FACULTY OF MECHANICAL ENGINEERING
UNIVERSITY OF ZILINA

RESEARCH AND INNOVATION POTENTIAL FOR INDUSTRIAL APPLICATIONS

FACULTY OF MECHANICAL ENGINE

tel.: +421 (0)41 513 2500, **web:** fstroj.uniza.sk, **e-mail:** dekan@fstroj.uniza.sk

HISTORY

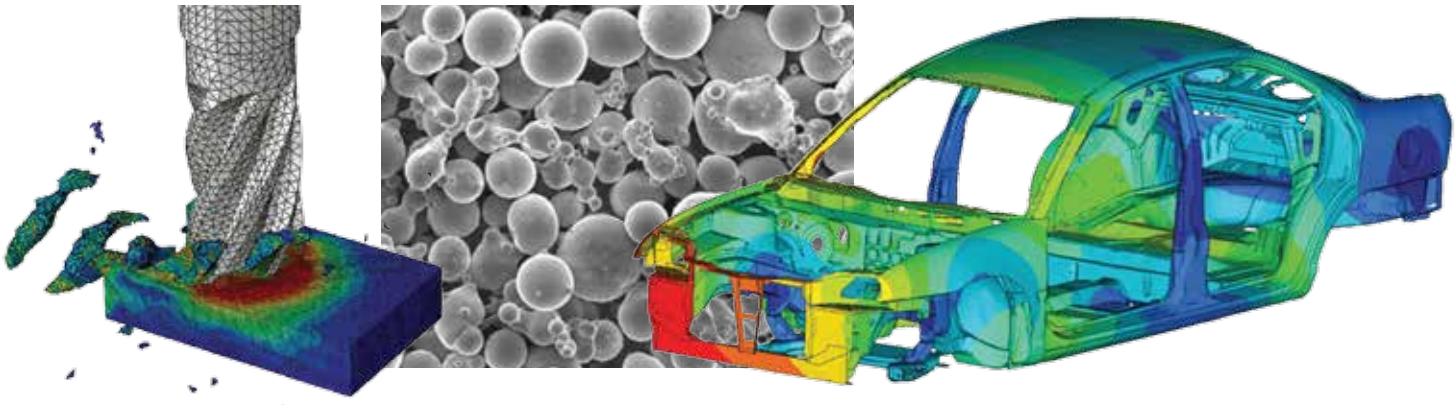
The history of Faculty of Mechanical Engineering at the University of Žilina dates back to the establishment of the university itself, thus to 1953, when the Faculty was one of five of the newly-established Railway College in Prague, whose roots are found in the Czech technical University (ČVUT) in Prague. After moving to Žilina and being renamed the Transport College, changes were made which lead to merging faculties, creating the Faculty of Mechanical and Electrical Engineering.

The Faculty gained modern autonomy on 1.9.1992, by decision of the Academic Senate of the University, when two separate faculties were created – the Faculty of Mechanical Engineering and the Faculty of Electrical Engineering. This determined the further trends direction and development in the Faculty, to obtain a significant position based on tradition and the realisation of latest science and technology results when performing tasks of social training, national and international education and R&D activities.

MISSION AND VISION OF THE FACULTY

The mission of the faculty is to ensure high level of technical education and research-scientific activities to improve skills and knowledge from the point of view of current practice needs in close connection to not only slovak but also european education and research area. Education and research are inseparable priorities while today there is dominated the need of efficient transfer of advanced technologies and new information between the faculty and industry sphere.

The vision of faculty is to achieve the recognition by scientific and industry community mainly in the education of new technical cadres and acceptance in the research area as respected and reliable partner providing added value in domestic but mainly in international projects and activities.



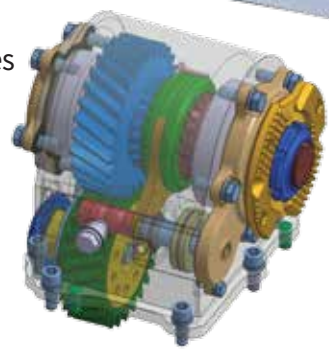
ERING, UNIVERSITY OF ZILINA

THE FACULTY'S MISSION IN RESEARCH AND DEVELOPMENT

The Faculty is one of the significant pillars of University of Žilina, mainly in research and development. Yearly, dozens to hundreds of projects are solved, with a focus on strategic areas, while the direction towards mechanical engineering and automotive production is the priority. The dominant motive is support for these production segments mainly from the perspective of the new visions and strategies based on digitisation and monitoring of all relevant processes.

TRENDS IN RESEARCH INTO VEHICLE DESIGN OF THE FUTURE

- research into the properties of modern vehicle components
- research into advanced materials with emphasis on predicting their functional properties



INTEGRATION OF INNOVATIVE TECHNOLOGIES IN MECHANICAL ENGINEERING

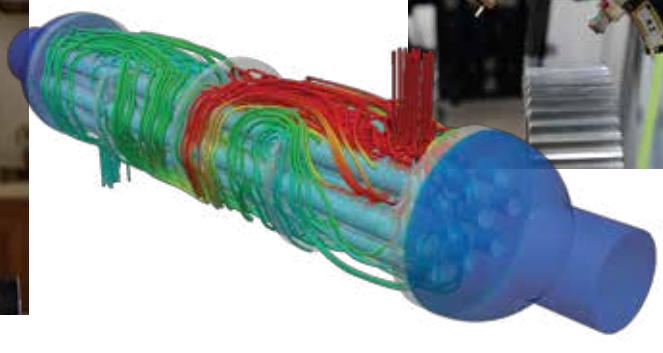
- innovations in energy-intensive engineering technologies
- research into progressive precise technologies for valorisation of advanced materials
- innovations in non-destructive testing and inspection technologies

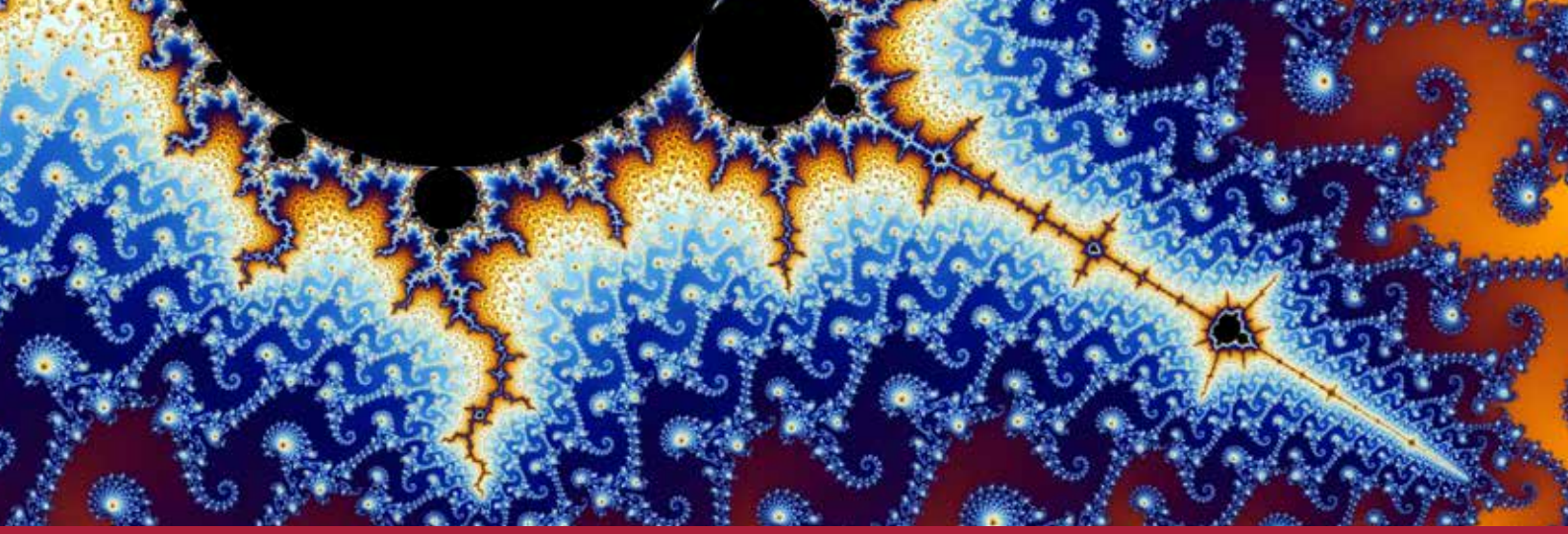
SMART PRODUCTION SYSTEMS

- innovation of production processes based on digital factory principles, creation of digital twins, application of the Internet of Things into engineering processes
- development and innovations of technologies for automation and robotics in the industry area according to strategy of Industry 4.0

GREEN ENERGY

- research into and optimisation of alternative energy sources
- research in the field of "green" vehicles
- research into technologies for energy storage





DEPARTMENT OF APPLIED MATHEMATICS

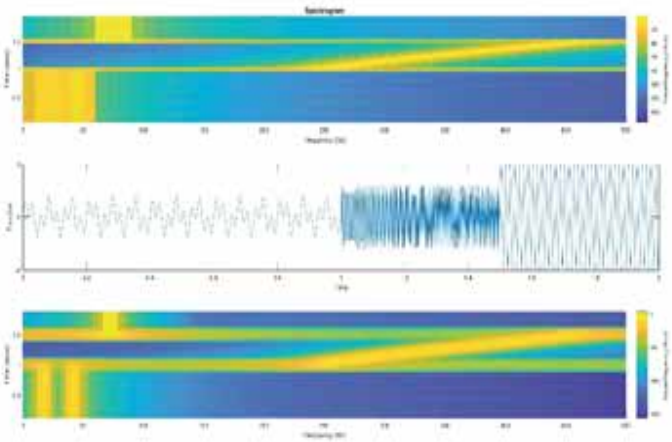
tel.: +421 (0)41 513 4951, **web:** fstroj.uniza.sk/kam, **e-mail:** kam@fstroj.uniza.sk

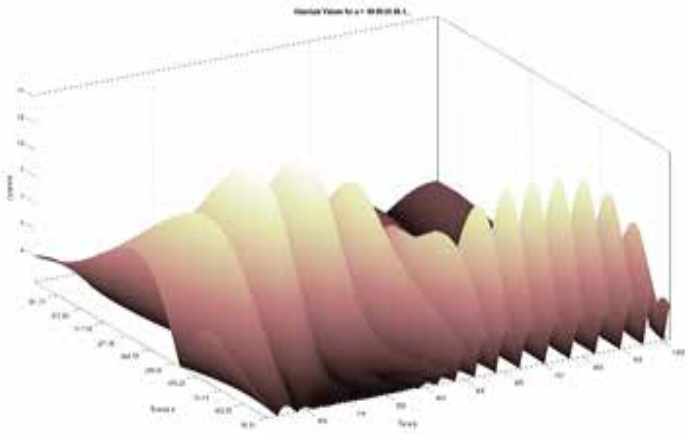
FOCUS OF THE DEPARTMENT

The Department of Applied Mathematics (DAM) participates in the education of comprehensively prepared students for two faculties of the University of Žilina – Faculty of Mechanical and Electrical Engineering. DAM provides the theoretical background required for technical subjects and later for work experience (industrial practice). Science and research is focused on the applied mathematics of engineering practice and some specific topics in basic research into the theory of differential equations and special functions.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The staff of the department provide teaching of mathematical subjects in all study programmes of the Mechanical and Electrical Engineering Faculties of the University of Žilina at undergraduate and postgraduate level.





SCIENTIFIC PROFILE OF THE DEPARTMENT

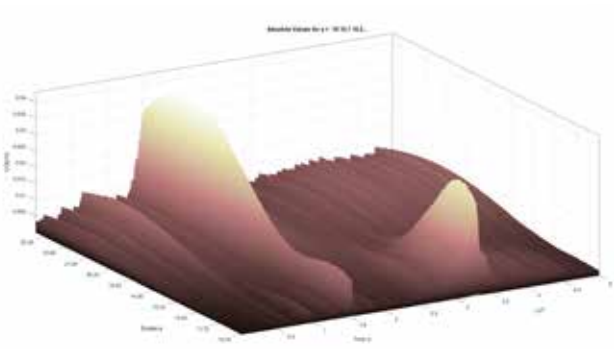
- questions of the qualitative properties of differential and difference equations with shifted arguments;
- research in the theory of special functions, especially orthogonal polynomials with one and more variables;
- mathematical modelling in economics and biology;
- applied nuclear physics – DAM is participating in the long-term monitoring of environmentally significant atmospheric radionuclides (such as 14C and 7Be) in collaboration with the Department of Nuclear Physics and Biophysics, Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava. These radionuclides are well known atmospheric tracers of the global carbon exchange reservoir and 14C in particular is currently a widely-discussed tool for monitoring anthropogenic CO2 emissions.

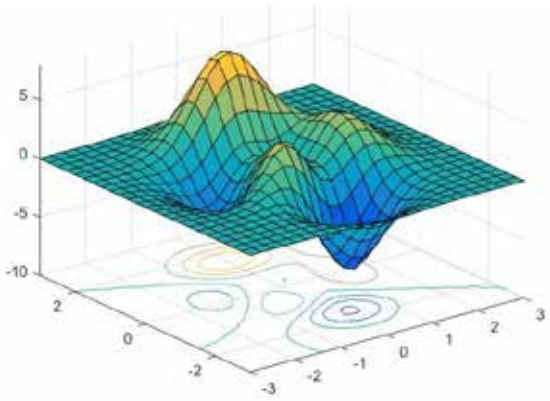
LABS WITH MATHEMATICAL SOFTWARE

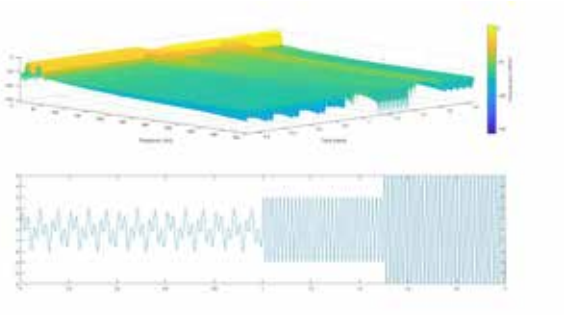
The Department manages two computer labs with mathematical software: MatLab® & Simulink® under the Total Academic Headcount licence: Lab work is focused on the field of study. The Introduction to MatLab® & Simulink® program package is provided for students of the Mechanical and Electrical Engineering Faculties of the University of Žilina. We focus mainly on standard methods in numerical mathematics and statistics, as well as on the creation of algorithms for technical calculations.

OTHER SOFTWARE

- WOLFRAM MATHEMATICA® - Computer Algebra Systems software;
- STATISTICA® - a comprehensive analytical tool for data management and processing.

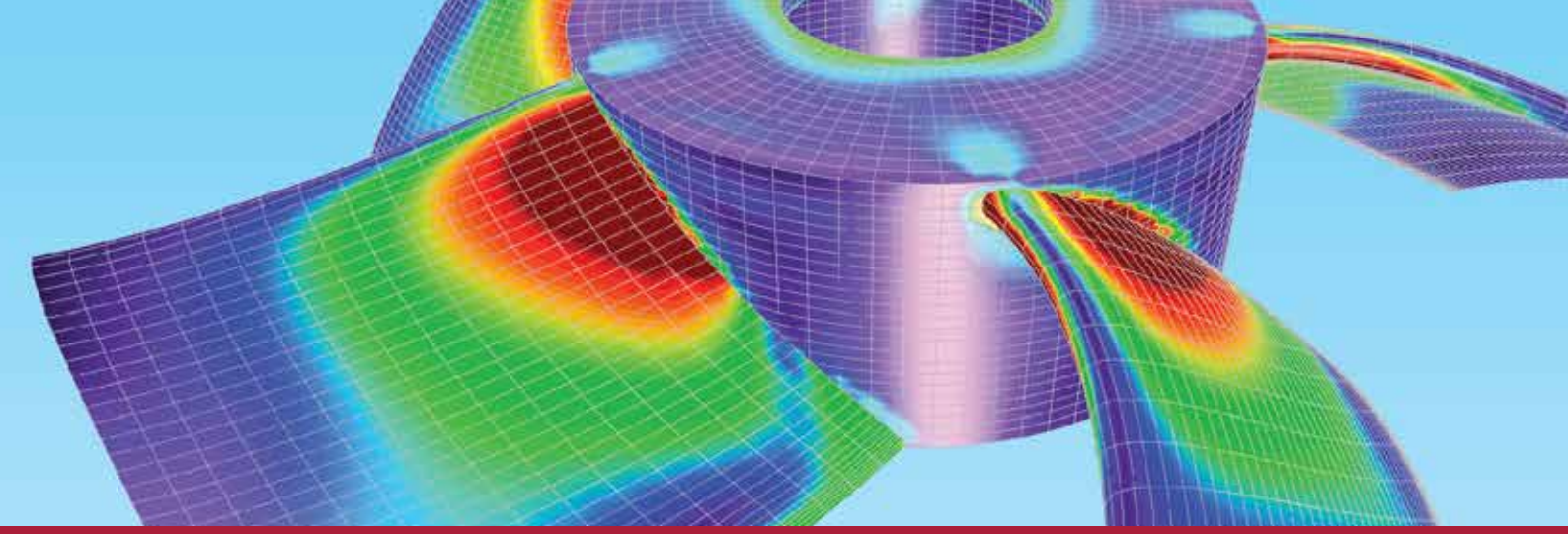






APPLIED RESEARCH – ACTIVITIES

- applied research in the field of technical sciences (mathematical and computer modelling, statistical analysis) and collaboration with other departments in the Faculty;
- analysis of different types of oscillating systems and corresponding differential equations and systems;
- energy-optimised control of electric drives for various applications.



