alloy with Tailored Biodegradability. Peter Gregorčič. 1.7.2019 – 30.6.2022

Ministry of Education, Science and Sport - Laser Process Research for the Clinics of the Future. Matija Jezeršek. 1.05.2019 - 31.03.2022.



UNIT FOR SUPPLEMENTARY DIVISION EDZ

The Faculty of Mechanical Engineering also hosts the Unit for Supplementary Division, which is not part of research groups, but operates independently as an organisational unit. The Unit for Supplementary Division covers the areas of mathematics and sports as the key supplementary factors contributing to the teaching process.



Photo: Ana Kregar

Unit for supplementary division **EDZ**

MEMBERS Jože Bratuž, Žiga Bratuž, Iztok Novak

ACTIVITIES OF COMPLEMENTARY KNOWLEDGE UNIT IN 2020

The epidemic also severely affected the field of student sports. The activities of the Supplementary Knowledge Unit have therefore been adapted to the special conditions in 2020.

- During the period from March to the end of May, students sent evidence of independent sporting activities to the sports lecturers.
- In summer, as usual, some outdoor activities and Cooper's running tests were organized.
- In October, a hybrid implementation of physical education took place. Practicing sports indoors (table tennis, badminton, fitness), ensuring distance between students at all times and hiking. Students had the opportunity to fulfil 50 percent of their commitments through independent sports activities.
- From 16 October to the end of the year, when the epidemic was declared again, students trained independently at home. In consultation with the Faculty of Pharmacy, a group exercise was organized three times a week on the Zoom application. During this time, students were engaged in walking, running, cycling and strength training. Evidence of all the above activities was provided on a weekly basis, taking advantage of the possibilities offered by modern technologies (sports watches, applications on smartphones). The lecturers were available daily to advise them on training.
- Due to the epidemic, most competitions were suspended or did not take place at all. However, the students were able to participate in at least some competitions.

THE BEST PERFORMANCES OF FME STUDENTS IN 2020 COMPETITIONS

3rd place	Table football	Gregor Menih and Jan Tomec
4th place in Group B	Football	Team
2nd place in Group B	Basketball	Team
1st place in Group B	Volleyball	Team



Mathematics Research Team **RSMAT**

DEPARTMENT HEAD Prof. Janez Žerovnik, PhD

DEPARTMENT MEMBERS Assist. Prof. Aljoša Peperko, PhD, Assist. Prof. Boštjan Gabrovšek, PhD, Assist. Tina Novak, PhD, Assist. Prof. Darja Rupnik Poklukar, PhD, Assist. Helena Zakrajšek, PhD, Teja Pirnat

ORIGINAL SCIENTIFIC ARTICLE

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UNIVERSITY, HIGER EDUCATION OR SHORT-TERM HIGER EDUCATION TEXTBOOK WITH REVIEW

NOVAK, Tina, POVH, Janez, ŽEROVNIK, Janez. Izbrana poglavja iz operacijskih raziskav. Ljubljana: Fakulteta za strojništvo, 2020.

PROJECTS

COST CA18232 - Mathematical models for interacting dynamics on networks. Aljoša Peperko. 04.10.2019 - 03.10.2023

Slovenian Research Agency. Stochastic models for logistics of industrial processes. Janez Žerovnik. 1.9.2020 - 31.8.2023

PROMOTION OF MECHANICAL ENGINEERING

Mechanical engineering offers many possibilities for participation and opportunities for creative solutions that are useful and interesting for people and their environment. The task of mechanical engineers is to transform ideas into products that enable them to help shape modern reality. The Faculty of Mechanical Engineering of the University of Ljubljana actively follows modern trends, promotes mechanical engineering in all its forms, organizes events, conferences and exhibitions, conducts workshops and publishes periodicals. Through its active work in the public sphere, the Faculty popularizes mechanical engineering and spreads awareness of the importance of technical sciences in everyday life.

INFORMATIVA

Once a year, before the Information Days, Informativa provides an overview of educational programs available in Slovenia and abroad in one place - from secondary schools to higher and postgraduate programs, additional education and training, language courses, lifelong learning, etc. Every year the Faculty of Mechanical Engineering presents itself at this fair for education and professions, as part of the University of Ljubljana.



PROMOTION OF MECHANICAL ENGINEERING IN SECONDARY SCHOOLS AND GYMNASIA

The FME pays special attention to promoting mechanical engineering in secondary schools and gymnasia, with the goal of making young people aware of the importance of this field. Mechanical engineering is introduced to more than 20 secondary schools and gymnasia. By joining the Inženirke in inženirji bomo! (We will be engineers!) project, young people's enthusiasm for engineering, technology and innovation is further strengthened. By the end of 2020, despite the epidemic, several online presentations have been made in secondary schools and gymnasia.