DEPARTMENT OF APPLIED MECHANICS

tel.: +421 (0)41 513 2951, **web:** kame.uniza.sk, **e-mail:** kame@fstroj.uniza.sk

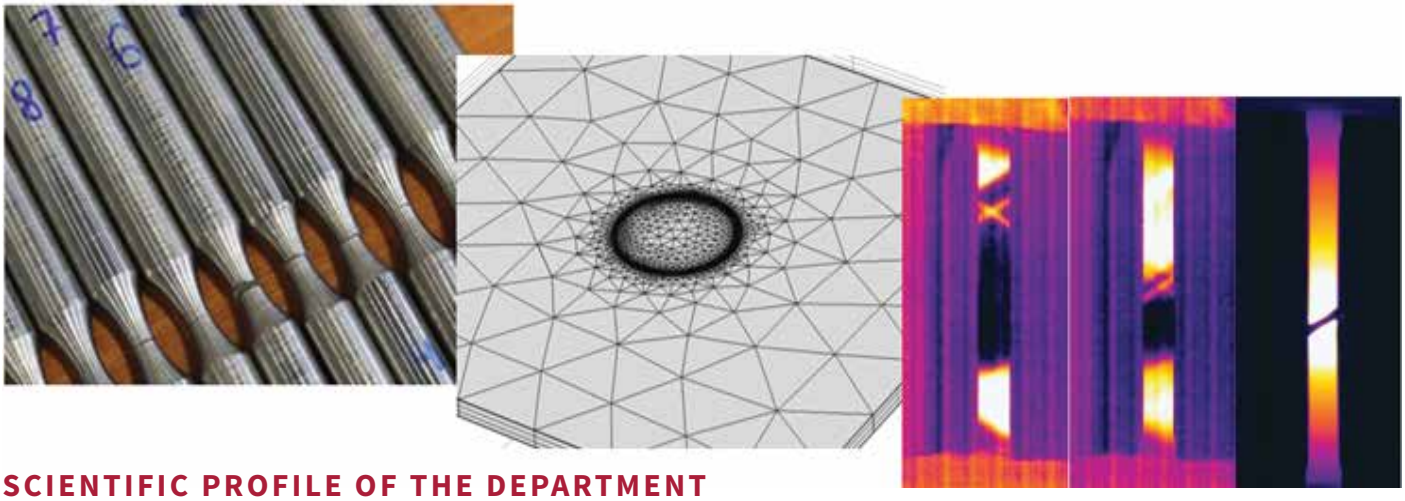
FOCUS OF THE DEPARTMENT

The Department is focused on the education of comprehensively prepared graduates in mechanical engineering. Emphasis is placed on computer modelling and simulation and on modern experimental methods of solving engineering problems at all stages of product life. Calculations are carried out using the software packages ANSYS, ADINA, MSC.ADAMS and Matlab, and experiments using the software packages LabVIEW, FLIR ResearchIR Max, Altair LI, AEwin, ME'scopeVES and others.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Computer Mechanical Design and Simulation**
- 2nd level – Master of Science degree in **Computer Modelling and Simulation in Mechanical Engineering**
- 3th level – PhD degree in **Computer Modelling and Machine Mechanics**



SCIENTIFIC PROFILE OF THE DEPARTMENT

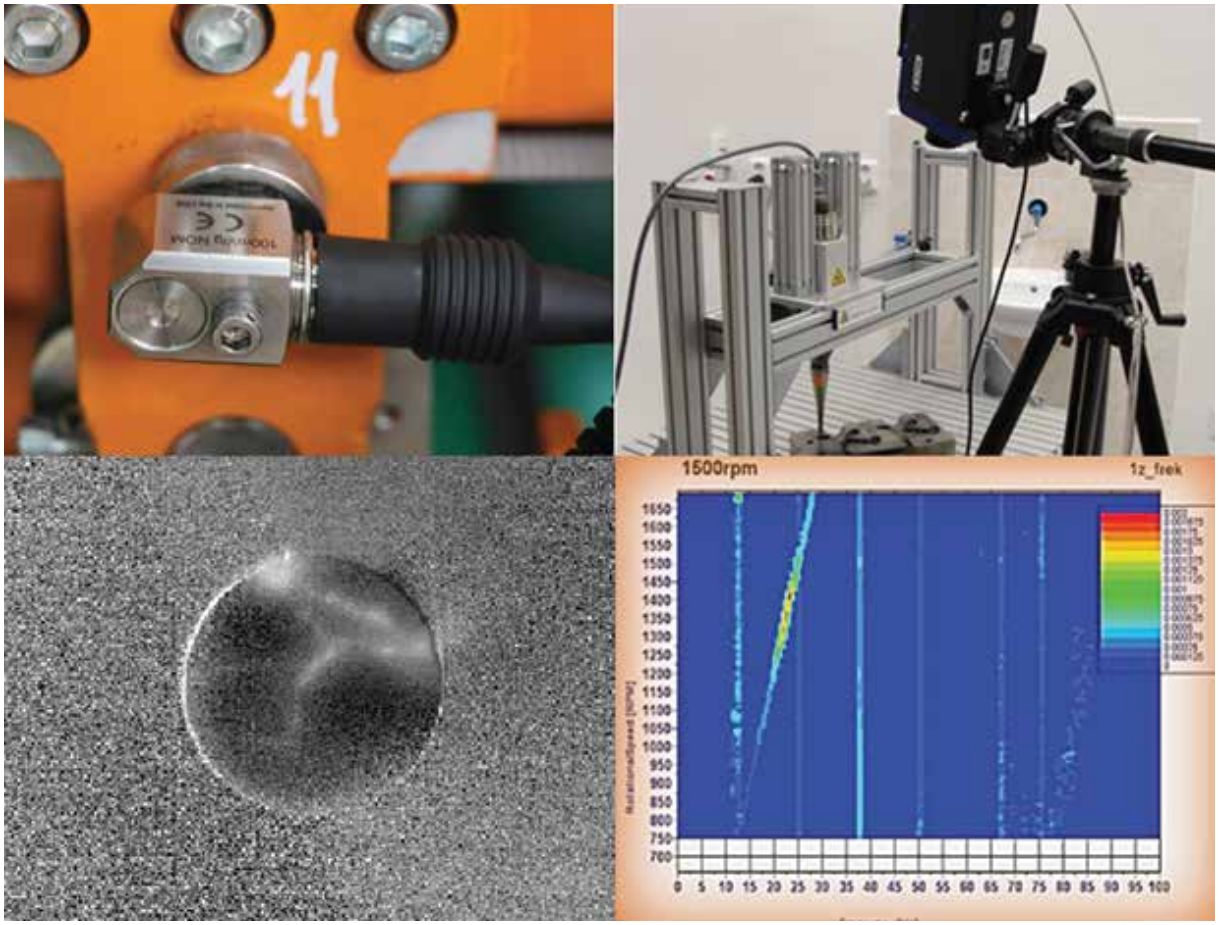
- analysis and calculation of machine loads, modelling, FEM calculations and optimisation;
- computational models of composite structures;
- computational models of multibody systems and mechanisms;
- assessment and calculation of the fatigue lifetime of construction materials used in engineering;
- analysis of critical components of structures;
- modelling and analysis of technological processes;
- training in computer modelling and simulation of statically and dynamically loaded structures, body systems and mechanisms.

EXPERIMENTAL MECHANICS GROUP

The aim of experimental work is to compare outputs from computational models with real measured, processed and interpreted experimental data. Another area is the prediction of limit states and also the preparation of input data for the damage hypotheses used and subsequent analysis. Attention is paid to: dynamic measurements (machine diagnostics also in non-stationary modes, modal analysis, damping, acoustic emission), infrared thermography measurement, determination of stress-strain fields and non-destructive testing methods (NDT).

EQUIPMENT

- multichannel data acquisition and National Instruments experiment control systems, a Polytec Doppler laser vibrometer, TIRA modal exciters;
- FLIR high-speed infrared (IR) camera with cooled detector;
- EDEVIS ultrasound excited system for NDT with IR detection test object;
- test machines are used in collaboration with other departments of the faculty.



APPLIED RESEARCH ACTIVITIES

- vibration condition monitoring techniques for fault diagnosis, analysis of causes of defects, determination of vibration sources, choice of optimal solution in pre-production stages;
- non-destructive testing of metals and composites, detection of cracks and inhomogeneities;
- limit state predictions, analysis of gradual degradation of objects, criteria for monitoring limit states;
- accelerated tests – determination of fatigue limits and fatigue process parameters based on radiation energy from the specimen detected by IR camera.

FATIGUE TESTING GROUP

Our group deals with research and selected material analyses for the evaluation of mechanical and cyclic fatigue tests for the purpose of experimental verification and determination of the residual fatigue lifetime by using real constructions and also laboratory test specimens. Force control can be realised on modern computer-controlled hardware devices such as uniaxial or multiaxial cyclic loading using push-pull vs. torsion and bending vs. torsion loading regime.

EQUIPMENT

- Zwick universal tensile testing machine for loading up to 50 kN, with Epsilon 3542 extensometers (uniaxial) and Epsilon E3560 (biaxial);
- low-frequency test equipment for fatigue multiaxial bending vs. torsion loading;
- biaxial low fatigue test stand for push-pull vs. torsion loading.

APPLIED RESEARCH ACTIVITIES

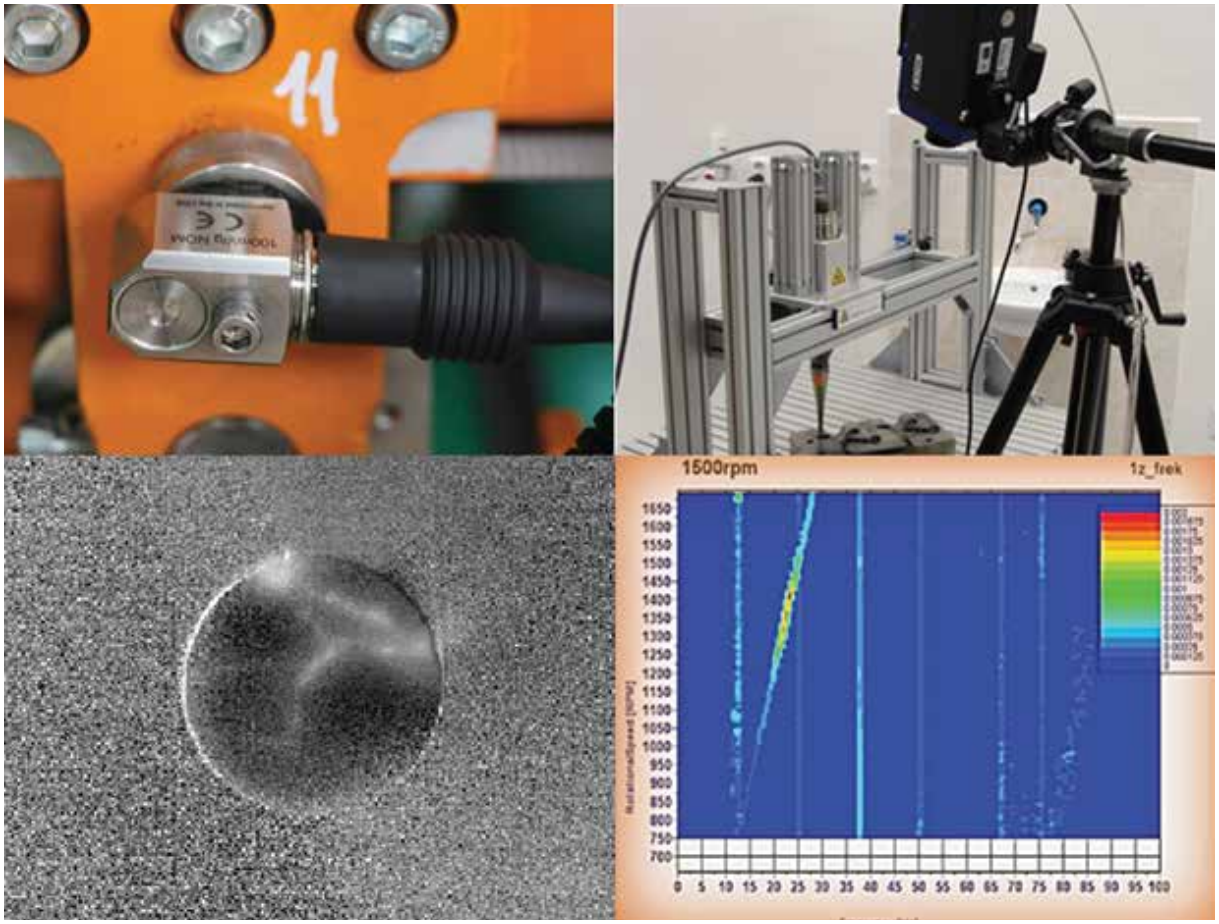
- analysis of fatigue and other types of machine and device damage;
- determination of parameters for combined (multiaxial) fatigue loading;
- computational prediction of limiting states and comparing results with experimental measurements using modern materials;
- scientific investigation and implementation of welding methods on the fatigue resistance of materials with a consequential evaluation system for experimental measurements and the further data measuring process.

COMPUTATIONAL MECHANICS GROUP

The group's research interest is the computational solutions to engineering problems, such as the stress – strain analysis of strain, degradation of analysed objects, prediction of fatigue life, optimisation of whole structures and their parts. The technological processes and their influence on the values of the calculated parameters are also of interest.

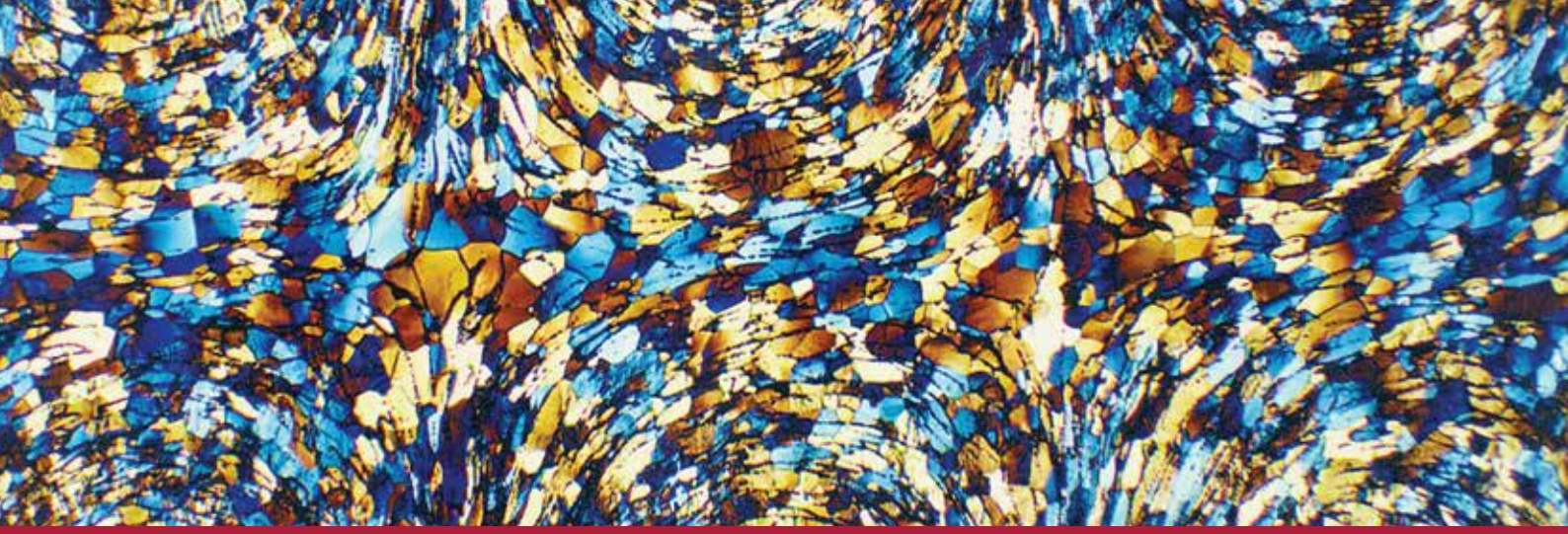
EQUIPMENT

- 4 IBM Servers, each with 32 cores, 256 GB of RAM, 10 TB RAID5 HDD – to handle smaller tasks;
- university cluster – to solve larger tasks;
- software for FEM computing (Adina, Ansys, Adams).



APPLIED RESEARCH ACTIVITIES

- stress – strain analysis of machines, modelling, FEM, calculations and optimisation;
- assessment and calculation of the fatigue lifetime of construction materials used in engineering;
- analysis of critical parts of structures;
- predictive calculation of the fatigue lifetime of device components;
- modelling and analysis of technological processes;
- training in computer modelling and simulation of statically and dynamically loaded structures and mechanisms.



DEPARTMENT OF MATERIALS ENGINEERING

tel.: +421 (0)41 513 2601, **web:** kmi2.uniza.sk, **e-mail:** kmi@fstroj.uniza.sk

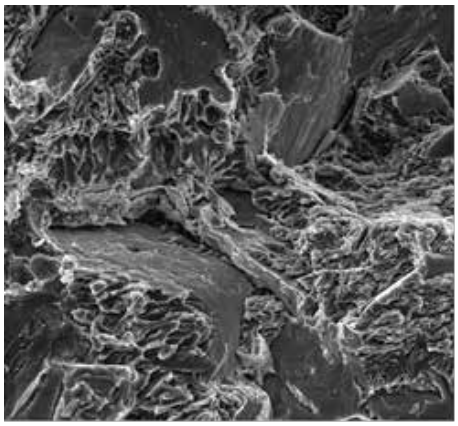
FOCUS OF THE DEPARTMENT

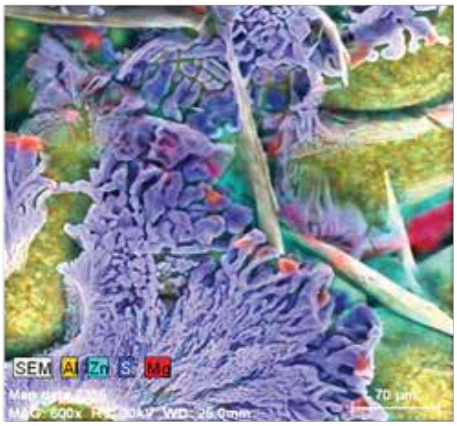
The department has a 65-year tradition in technical education and scientific research in compositional and structural effects on the properties of construction materials, in the evaluation of their resistance to mechanical, fatigue, physical and chemical stress (strength characteristics, giga-cycle fatigue, chemical and electrochemical corrosion resistance, degradation of properties etc.) with a good output for domestic and foreign engineering practice.

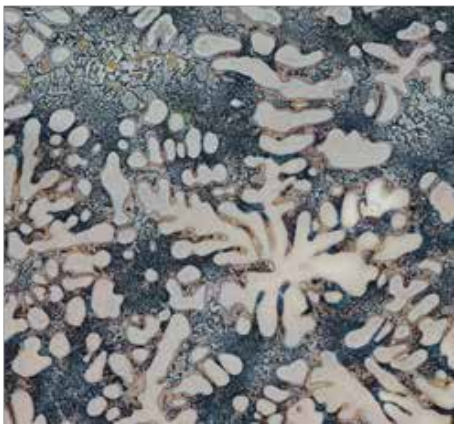
PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Materials and technologies in automobile production**
- 2nd level – Master of Science degree in **Technical materials**
- 3th level – PhD degree in **Technical materials**







SCIENTIFIC PROFILE OF THE DEPARTMENT

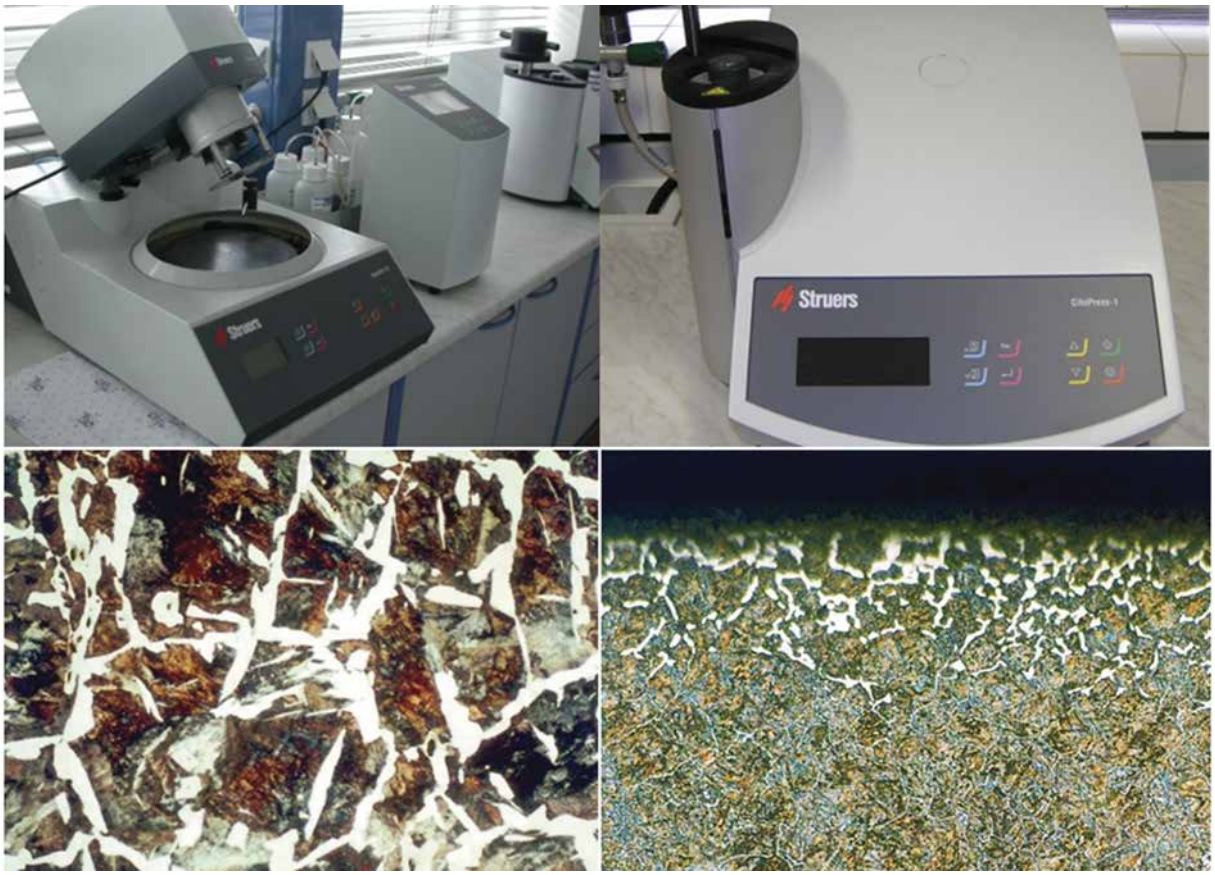
- new trends in the field of materials engineering with the aim of using limit properties of materials in all areas of their applications;
- evaluation of the resistance of materials to mechanical, fatigue, physical and chemical stress;
- increasing the utility properties of construction materials intended for applications in transport, especially in the automotive industry;
- prediction of the lifetime of the heat-loaded components;
- evaluation of the properties of materials for biomedical applications, focused on their resistance to corrosion and fatigue in a saline environment;
- development of knowledge and education in the field of waste treatment and disposal;
- research into the rheological properties of plastics depending on their degradation by mechanical and chemical stress;
- an education and research system focusing on the automotive industry.

LIGHT MICROSCOPY AND METALLOGRAPHIC SAMPLE PREPARATION GROUP

The group's laboratory provides the preparation of high-quality sections (sampling, preparation, grinding, polishing and etching) from both very soft materials and difficult materials; performs standard metallographic analyses of metallic and non-metallic materials in accordance with STN and EN ISO standards. In addition to the basic methods of structural evaluation, the laboratory specialises in the utilisation of colour contrast in phase analyses and quantitative evaluation of structure and fracture profile.

EQUIPMENT

- Neophot 32 light microscope (magn. 25 – 2000x); Motic stereomicroscope (magn. 10 – 50x); NIS Elements software for quantitative analyses;
- MTH MIKRON 3000 precise saw for cutting samples with DOS-100 digital measurement;
- CitoPress-1 pressing machine and CitoVac pressing machine for pressing the samples in a vacuum and under UV light;
- TEGRA System machine for automatic preparation of samples.



APPLIED RESEARCH ACTIVITIES

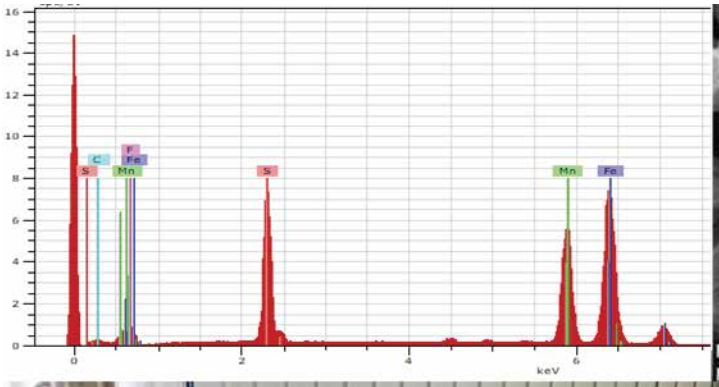
- macro- and microstructure evaluation of materials in cast and wrought states in order to examine heat treatment quality or structure degradation;
- evaluation of the degree of effect on the structure in the case of a system crash caused by exceeding the specified operating temperature in order to examine the subsequent operation possibilities;
- evaluation of grain size and micropurity of materials;
- appraisal of thermal and thermo-chemical surfacing (nitriding, carburising, carbonitriding, alitising, etc.); determination of the steel decarburisation depth;
- appraisal of quality and measurement of metal coatings and surface film thickness; appraisal of the type and degree of the corrosion attack.

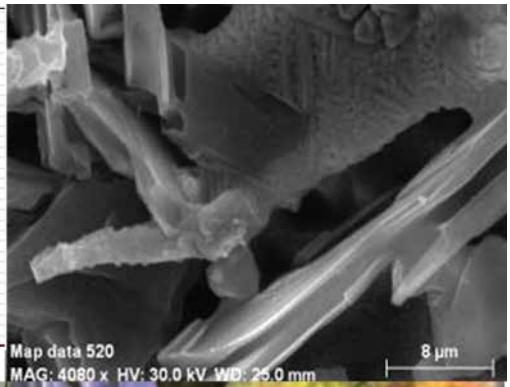
ELECTRON MICROSCOPY AND SPECTROSCOPY GROUP

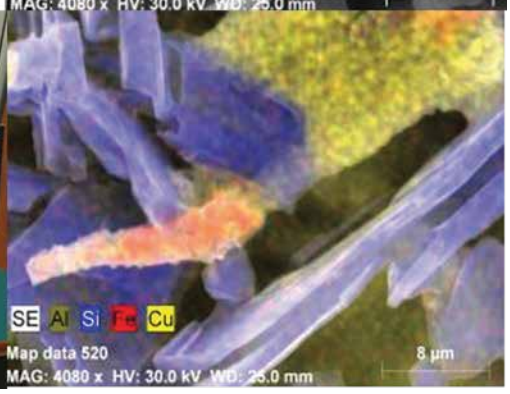
The group deals with the evaluation of damage to construction materials after overloading, fatigue failure, creep and corrosion or wear (fractography, surface morphology etc.); provides detailed analyses of the structure of a material and its chemical composition after technological operations or after operation load; provides precise chemical analyses of metal alloys (steel of every grade, copper alloys, aluminium alloys, magnesium alloys, titanium alloys, cobalt alloys).

EQUIPMENT

- TESCAN VEGA LMU II scanning electron microscope with SE, BSE and LVSTD detectors; EDX analyser (BRUKER electron probe micro-analyser);
- TESLA BS 343 scanning electron microscope;
- Q 150R ES combined metals sputter coater;
- SPEKTROMAXx spark spectrometer;
- SPECTRO xSORT manual RTG spectrometer for quick identification of all kinds of materials;
- Metaval (magn. 50-500x) and Neophot 2 (magn. 50-2000x) optical microscopes.







APPLIED RESEARCH ACTIVITIES

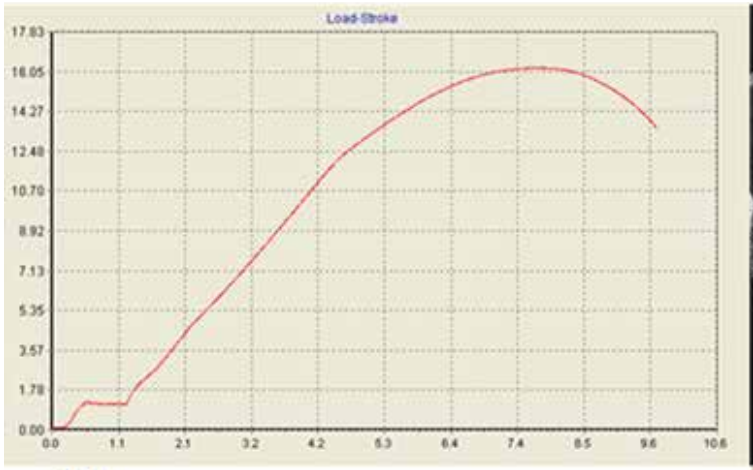
- fractography and microfractography of fracture areas after overloading, fatigue failure and creep, evaluation surface degradation of materials;
- macro- and microstructure evaluation of materials in the cast and wrought state in order to examine the heat treatment quality, structural degradation or depending on the analysis requirements by determination of the cause of material failure;
- evaluation of the degree of effect on the structure in the case of a system crash caused by exceeding the specified operating temperature in order to examine the following operation possibilities; assessment of the type and degree of corrosion attack;
- evaluation of coating thickness (PVD and CVD, nitrided, cemented and galvanically applied surface coatings etc.);
- local detection of chemical composition, phase identification and its distribution and mapping;
- a precise chemical analysis of metal alloys;
- confirmation of authenticity or material switch; quick identification of materials.

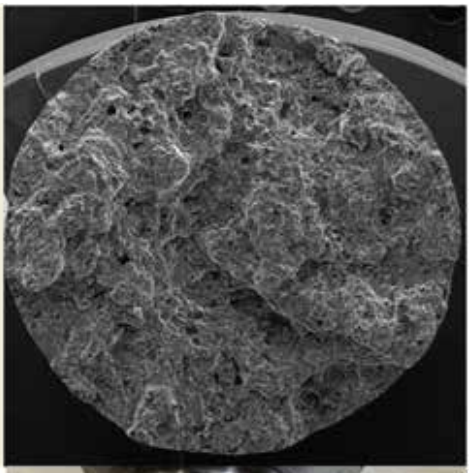
MECHANICAL TESTING GROUP

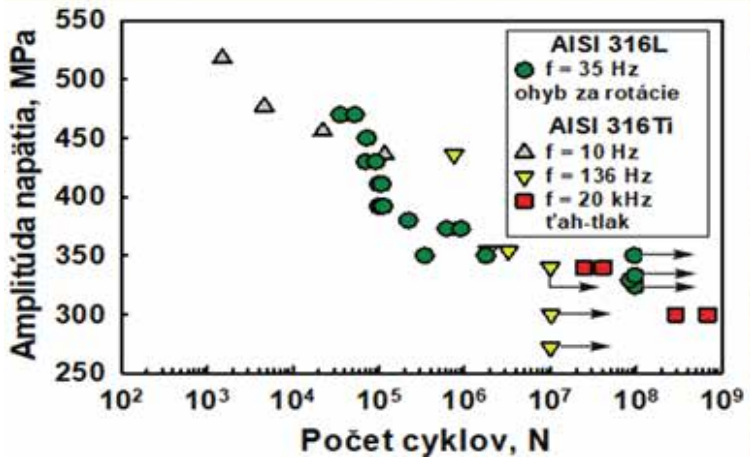
The group provides all elementary mechanical tests of metals, polymers and other construction materials, such as tensile, pressure and bending tests according to STN EN ISO standards; tensile tests, bending tests and torsion tests of complete device parts, cog wheels etc.; bending – rotation fatigue tests; impact toughness tests; Brinell, Vickers, and Rockwell hardness tests; non-destructive tests (ultrasonic, magnetic and capillary testing).

EQUIPMENT

- ZDM 30 (for loading up to 300 kN) and EDZ 100 (for loading up to 1000 kN) universal tensile testing machines;
- PSW 150 and 300 J Charpy hammer and Charpy hammer from 7,5 to 50 J;
- LaborTech JTR cooling chamber (from -70 °C to +200 °C)
- Rotoflex testing machine for bending – rotation fatigue tests;
- Brinell CV-3000LDB, Vickers HPO 250/AQ and Rockwell RR-1D/AQ hardness test machines, BVR 250 N universal hardness test machine; TH-170portable hardness test machine, Poldi-hammer; Zwick/Roel ZHVμ -A automated microhardness machine;
- Sonagage III UT thickness measurement machine;
- Starman DiO 562 ultrasonic flaw detector and Inkar HD 400 magnetic flaw detector;
- Zwick dynamic pulsation machine.