ALUMNI CLUB

In 2020, the Alumni Club of the Faculty Mechanical Engineering in collaboration with Cankarjev dom organized lectures - Hydraulics from Antiquity to the Present Day and Construction from Antiquity to the Present Day - held simultaneously with the exhibition Idea - Ancient Greek Science and Technology. Attending the lectures proved to be a great way to stay in touch with alumni and an opportunity to gain a thorough insight into the past and future of mechanical engineering. At the same time, the lectures stimulated many professional debates and pointed out the importance of mechanical engineering in Slovenian society, its achievements and the ways and anomalies that hinder the development of mechanical engineering and thus the entire society.



MECHANICAL ENGINEERING SUMMER CAMP

Mechanical Engineering is creative and we want to show this to pupils from the 6th grade of primary school to the 3rd year of secondary school. To this end, every August we organize the Mechanical Engineering Summer Camp. In 2020, we organized it for the 7th consecutive year, which indicates that it is becoming a tradition. Despite the corona virus, we had a record attendance of a whopping 82 participants, almost 15 percent of whom were girls. At the Summer School of Mechanical Engineering, participants are divided into small groups and they get to participate in thematic workshops such as hydraulic arm, 3D printing, portable weather station, remote-controlled aircraft construction, USB drink and air cooling, where participants learn about and make products to take home at the end of the workshop.



STUDENT CONFERENCE ON ENGINEERING - ŠTeKam

Every year in September, we enable young people to take their first step into the scientific world by presenting papers at the ŠTeKam student conference on engineering. The conference is open, which means that students from all faculties can participate, and this year, for the first time, we have also given students from the final year of secondary schools and gymnasias the opportunity to take part. Students may also claim their participation in the conference as a remarkable achievement, a prerequisite for receiving the Zois Scholarship. All papers are published in the conference's comprehensive proceedings and entered into the Cobiss system.



MECHANICAL ENGINEERING DAYS

The Mechanical Engineering Days event is held every September in Bistra in cooperation with the Technical Museum of Slovenia and offers visitors an insight into the attractive world of engineering. During the week, the program is mainly intended for the pre-registered groups of 6th to 9th grade students and high school students, and on Sunday for individual visitors interested in the world of mechanical engineering. This time, visitors were able to take a closer look at the exceptional projects of students and established experts from the FME UL and learn many interesting things about drones, automated diagnostics, Formula Student team Ljubljana, acoustic emission, weather forecasting, tribology and many other technologies.



NIGHT HAS ITS POWER

Also in 2020, the traditional European Researchers' night took place, where the doors of science and research institutions in Europe are opened wide for one day a year. On this day we carried out the project "Night has its power" in Slovenia, in which the Faculty of Mechanical Engineering also participated. Within the activities Scientific Express, Dr. Franci Pušavec presented the topic of cutting processes and 3D printing in more detail.



EXHIBITION KRAKOVSKI NASIP

In cooperation with Tourism Ljubljana we prepared an exhibition of selected snapshots from the research activity of the Faculty Mechanical Engineering on the Krakovski nasip along the Ljubljanica river. With the photographs on display, we wanted to show the breadth of its activities and present our efforts, especially in the field of environmental issues and economic development. The exhibition was designed in an attractive and understandable way, which surprises the viewer both from an aesthetic and scientific point of view.



VIRTUAL CAREER FAIR

In 2020, the Faculty of Mechanical Engineering participated for the first time in Virtual Career Fair, which provides access to its content for more than half a year, covering all needs of searching for important information and support in choosing further education.



EXHIBITION OF PUBLIC COMPETITION PROPOSAL FOR THE NEW FACULTY OF MECHANICAL ENGINEERING AND FACULTY OF PHARMACY FACILITIES

In July 2 2020, in the company of important representatives from the field of science and education, an exhibition of competition studies for the selection of the most professionally suitable proposals for new facilities of the Faculty of Pharmacy and the Faculty of Mechanical Engineering of the University of Ljubljana has been opened. It offered an insight in to the future of both faculties. The exhibition was created at the end of public competitions for urbanism and architecture. At the latter, the Faculty of Mechanical Engineering chose the solution of the Sadar + Vuga studio, which offers an innovative, attractive, recognizable, modern, functional and, above all, reasonable and well-founded solution.



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