APPLIED RESEARCH ACTIVITIES

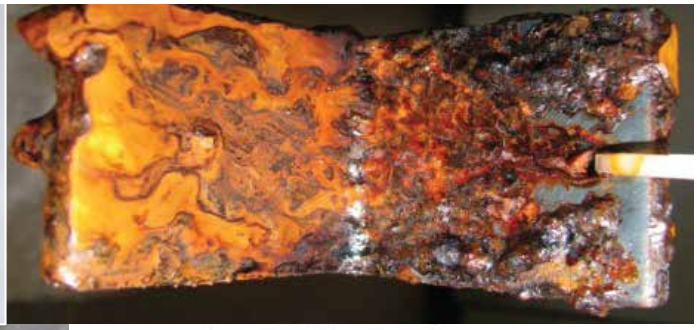
- analyses of machine and device accidents in industry;
- analyses of the mechanical properties of newly designed construction parts;
- diagnostics of fatigue and other types of machine and device damage;
- determination of the fatigue characteristics (Wőhler curve; fatigue strength and time fatigue strength; fatigue lifetime in ultra-high cycles of loading (107 < N < 1010 cycles) etc.);
- residual fatigue lifetime prediction for real devices.

METAL CORROSION GROUP

The group is focused on the determination of the suitability of materials in given working environments, the prediction of material degradation by corrosion attacks in various corrosive environments – real (soil, water, atmosphere) and simulated (rural, industrial, marine atmosphere, standardised environment) conditions; the evaluation of anti-corrosive protection systems – passive (organic and inorganic layers and coatings) or active (anodic and cathodic protection); the design of surface treatment by layers and coatings and the evaluation of their electrochemical properties; the evaluation of material/environment electrochemical properties at various temperatures (normally from -50 °C to 120 °C).

EQUIPMENT

- Radiometer Analytical Voltalab 10 measuring system with rotating electrode;
- Bio-Logic VSP system with thermostatic corrosion cells;
- Milwaukee MA886 refractometer for determination of NaCl content in solutions;
- Milwaukee Mi414 and Mi408 photometers for determination of chloride and iron content;
- device for determining the pH/ORP/ISE/temperature ADWA 1020
- a source of direct current for the electrochemical treatment of metal surfaces;
- Angelantoni DCTC 1200 system; ZKO-1condensation chamber;
- Co.Fo.Me.Gra Solarbox 1500e system;
- thermostat for simulation of temperature of environments from -70 to 150 °C.

APPLIED RESEARCH ACTIVITIES

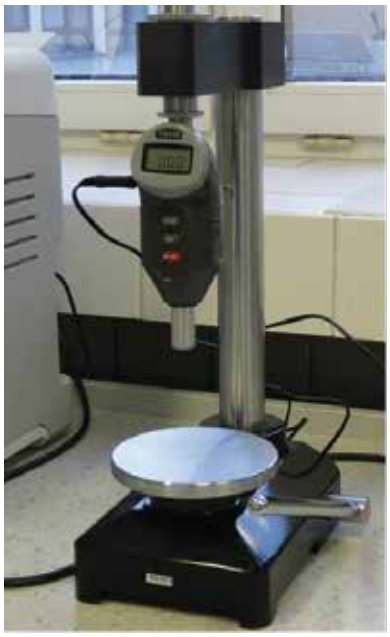
- design and evaluation of conditions of active (cathodic and anodic) anti-corrosive protection of metals under various conditions (soil, water, temperature, humidity);
- determination of the electrochemical characteristics and the basic parameters for dimensioning anti-corrosive protection using voltamperic methods;
- evaluation of properties of passive anti-corrosive protection (layers and coatings);
- designing conditions of surface treatment and surface treatment by layer formation – passivation, creating conversion layers – phosphating, chromating, anodising (eloxal coating, colour eloxal coating), electrochemical polishing and etching of metal surfaces;
- refractometric determination of NaCl content; photometric determination of chloride and iron content
- standardised tests in condensation chamber according to STN 03 8213; in salt fog according to DIN 50 021 and STN ISO 922; testing material degradation due to UV radiation according to ISO 4892-2 and DIN EN 513; cyclic tests of corrosion resistance.

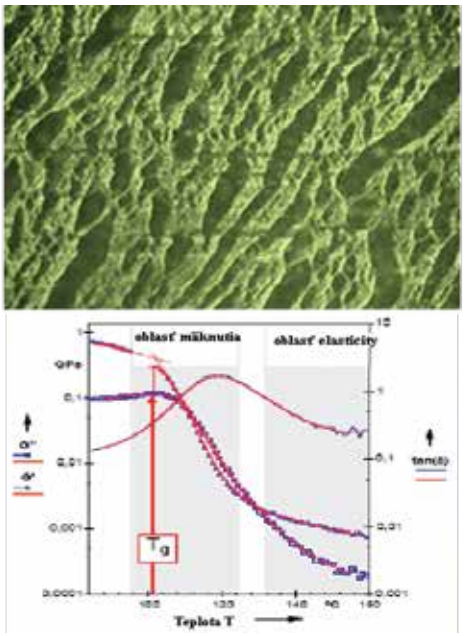
EVALUATION OF POLYMER MATERIAL PROPERTIES GROUP

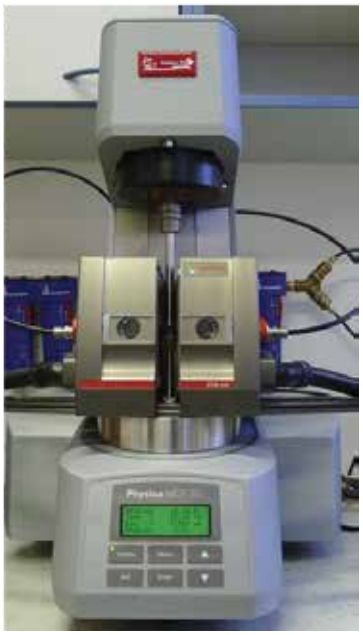
The group is focused on the measurement of rheological properties (dynamic viscosity, modulus of elasticity and plasticity, damping factor, changes of molecular masses etc.) of polymer construction materials and highly viscous liquids. It enables tensile testing, hardness measurement and impact bending tests, the measurement of density, polymer degradation in various environments.

EQUIPMENT

- Physica MCR301 oscillatory rheometer;
- Shore D digital hardness tester, type THS – 210D with HD stand;
- Dynstat;
- Solarbox 1500;
- light stereomicroscope.







APPLIED RESEARCH ACTIVITIES

- measurement of the rheological properties of polymers in solid and plastic states;
- measurement of the rheological properties of highly viscous liquids;
- measurement of polymer hardness; tensile tests;
- impact strength testing (shock, bending);
- polymer degradation in various environments;
- polymer ageing in the UV chamber.

DEPARTMENT OF DESIGN AND MECHANICAL ELEMENTS

tel.: +421 (0)41 513 3007, **web:** kkcs.uniza.sk, **e-mail:** kkcs@fstroj.uniza.sk

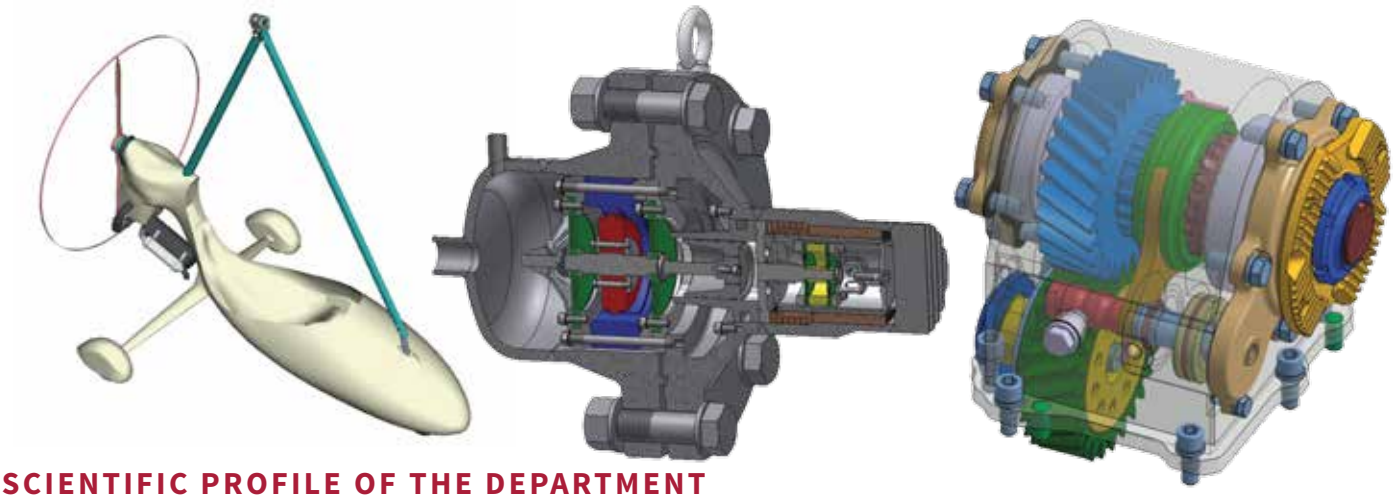
FOCUS OF THE DEPARTMENT

The Department is focused on the education and training of design engineers of machines and equipment, with expert knowledge of mechanical design, construction materials, design methodology, innovations, calculation and simulation methods, optimisation of mechanical elements and nodes. All this knowledge is required for successful employment of mechanical design engineers in the European labour market.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Computer Construction and Simulation**
- 2nd level – Master of Science degree in **Mechanical Design of Machines and Equipment**
- 3th level – PhD degree in **Computer Mechanical Elements and Mechanisms of Machines**



SCIENTIFIC PROFILE OF THE DEPARTMENT

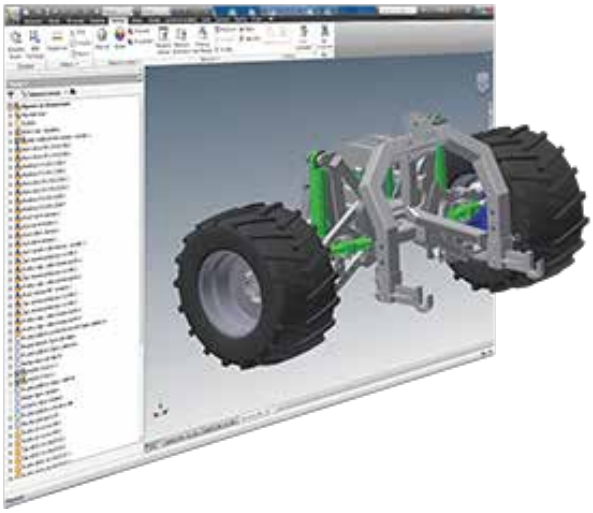
- design of machines and equipment;
- Rapid Prototyping and Rapid Tooling additive technologies;
- 3D digitisation – Reverse Engineering Design, analysis of transmission systems and transmissions;
- design and analysis of rolling bearings;
- stress analysis of machine elements using FEM, Rigid Dynamic simulation;
- virtual testing;
- applied tribology;
- biomimetics;
- electromobility – the Edison Project.

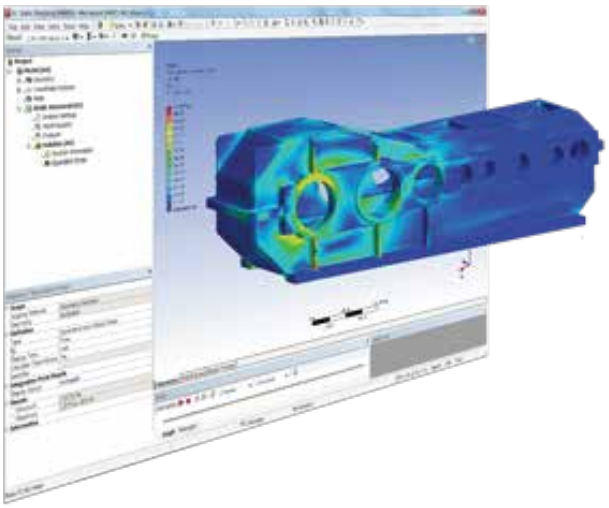
CA SYSTEMS

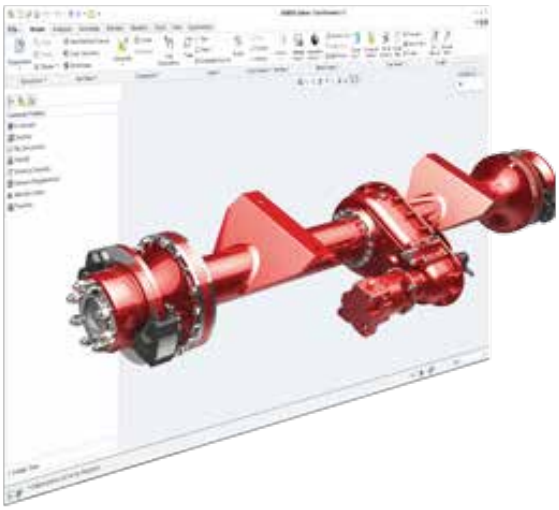
CA systems are computer systems designed to support activities at all stages – from development and design through production planning to production and assembly, storage and shipping. CA systems allow the acceleration and simplification mainly of the processes of modelling and drawing, dimensioning, analysis, design, but also various administrative tasks such as archiving, searching and the like. CA systems include CAD, CAE, CAPP, CAM, CAA, and CAL. This is all software for creating models and drawing documentation, for technical calculations, simulations and analysis.

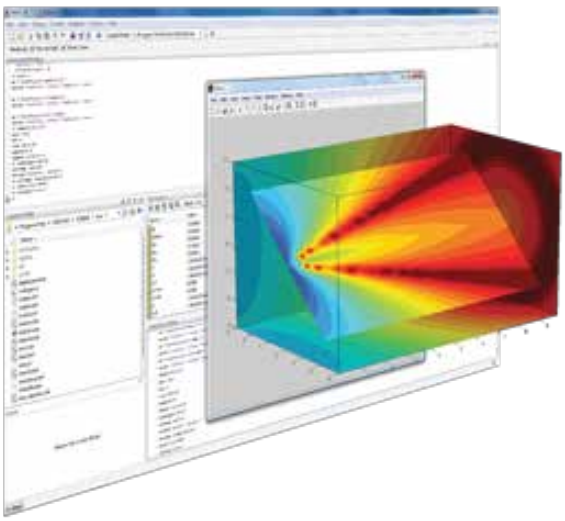
SOFTWARE PACKAGES

- PTC Creo Parametric;
- CATIA V5;
- Autodesk Inventor;
- MSC Marc;
- MSC Adams;
- MSC Apex;
- ANSYS Workbench;
- Matlab.









APPLIED RESEARCH ACTIVITIES

- machine construction development and design;
- design and calculation of transmission systems;
- deformation and stress analysis of structures;
- dynamic analysis of machine mechanisms;
- optimising machine elements and mechanisms.

BEARINGS AND BEARING MATERIALS TESTING GROUP

The group deals with the applied research into rolling bearings and the tribological properties of materials and surfaces. The constructed testing machines are tailored to specific tasks, conditions and requirements. The testing machine equipment is always specific for that task, therefore pecific types of drives, sensors, strain gauges, hydraulic components, electronic components, and the like are used. The appropriate hardware and software are also standard equipment.

EQUIPMENT

- testing machine for lifetime testing of rolling bearings
- vacuum chamber with accessories for generating specific vacuum conditions
- linear tribometer with appropriate equipment – a device for detecting the tribological properties of materials and coatings
- rotary tribometers with accessories – one working in a vacuum – to detect the tribological properties of materials and coatings
- optical microscope for microscopic examination of wear
- Mahr MarSurf PS1 manual roughness tester with appropriate measurement software for surface roughness profile evaluation
- National Instruments measuring station for measuring data from sensors placed on tribometers and their evaluation
- optoNCDT 2401 non-contact measuring sensor to measure the depth of surface wear with a resolution of 0.12 microns during testing.

APPLIED RESEARCH ACTIVITIES

- optimisation of bearing design parameters for increasing the lifetime of the bearings
- ProHiSpeB – a prototype of high speed axle telematics bearing
- constructional design of the equipment for the lifetime testing of large-dimensional bearings

THE EDISON PROJECT AND ELECTROMOBILITY GROUP

The Edison Project deals with research in the field of electromobility, unconventional drives and their components. Research is divided into three interconnected areas. The first is the construction of an actual “EDISON” experimental electric vehicle with verified design elements, ergonomics and safety. The second area of research is oriented towards the optimisation of energy flow and testing of the driving, electric and mechanical properties of electric and hybrid vehicles. The development of an electronic power assistant for an electric car driver also falls within the second area. The third area is research into and the development of mechanical and electronic components for electric vehicles using modern design methods. To test of these features, a testing laboratory was founded, with an intelligent test and diagnostic system for unconventional car drives and their components.

EQUIPMENT

- experimental electric vehicle with an asynchronous electric motor with the nominal / maximum output of 16kW/30kW, with a CURTIS inverter and LiFeYPO4 300Ah traction batteries with a BMS and panel charger;
- YAMAHA MSR 1050 power hydraulic testing machine for testing vehicles with Hybrid Drive and 4x4 Drive, with programs for measuring engine power, pulling force, loading simulation and driving cycle simulation.

APPLIED RESEARCH ACTIVITIES

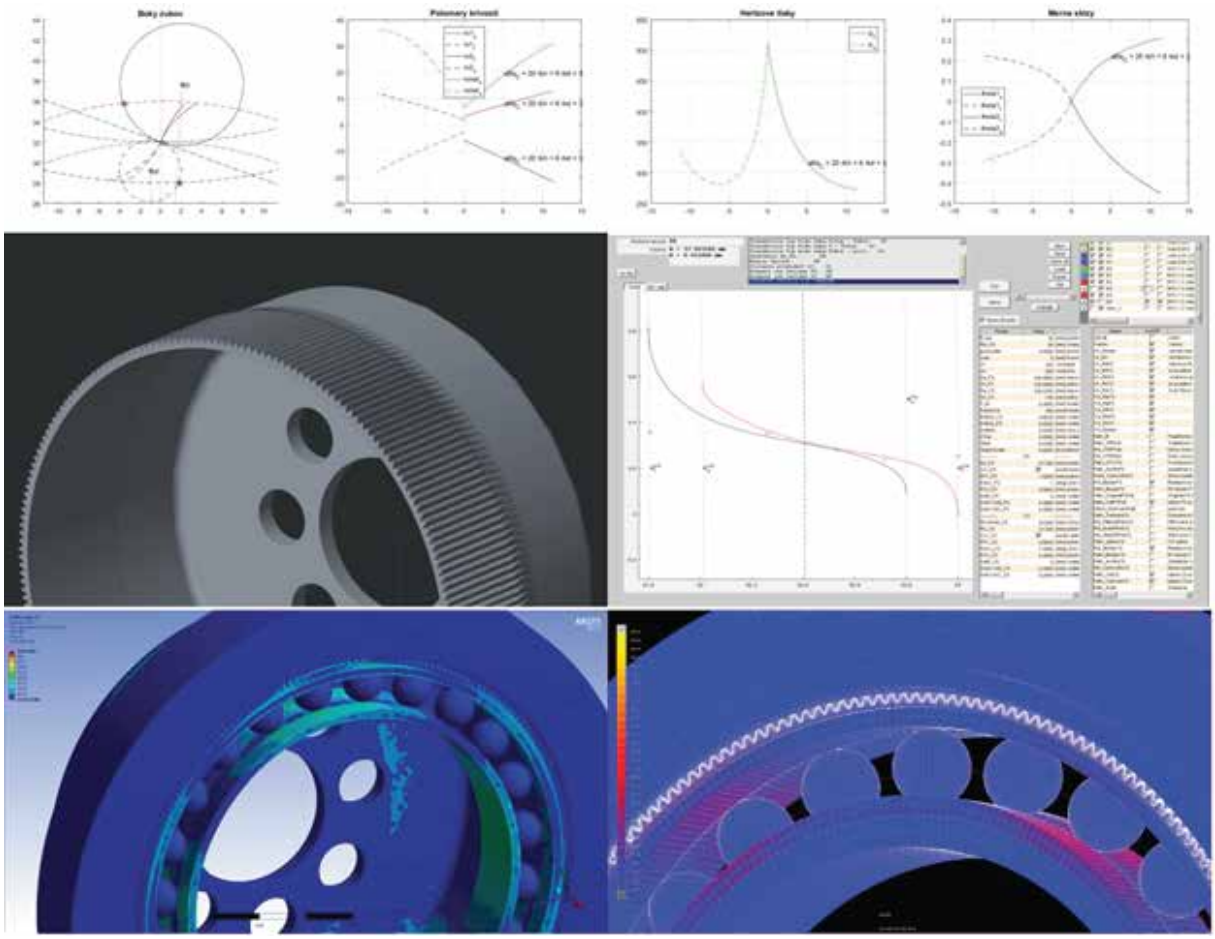
- development of an unconventional gearbox for a small city electric car;
- development of a small off-road vehicle with electric drive, and using unconventional materials for constructing the chassis and bodywork;
- development of an electric car with a safe bio-telemetry system for monitoring the driver’s condition.

DESIGN OF SPECIAL TRANSMISSION L-SYSTEMS GROUP

The department has the capacity to solve unconventional problems in driving systems. Research is focused on the design of cycloidal gears, defining geometrical characteristics, engagement and slip ratios, and defining contact stresses at contact points. The group deals with researching a new type of harmonic gearbox with a special tooth shape for robotics and automation.

EQUIPMENT

- powerful computing stations;
- top-of-the-range Eizo imaging units;
- software packages: Ansys, Creo, Marc / Mentat, MSC Adams, Matlab.



APPLIED RESEARCH ACTIVITIES

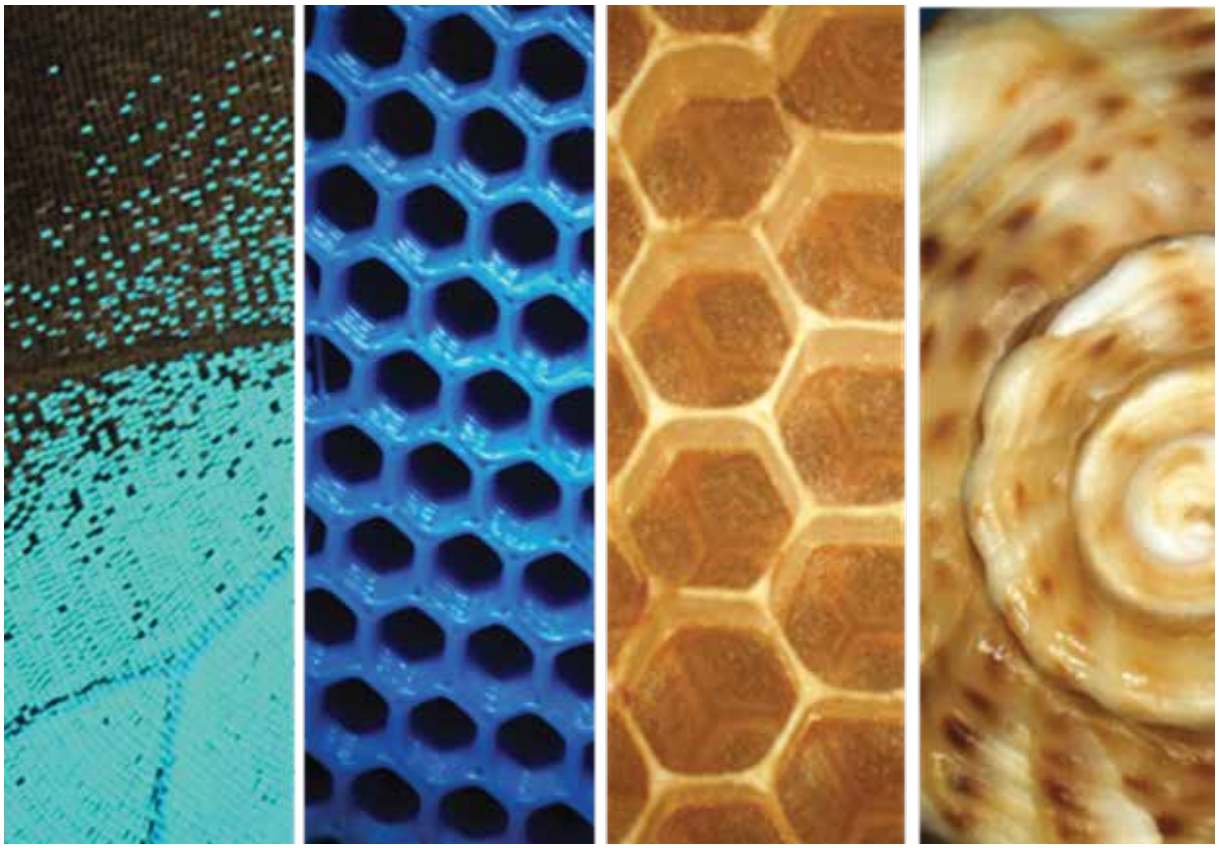
- design of gears with cycloidal tooth flanks based on the definition of their action curve;
- geometrical analysis of the cycloid tooth flanks, sliding speeds, and contact pressure definition at individual points of the action curve;
- design of gears based on gearing requirements for a rigid and flexible transmission element;
- interference analysis of toothing of harmonic gear elements during assembly
- design of wave generators based on gearing requirements for a rigid and flexible transmission element;
- contact pressure analysis between the teeth of the flexible and rigid gear elements;
- analysis of the gear unit backlash under particular conditions.

BIOMIMETICS GROUP

In the Department of Design and Mechanical Elements, the study of biomimetics is supported in all fields. However, research is mainly focused on technical innovations inspired by natural structures, morphology, processes, equipment, motion, nanotechnologies and anthropo-biomimetics, etc. The aim of biomimetics is to teach design engineers to find innovative solutions to problems in a perfectly optimised natural and non-natural world. The Biomimicry Laboratory is equipped with modern technologies for the educational process and the scientific research activity.

EQUIPMENT

- NT-MDT Solver Next atomic force microscope;
- OLYMPUS Iplex FX high-speed camera I-speed 3 & Videoscope with probe;
- Surftest Mitutoyo SJ-210 roughness tester & HT 2000A dynamic portable hardness tester ;
- SZX16, OLYMPUS & SteREO Discovery.V8, ZEISS stereo microscopes;
- Axio Observer Z1.m, ZEISS and other light microscopes.



APPLIED RESEARCH ACTIVITIES

- use of renewable energy – the application of a flexible photovoltaic panel with nominal power (150W) and an MPPT power distributor on the roof of the Edison experimental electric vehicle;
- use of bio-telemetry technology and intelligent textile materials in the electric vehicle assistance system for monitoring the physiological parameters of the driver's condition, the University of Žilina in collaboration with the companies VÚTC and CHEMITEX;
- research into natural models for technical applications.

DEPARTMENT OF TECHNOLOGICAL ENGINEERING

tel.: +421 (0)41 513 2757, **web:** kti.uniza.sk, **e-mail:** kti@fstroj.uniza.sk

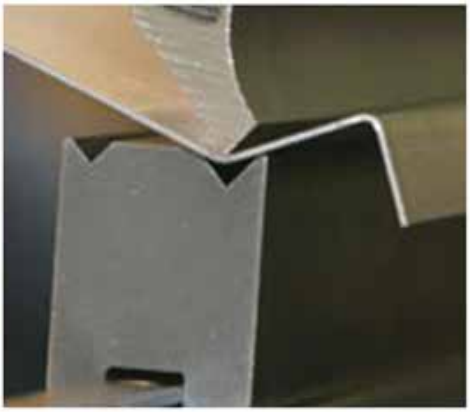
FOCUS OF THE DEPARTMENT

The Department of Technological Engineering focuses on the area of chipless technologies – casting, welding, forming and heat treatment. For many years, the department has been able to provide high-quality graduates at all levels of university education. The department is composed of a team which excels in the field of science, research and teaching, and is are fully prepared to flexibly adapt the learning process to the needs of the engineering industry.

PEDAGOGICAL PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Engineering technologies**
- 2nd level – Master of Science degree in **Engineering technologies**
- 3th level – PhD degree in **Engineering technologies and materials**



SCIENTIFIC PROFILE OF THE DEPARTMENT

- research into and development of casting, metallurgy and casting technology production from ferrous and non-ferrous materials with the support of modern numerical simulation;
- research into and development of welding and related processes, focused on the assessment of the proposed welding procedures with the support of numerical simulations and modern experimental methodologies to measure process variables, especially for arc welding technologies;
- research into and development of forming processes, focusing on progressive unconventional technologies and forming tools with emphasis on the use of physical knowledge and the needs of forming industry;
- research into and development of heat treatment of ferrous and non-ferrous metals, material analysis (macrostructure and microstructure), evaluation of hardness and mechanical properties.

CASTING GROUP

Provides research and development work in the field of metallurgy and casting technology. The lab is used for moulding, casting and examining the casting alloy properties. The group also provides techniques for verifying experimental work related to materials analysis and various research tasks focusing on progressive methods of casting. It is also possible to use ProCAST casting simulation software, which can predict casting processes and defects, such as melt flow, solidification, reoxidation processes, vector analysis, and analysis of temperature fields. In the lab, it is possible to perform gravity casting into sand, chill, plaster and ceramic moulds, in small-scale production.

EQUIPMENT

- electric induction and resistance furnaces;
- an electric resistance chamber for heat treatment of castings;
- a device for recording cooling curves and thermal analysis;
- a device for evaluating hydrogen content in molten aluminium alloys (Dichte index);
- spectral analysis;
- a CNC milling machine for the patternless casting process, quick prototype design;
- equipment to evaluate the dilatation of casting alloys.

APPLIED RESEARCH ACTIVITIES

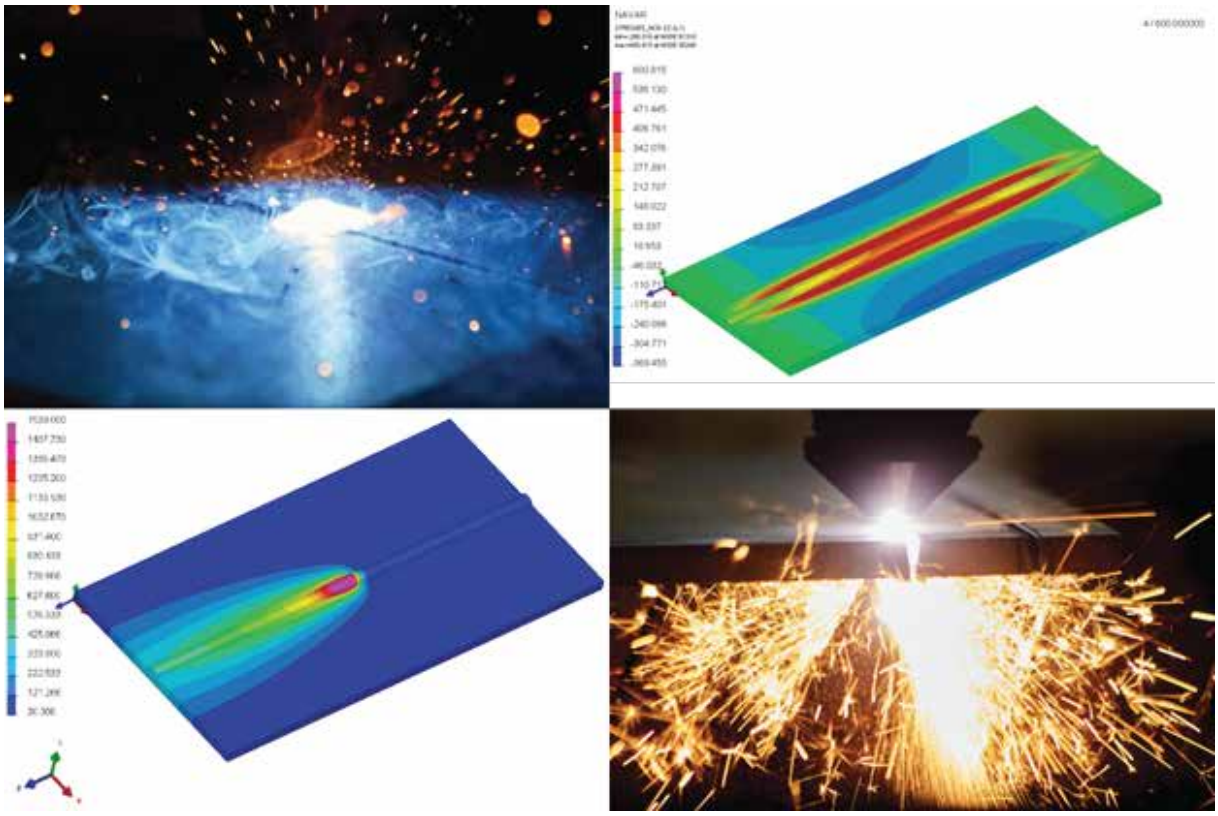
- development and production of prototype castings using the patternless process;
- development and production of special purpose equipment for the foundry industry;
- design, development and simulation of foundry technologies;
- experimental verification of foundry processes;
- development and testing of new types of foundry alloys;
- small-scale casting production (cast iron and non-ferrous metals).

WELDING GROUP

The Welding group provides verification of technological procedures for the following welding methods – MMA, MIG / MAG, TIG, gas welding and electrical resistance welding for different types of materials. The lab can arrange the monitoring of welding parameters by applying basic process variables, followed by a mathematical evaluation of the whole process for various arc welding methods. In collaboration with other labs, the Welding Laboratory can provide numerical solutions for thermal fields, deformations and residual stresses during welding.

EQUIPMENT

- a modern inverter and standard arc welding sources for MIG/MAG, MMA, TIG, ZPT technologies
- a monitoring unit for arc welding parameters and the measurement of thermal cycles;
- equipment for point and micropint welding, poly-fusion welding equipment and equipment for welding thermoplastic materials using hot air;
- plasma and oxygen-acetylene equipment for thermal cutting,
- equipment for a non-destructive evaluation of weld joints by visual, capillary, magnetic and ultrasonic methods (conventional methods, phased array method and TOFD).



APPLIED RESEARCH ACTIVITIES

- design of preliminary welding procedures for the approval process in the implementation of welding quality systems;
- experimental measurements of thermal processes near the weld areas and measurement of parameters for arc welding processes;
- numerical solutions of thermal fields, deformations and residual stresses;
- welding design, renovation and repair of machine parts from graphite cast iron.
- process design and application for surface and volume non-destructive evaluation of material.

FORMING GROUP

The group provides research and development experiments focusing on new progressive conventional forming methods as well as on unconventional forming technologies with an emphasis on the use of physical knowledge.

EQUIPMENT

- a preheating furnace for samples up to 45 mm in diameter;
- a WDW 20 tensile testing machine;
- a laboratory hydraulic press;
- equipment for testing the suitability of material designed for the active parts of forming tools;
- a tool for drawing in the hydro-environment;
- a tool for deep drawing with active forces of friction;
- equipment for monitoring the temperature during hot bending;
- equipment for influencing the forging process with a magnetic field, a device for cutting in the magnetic field;
- a tool for drawing using the Hydroform method;
- a riveting tool.

APPLIED RESEARCH ACTIVITIES

- design of progressive solutions for forming tools;
- measuring and analysing the effect of magnetic fields on the evaluated samples;
- surface layers of active parts of forming tools;
- assessment of the ultrasonic characteristics of materials (in collaboration with the Physics Department).

HEAT TREATMENT GROUP

The group provides heat treatment by annealing, hardening, tempering and metal finishing. In the heat treatment laboratory, annealing, quenching and tempering without a protective atmosphere are carried out to a temperature of 900 °C, with a maximum 100 kg batch material, isothermal heat treatment in Durferrit AS 140 salts up to 450 °C with a max. batch weight of 20 kg. The group also has a laboratory for the evaluation of technological processes. This laboratory is focused on microscopic and macroscopic sample analysis, photodocumentation, measurement of hardness HRA, HRB, HRC, HB, HV, HVm and the elaboration of hardness protocols.

EQUIPMENT

- equipment for surface induction hardening GV11;
- a resistance chamber furnace for up to 60 kg batch material with muffle dimension 60 x 40 x 20 cm, max. temperature 900 °C;
- a resistance chamber furnace with muffle dimension 20x20x30cm, max. temperature 900 °C;
- a resistance chamber furnace with muffle dimension 15x10x25cm, max. temperature 900 °C;
- a salt bath for isothermal quenching suitable for a batch weight of 20 kg, max. temperature 400 °C;
- Rockwell RB1 PC-AQ hardness tester.

APPLIED RESEARCH ACTIVITIES

- the design, development and application of heat treatment for ferrous and non-ferrous metals;
- heat treatment of samples – annealing, isothermal annealing, quenching, surface hardening, analysis of heat treatment results;
- hardness and microhardness measurement;
- photodocumentation of microstructures and macrostructures.

DEPARTMENT OF MACHINING AND PRODUCTION TECHNOLOGY

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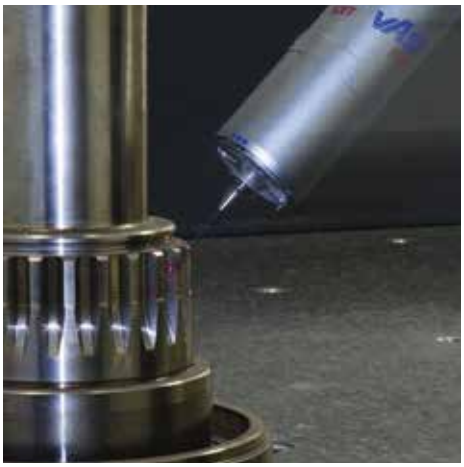
FOCUS OF THE DEPARTMENT

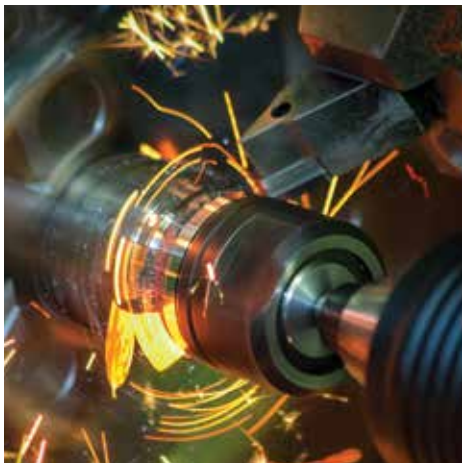
The Department is focused on the education of comprehensively prepared mechanical engineers with emphasis on machining technologies, non-conventional machining methods, production technology and advanced technologies, which are focused on the machining of hard-to-machine and biocompatible materials.

PEDAGOCIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Engineering technologies**
- 2nd level – Master of Science degree in **Engineering technologies**
- 3th level – PhD degree in **Engineering technologies and materials**





SCIENTIFIC PROFILE OF THE DEPARTMENT

- applied research into the machinability of conventional and specific materials;
- application of advanced cutting materials with cutability monitoring;
- monitoring of the character and intensity of cutting tool wear;
- precise hard machining using tools with defined and undefined geometry;
- experimental study of tribological phenomena in liquid, dry and cryogenic process environments;
- monitoring of technological parameters and their intensification with respect to productivity;
- identification of functional properties by non-destructive detection technologies;
- quality managing, metrological production assurance;
- education and research systems focusing on the automotive industry.

MACHINING AND PRODUCTION TECHNOLOGY GROUP

The group focuses on the implementation of advanced machining technologies. The laboratory's main focus is the application of hard machining, HSC high speed cutting machining, HSM high feed machining with the application of the nonlinear movements of trochoidal machining, HPM productive machining, implementation of precise machining with defined geometry to replace non-ecological technologies, machining of hard-to-machine materials based on titanium, nickel, tungsten, sintered carbides, technical ceramics etc.

EQUIPMENT

- STAMA 325CM 3-axis milling centre with rotary table;
- HURCO VMX30 4-axis milling centre;
- MAZAK Nexus II 100M 3-axis turning centre with vertical and horizontal rotary tool;
- HURCO TM D200 x L4002-axis lathe;
- CNC lathe PolyGim Diamond 20 – lathe with two spindles for miniature machining (4-axis)
- ZOLLER V720 measuring and shunting digital machine;
- measuring system with multiple inputs, A/D conversion and recording in DasyLab.

APPLIED RESEARCH ACTIVITIES

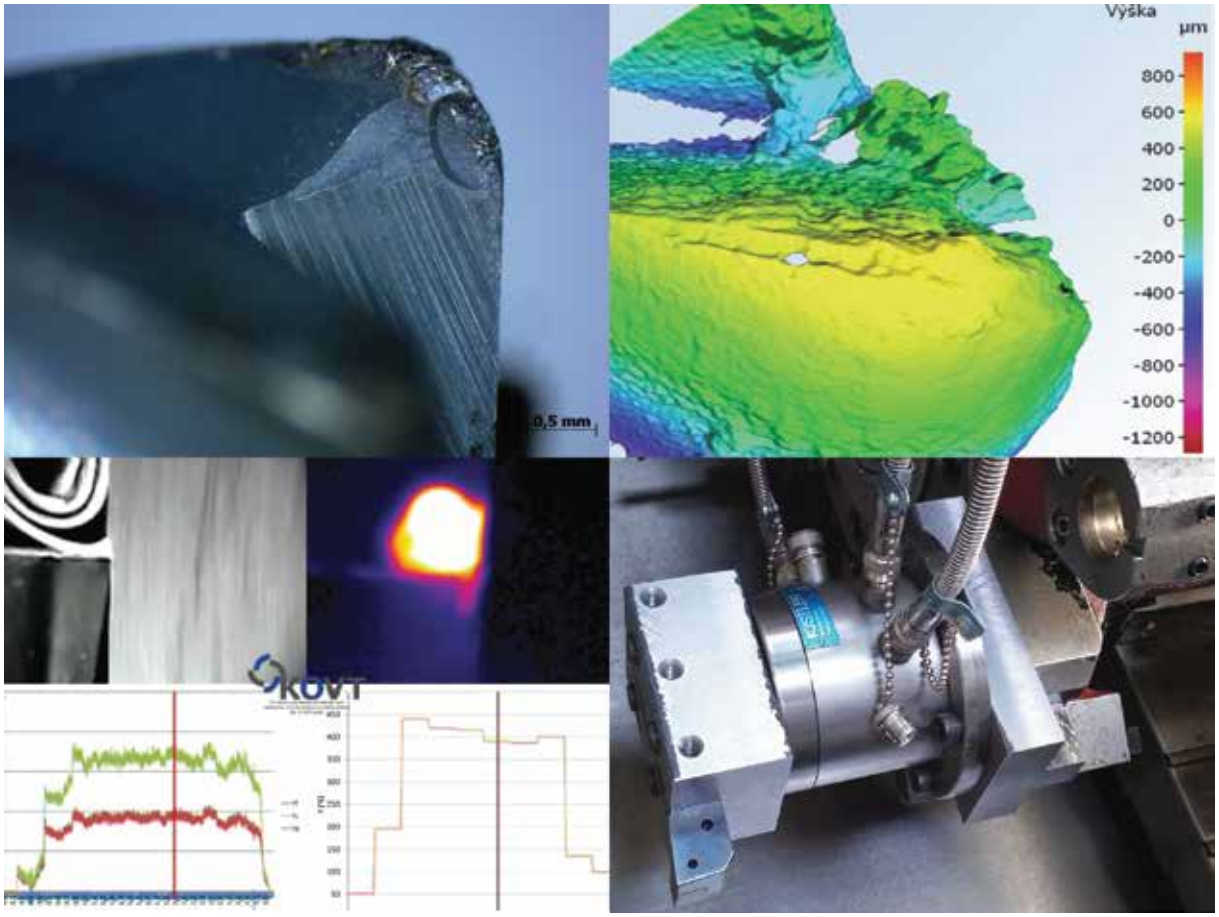
- applied research into the machinability of conventional and specific materials;
- application of advanced cutting materials with cutability monitoring;
- precise hard machining using tools with defined and undefined geometry;
- experimental study of tribological phenomena in liquid, dry and cryogenic process environments;
- implementation of new multiaxis machining technologies and investigation of technological parameters;
- investigation and realization of nonlinear movements of rotary tools by trochoids, minimised cuts and process dynamics control.

TECHNOLOGICAL PARAMETERS MEASUREMENT GROUP

The group carries out research into the functional properties of construction elements using non-destructive detection technologies based on X-ray diffraction, the potentiometric detection of crack depth, contourgraphic scanning of surface profiles, microscopic surface unevenness and hardness testing in minimally accessible places etc.

EQUIPMENT

- KISTLER piezoelectric dynamometers (three components Fx, Fy, Fz – types 9255, 9257 and 9265, and four components Fx, Fy, Fz and Mz, type 9266);
- MOBIR m8 thermo-vision system up to 1200 °C;
- ZEISS Stemi DV4 stereomicroscope with digital camera;
- ZEISS 150x50 4-axis measuring microscope.



APPLIED RESEARCH ACTIVITIES

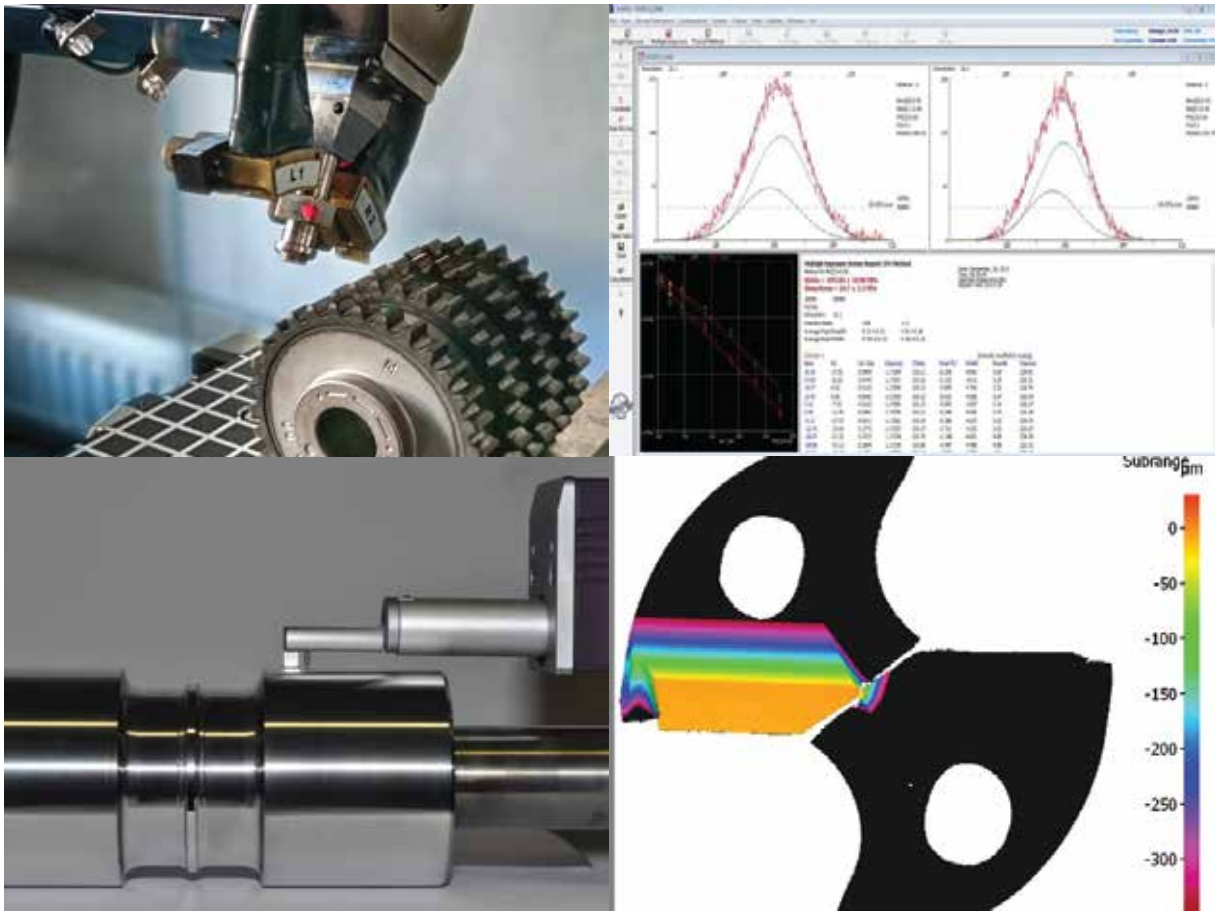
- monitoring of roughness parameters and accuracy of machined surfaces;
- monitoring of dynamic phenomena such as the force effect and torque;
- monitoring the character and intensity of cutting tool wear;
- monitoring of temperature distribution using a thermo-vision system (at points and over surfaces);
- multi-parametric recording of the dynamics of process, temperature and cutting zone deformations.

NON-DESTRUCTIVE TECHNOLOGIES GROUP

The group carries out research into the functional properties of construction elements using non-destructive detection technologies based on X-ray diffraction, the potentiometric detection of crack depth, contourgraphic scanning of surface profiles, microscopic surface unevenness and hardness testing in minimally accessible places etc.

EQUIPMENT

- ProtoXRD X-ray diffractometer;
- ZEISS Contourrecord 1700 SD3 profile machine;
- KarlDEUTCH RMG 4015 crack depth meter;
- THD160D hardness measuring system;
- Mitutoyo SJ400 measuring system with stationary and portable unit



APPLIED RESEARCH ACTIVITIES

- monitoring of normal and shear residual stress, study of retained austenite, 3D mapping of planar and rotary surfaces;
- measuring the depth and direction of detected cracks;
- monitoring of surface micro-unevenness and its integrity.

METROLOGY ENGINEERING GROUP

The group focuses on the application of metrological devices ensuring maximum control of all qualitative parameters. The modern laboratory is equipped with measuring devices from Carl Zeiss, Talyrond and Werth, which are used by a number of companies in industry. Using these systems, it is possible to provide fast and highly sophisticated measurements of the complex shape elements common in the automotive and engineering industry.

EQUIPMENT

- Zeiss Eclipse coordinate measuring instrument (1000x1000x600mm) with RDS CAA scanner head;
- Mitutoyo HDM 192 horizontal length measuring instrument;
- ZEISS universal measuring microscope;
- TALYROND 73 digital roundness measuring instrument;
- MORA MS10 3-axis measuring instrument;
- Renishaw XL80 laser interferometer – for diagnostics and verification of production machine accuracy.

APPLIED RESEARCH ACTIVITIES

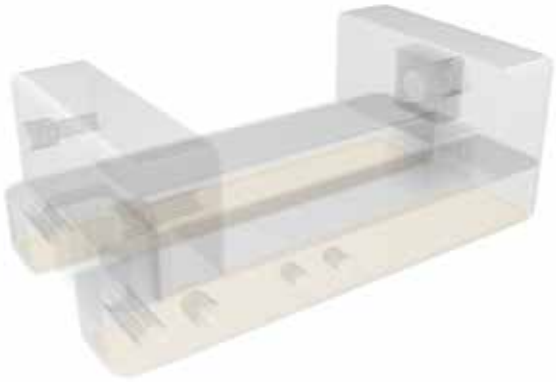
- design and development of measuring methods, calibration and verification of dimensions;
- development and application of theoretical and practical knowledge when creating measurement devices;
- implementation of scientific methods of experiment designs;
- scientific research into and development of evaluation methods for measurements and processing measured data.

DIGITAL AND ADDITIVE TECHNOLOGIES GROUP

This group focuses on the implementation of advanced digital and additive technologies using modern IT technologies and is oriented towards smart and circular economics of production. The laboratory's main focus is the application of constructional elements created by digital technology, such as fusing thermoplastic and composite fibres (based on carbon fibres and fibreglass), and laser sintering plastic and metal materials. This laboratory also ensures the digitisation of objects with transformation for CAM applications or the metrological identification of produced constructional elements. The laboratory is equipped with software and hardware tools for digital machining following Industry 4.0.

EQUIPMENT

- multifunctional device for scanning, engraving and FFF additive printing;
- device for producing composite products with special ultra-strong fibres using CFF additive printing technology;
- laser sintering device with SLS technology;
- scanning device for obtaining object data as cloud of points;
- tools for smart machining technologies.



APPLIED RESEARCH ACTIVITIES

- applied research into the implementation of smart digital technologies;
- application of progressive additive technologies;
- monitoring of quality and accuracy using object scanning;
- experimental investigation of the functional properties of constructional elements produced by digital manufacturing.

DEPARTMENT OF AUTOMATION AND PRODUCTION SYSTEMS

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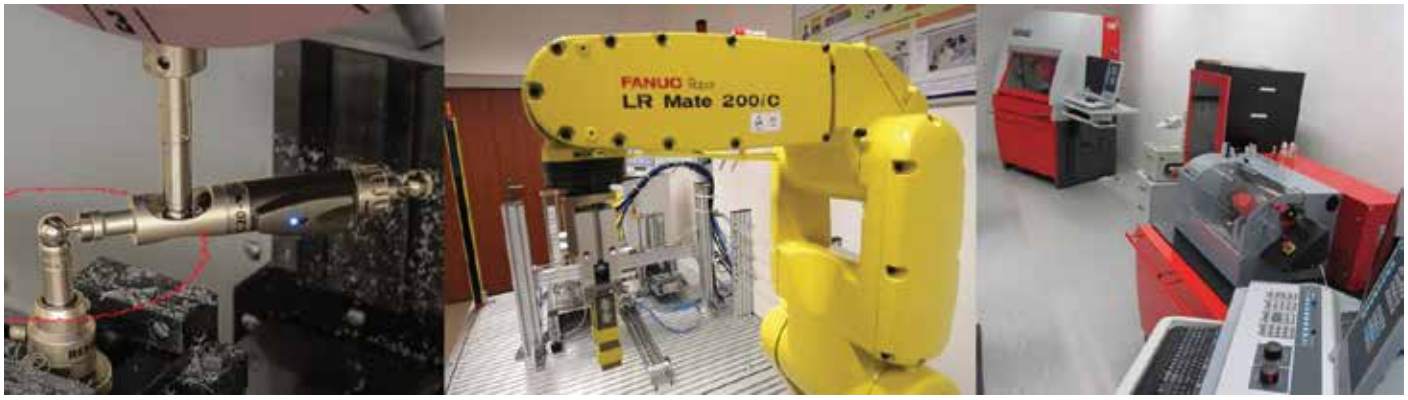
FOCUS OF THE DEPARTMENT

The department's priority is scientific research and education in the area of intelligent and automated production systems using and applying the IT methods of virtual modelling and simulation of manufacturing processes, including all CA technologies used in industry to develop, innovate and produce products and design production systems. Major development areas include CNC manufacturing technology and robotics, the development and implementation of unconventional robot structures, collaborative robots, handling, technological and service robots, and robot-technology devices in automated production systems. Another area of research is the development of methods oriented towards fault detection and multi-criteria diagnostics of technical devices based on artificial intelligence, neural networks, expert systems, and big data analytics.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Engineering technologies**
- 2nd level – Master of Science degree in **Automated Production Systems**
- 3th level – PhD degree in **Automated Production Systems**



SCIENTIFIC PROFILE OF THE DEPARTMENT

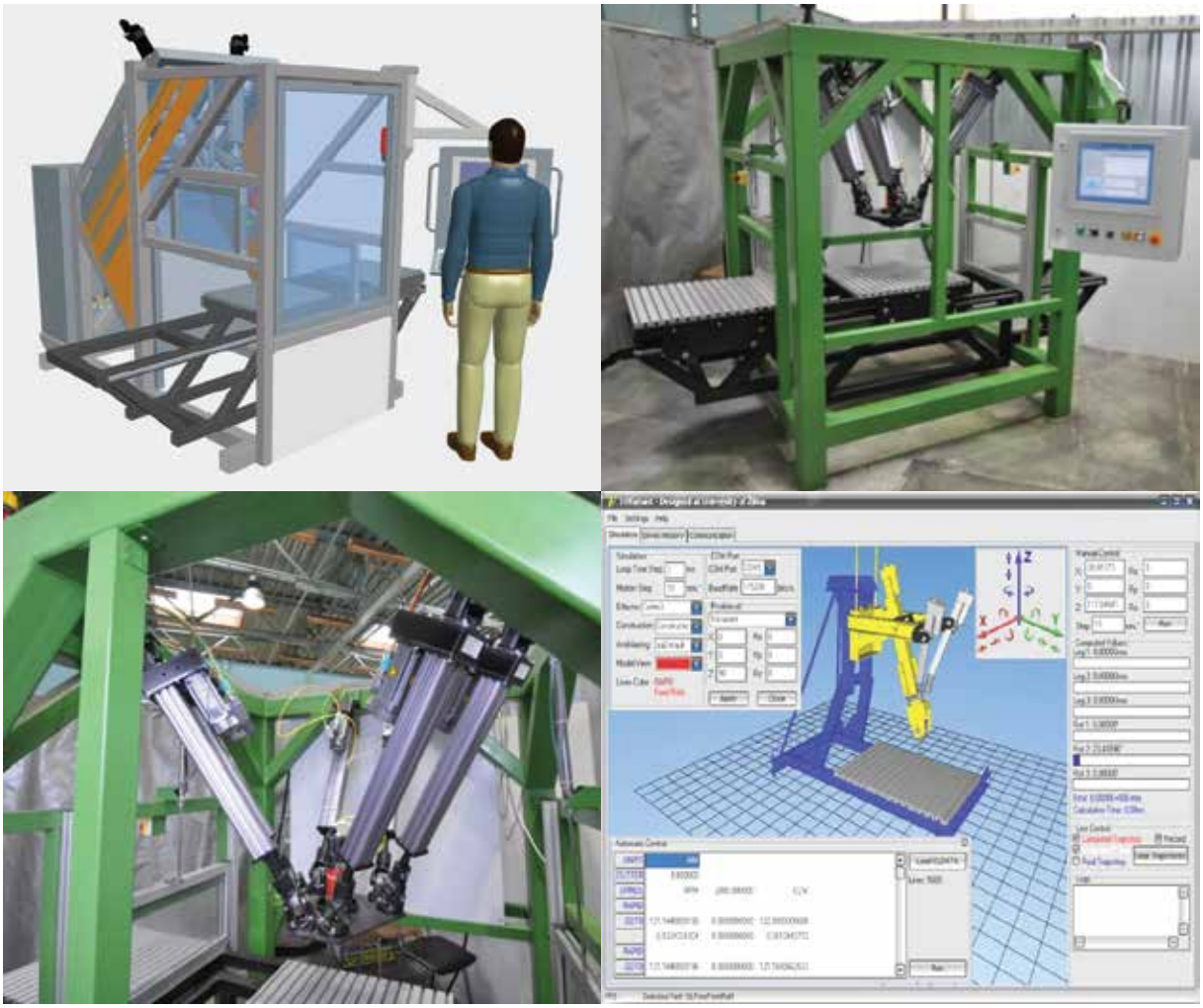
- intelligent and automated production systems;
- development of control systems for automated manufacturing systems;
- automated assembly systems and processes;
- CNC machine tools and robot programming;
- design and implementation of robotic workcells;
- parameter measurement and technical diagnostics of production machines;
- multi-criteria diagnostics of technical devices and analytical data processing;
- microcontroller technology.

PARALLEL KINEMATIC STRUCTURES GROUP

The group focuses mainly on research into the development of parallel kinematic structures and their application under real technological conditions. The machine tool prototypes developed with hexapod and hybrid kinematic structures are used to verify operating parameters and the functionality of developed simulation and control systems.

EQUIPMENT

- University of Žilina prototype of Hexapod machine tool;
- University of Žilina prototype of Tripod machine tool;
- control system based on Siemens Simatic.
- simulation programming equipment for prototype machines.



APPLIED RESEARCH ACTIVITIES

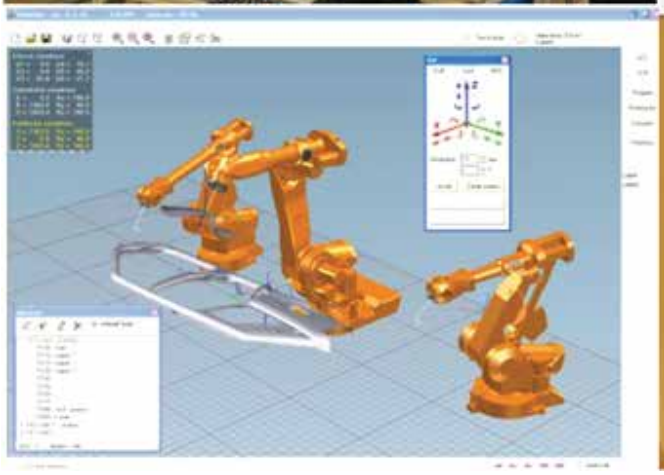
- applied research focused on the development of parallel kinematic machine tools and robots and the verification of their operating parameters and capabilities.
- research into and development of tool movement control using measuring and diagnostics tools.
- development and design of simulation software tools for developed prototypes with parallel kinematic structures.

MECHATRONICS AND MOBILE ROBOTICS GROUP

The group focuses on the development of different mechatronic devices in the field of numerically controlled machines, industrial robots and also mobile robots. The technical equipment is used by students during their work on their final thesis and in laboratory classes.

EQUIPMENT

- Prototype of Trivariant mechanism.
- Prototype of Caertec rk 2010delta robot.
- FANUC M1-iA delta robot.
- Prototype of mobile robots – based on wheeled and walking locomotion systems.
- Software for simulation and control of the Trivariant mechanism.



APPLIED RESEARCH ACTIVITIES

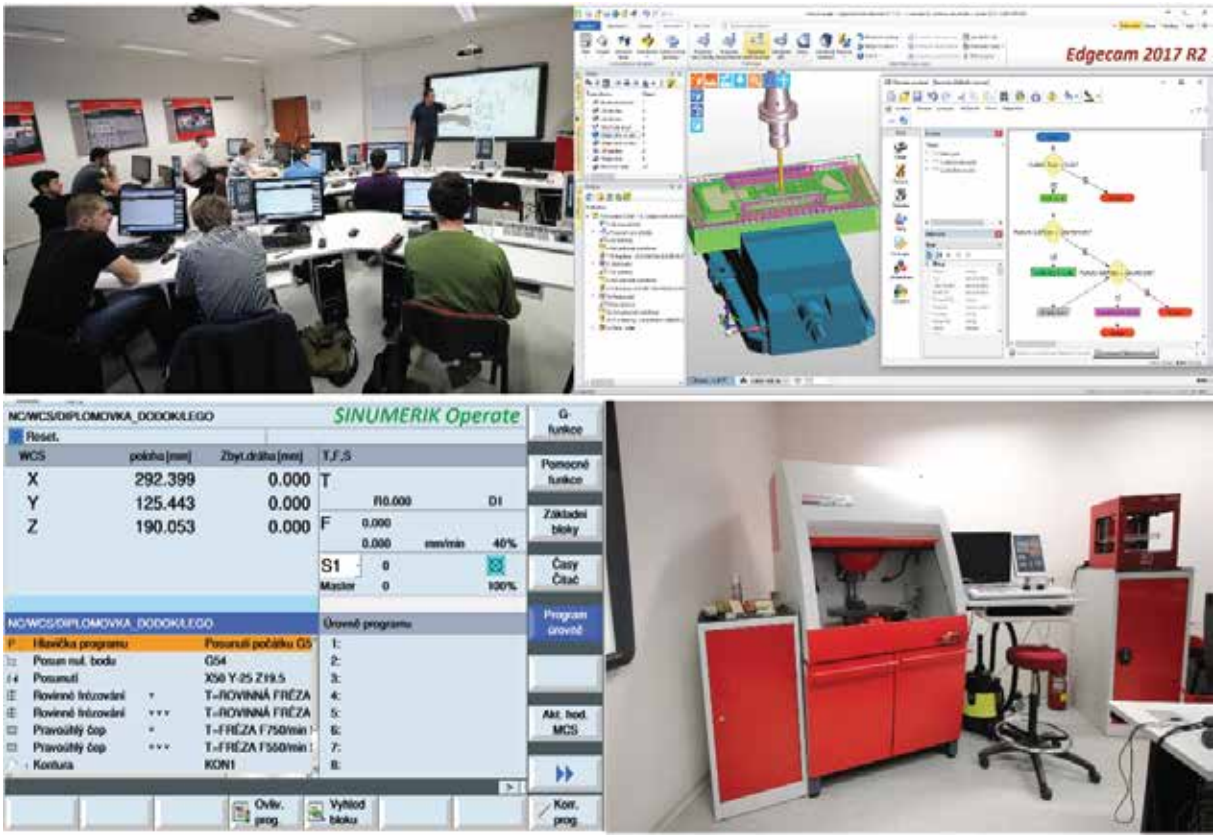
- applied research in the field of object manipulation, automated assembly and disassembly processes with delta robots using vision navigation.
- research and development in the field of mobile robot design for in-process transport and exploration purposes.
- research and development in the field of control and simulation systems of mobile robots for industrial applications.
- development of machine tools and robots with parallel kinematic structure.

CNC MACHINE TOOLS PROGRAMMING GROUP

The group focuses on applied research in the field of automated preparation of control programs for CNC machine tools with interchangeable control systems. It is possible to solve the optimisation of machining process preparation for the production of complex shape workpieces using CAM systems, as well as using workshop programming modern systems.

SOFTWARE AND EQUIPMENT

- EMCO Concept Mill 105 with interchangeable control systems (Sinumerik 840D, Heidenhain TNC 426, Sinumerik Operate 840D SL);
- EMCO Concept Turn 55 with interchangeable control systems (Sinumerik 840D, Sinumerik Operate 840D SL);
- 10 workstations with control panels for CNC machines;
- Edgecam 2017R2CAD/CAM software;
- Creo 2.0 CAD/CAM/CAE software.



APPLIED RESEARCH ACTIVITIES

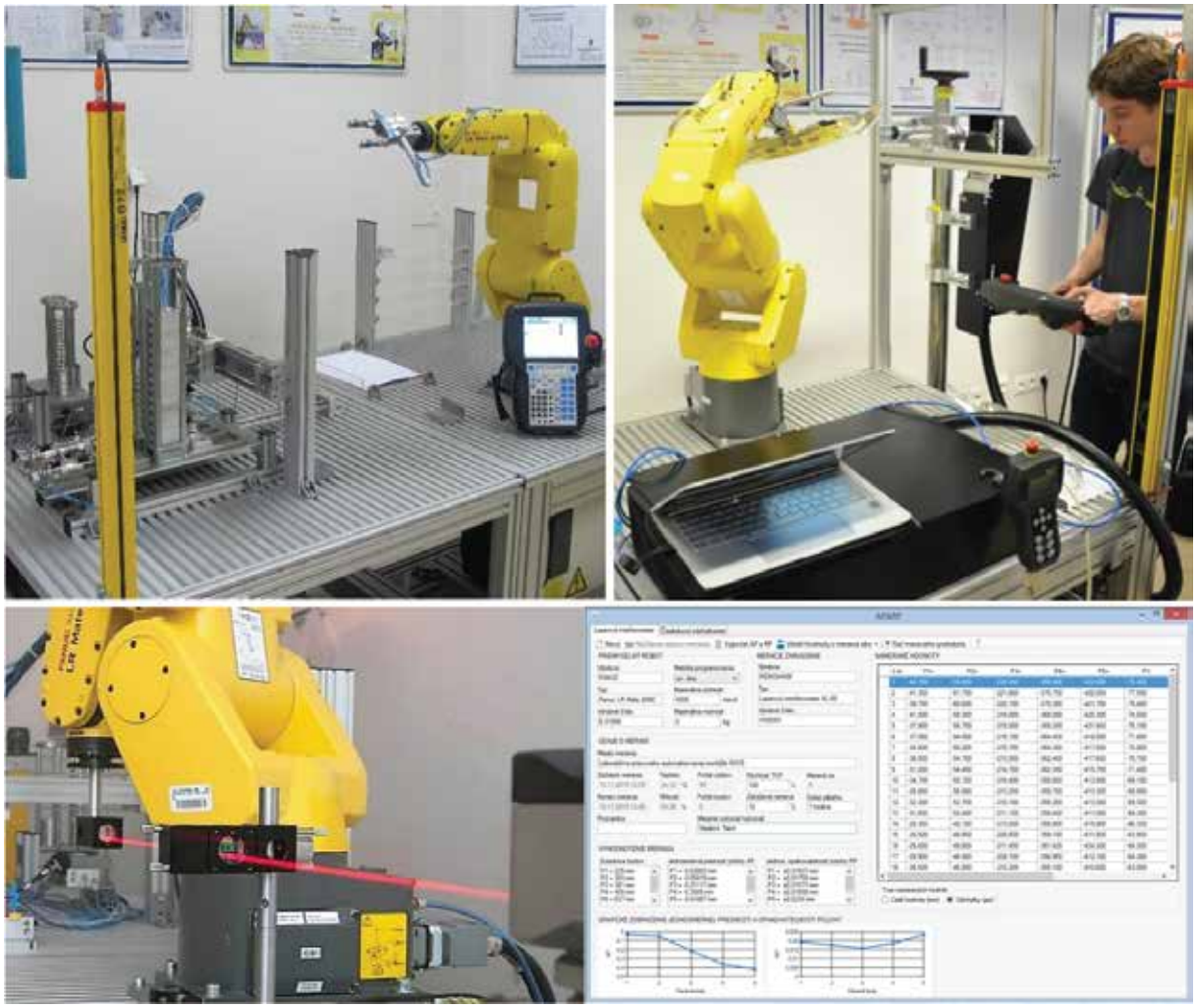
- development and application of postprocessors;
- optimisation of CAM system strategy generation;
- implementation of optimisation methods based on genetic approaches in the automation of pre-production stages;
- implementation of the STEP NC format for CNC machine tool programming.

PRODUCTION PROCESSES AUTOMATION AND ROBOT PROGRAMMING GROUP

The group conducts research into methods of measuring industrial robot performance characteristics and automated processing and evaluation of the data measured. The following measuring devices are used in the workplace: Renishaw XL-80 and Renishaw Ballbar QC20-W laser interferometers. Research is focused on testing the pose accuracy of industrial handling robots. The group also offers the option of design and practical verification of the concepts of robotic solutions for industrial practice.

EQUIPMENT

- Fanuc LR Mate 200iC robot;
- Renishaw Measurement devices;
- Fanuc Roboguide HandlingPro v. 8 and AutoPlace v. 8 off-line software.



APPLIED RESEARCH ACTIVITIES

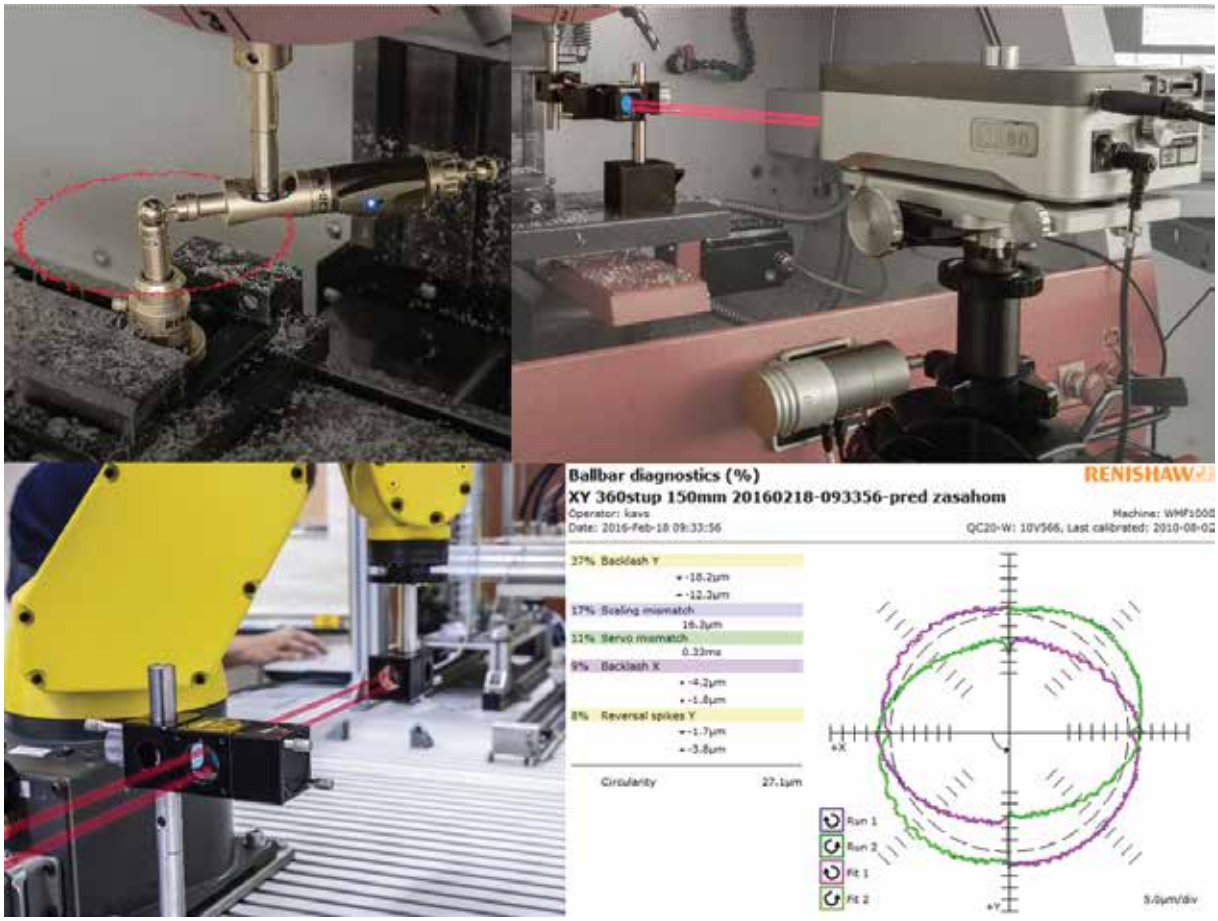
- automation of production and handling processes by robots;
- methods of measuring robot performance criteria using contact and non-contact methods;
- calibration of industrial robots;
- use of computer vision systems for industrial practice.

CNC MACHINE TOOL DIAGNOSTICS GROUP

The group focuses mainly on the application of specialised diagnostic devices for the analysis of the geometric and dynamic characteristics of CNC machine tools and industrial robots. The purpose of such measurements is to determine the current and future condition of the measured devices, to determine the compensation tables for the control system, which increase the accuracy of production without mechanical interventions. Another benefit is precise maintenance targeting and planning in order to maximise efficiency. The laboratory is equipped mainly with Renishaw measurement devices.

EQUIPMENT

- Renishaw XL-80 laser interferometer with expanding optics for diagnostics, verification, and calibration of CNC machines;
- Renishaw Ballbar QC20-W – a wireless device for rapid positioning accuracy diagnostics using circular interpolation analysis;
- Voltcraft IR1000-50CAM – a non-contact infrared thermometer combined with a camera designed to record measured points;
- Spirit Wyler – a precise spirit level for machine tools setting and checking;
- POWER TEST Indicator– a tool for measuring clamping forces on machine tools with SK50 and SK40 tapers.



APPLIED RESEARCH ACTIVITIES

- measurement of the geometrical and dynamic characteristics of CNC machine tools and robots;
- design and development of diagnostics methods for CNC machines and robots;
- application of theoretical knowledge and practical experience in industry;
- development of analytical methods of diagnostic measurements, processing and evaluation of measured data.

DEPARTMENT OF INDUSTRIAL ENGINEERING

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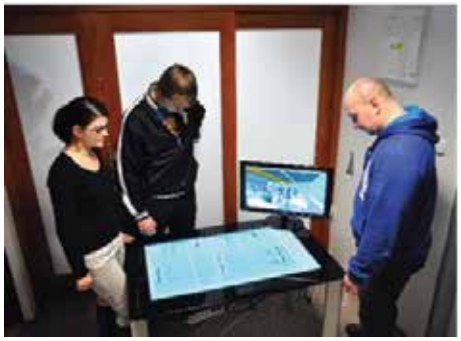
FOCUS OF THE DEPARTMENT

The Department focuses on the education and training of industrial engineers who are able to solve complex tasks in the fields of production, logistics, supply chain management, service and maintenance, implementation of corporate enterprise information systems, production planning and control, quality assurance, production process and system design, project management, application of operational research methods, innovation management and introduction of industrial engineering methods into individual company departments. In the area of research, the Department focuses mainly on the development of advanced industrial engineering methods reflecting the requirements of Industry 4.0 and intelligent manufacturing companies.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Industrial Engineering**
- 2nd level – Master of Science degree in **Industrial Engineering**
- 3th level – PhD degree in **Industrial Engineering**



SCIENTIFIC PROFILE OF THE DEPARTMENT

- 3D design of production and logistics processes and systems using 3D laser scanning, augmented reality, virtual reality, simulation and other digital factory tools;
- new approaches to artificial intelligence and image recognition;
- innovative solutions in low-cost automation, automation of production and assembly processes;
- digital ergonomic analysis with 3D Motion Sensing, Motion Capture Technology;
- organisation, planning and management of business processes with the support of progressive IT;
- progressive approaches and software solutions in the field of economic analysis for enterprise performance;
- projects focused on lean production, introduction of advanced industrial engineering elements;
- Industrial audits to improve performance processes;
- projects in the spatial and time structure of the production process;
- research into and development of intelligent and reconfigurable production and logistics systems;
- new approaches and technologies in the construction and operation of an intelligent factory in the Industry 4.0 context.

DIGITAL FACTORY LABORATORY

The laboratory is focused on research in the field of creating a methodology of implementation for the digital business concept and its application in industrial practice. The main activities are focused on the creation of a universal database (PPR hub) describing products, processes and resources in the pre-production stage in order to optimise and shorten the onset of real production. The group currently focuses primarily on using digital technology to integrate a real factory and its virtual image into a Digital Twin.

EQUIPMENT

- software package for the Tecnomatix digital factory solution (Plant Simulation, Jack, Process Designer, Process Simulate, Teamcenter);
- Delmia – software package for complex digital factory solutions (Delmia V5, Delmia Process Engineer and Delmia QUEST);
- Simio – software for process simulation in non-production areas (for example healthcare);
- Sysklass – software for the complete administration and management of technical documentation;
- AutoCad, Tecnomatix FactoryCAD and FactoryFlow software applications for designing 2D and 3D production layouts.

APPLIED RESEARCH ACTIVITIES

- applied research in logistic process design using simulation and emulation;
- analysis of production systems in a digital environment;
- rationalisation and optimisation of workplaces in a digital environment;
- design of new manufacturing systems for smart businesses;
- 2D and 3D visualisation of production, assembly and logistics systems and processes;
- solution of technical production preparation.

LOGISTICS LABORATORY

The laboratory focuses on creating conditions for the efficient use of progressive tools and technologies for real industry requirements in order to streamline business processes. The technical security of the workplace enables research into innovative logistic system design in the virtual environment as well as research into technical systems in the internal logistics process.

EQUIPMENT

- automatic input buffer;
- automatic output buffer;
- automatic transhipment system for buffering cartridges;
- automatic buffer storage system;
- automated guided transport systems (AGV);
- AGV system for monitoring and control of logistical resources;
- control system – industrial rack;
- PLC automation management program;
- IPC program for coordinating buffering cartridges;
- conceptual planning system.

APPLIED RESEARCH ACTIVITIES

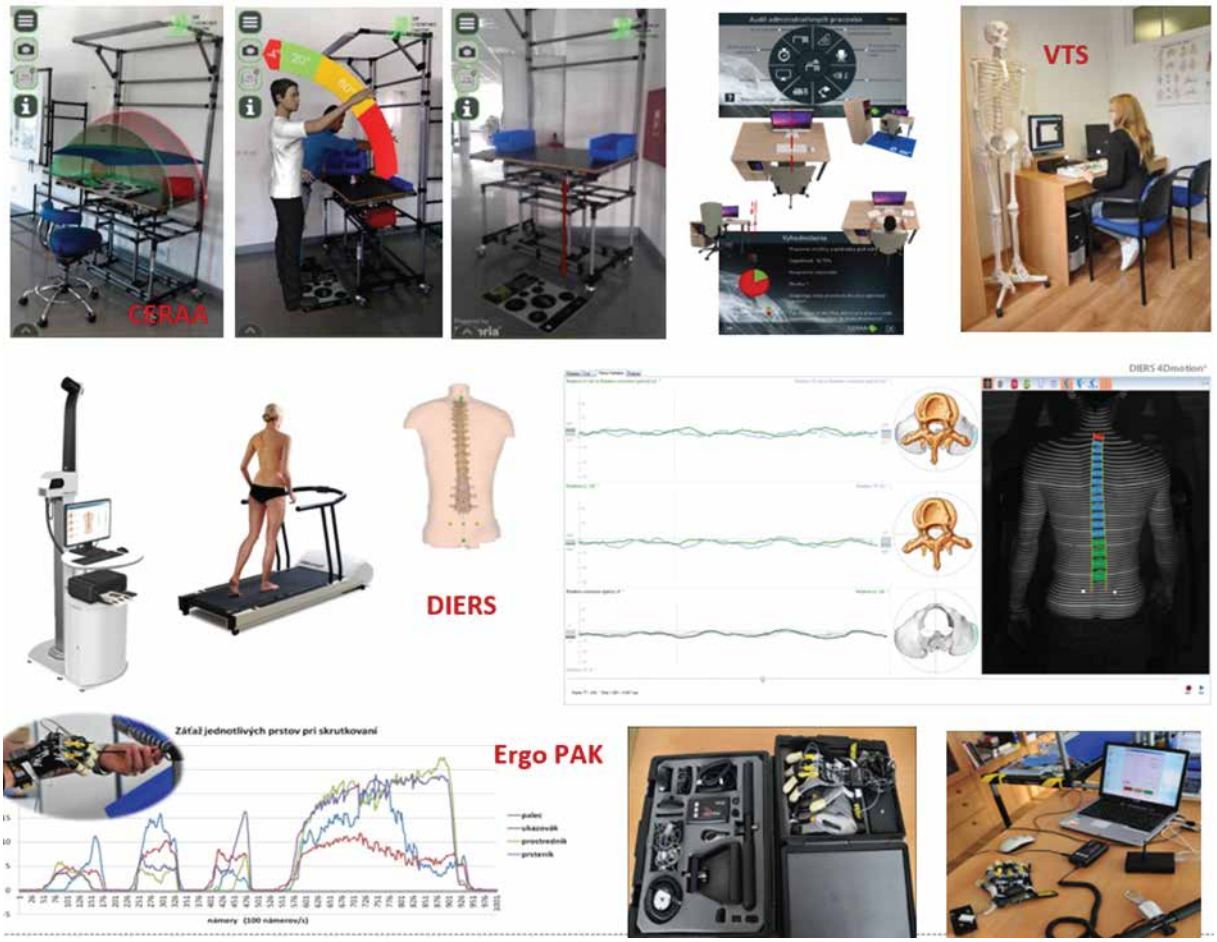
- basic concept design of a smart logistics system based on a digital factory;
- research into and testing of a dynamic simulation model of an intelligent logistics system;
- research into the basic modules of internal logistics technical systems;
- research coordination and collaboration of individual modules and their connection to the enterprise information system.

ERGONOMICS LABORATORY

The laboratory focuses on the field of industrial ergonomics using state-of-the-art hardware and software packages. The main direction is physical loading in the work process in relation to human health and labour productivity.

EQUIPMENT

- CERAA – CEIT Ergonomics Analysis Application;
- VTS – Vienna Test System by Schuhfried;
- Ergo PAK glove – Portable Analysis Kit;
- DIERS – 4D Spine & Posture Analysis;
- Ergometer Kettler, models of the human skeletal system;
- Tecnomatix Jack a 3D projection.



APPLIED RESEARCH ACTIVITIES

- solutions for the collection of information on the human physiological and vital functions in the work process;
- screening assessments of spatial conditions in the workplace, a worker's working positions, administrative workplaces and manipulation on the augmented reality platform;
- evaluation of small muscle group loading of the arms in cyclic manipulation and handling of loads;
- ergonomic prevention programmes and their application into the industrial practice;
- virtual evaluation of ergonomics in the digital company environment;
- radiation free spinal scanning based on mathematical modelling.

VIRTUAL AND AUGMENTED REALITY GROUP

The group is devoted to research into the use of progressive technologies of virtual and augmented reality in the field of Industrial Engineering. The software and hardware in this group enables research into applications in the areas of production planning and control design, assembly and logistics processes and systems, as well as service activities in enterprises.

EQUIPMENT

- AutoCad, CATIA and MANTRA 4D software for creating 2D and 3D digital content;
- Metaio Unifeye Design 2.5 augmented reality software;
- Vuzix Wrap 920ar augmented reality glasses;
- Samsung multitouch LH40 planning projection table equipped with visTABLE®touch 2.2 software for interactive designing of production and logistics systems;
- Tecnomatix FactoryCAD and FactoryFlow software modules for 3D design and optimisation of production and logistics systems;
- Samsung Gear VR and Evolveo VRC-4 virtual reality glasses.

APPLIED RESEARCH ACTIVITIES

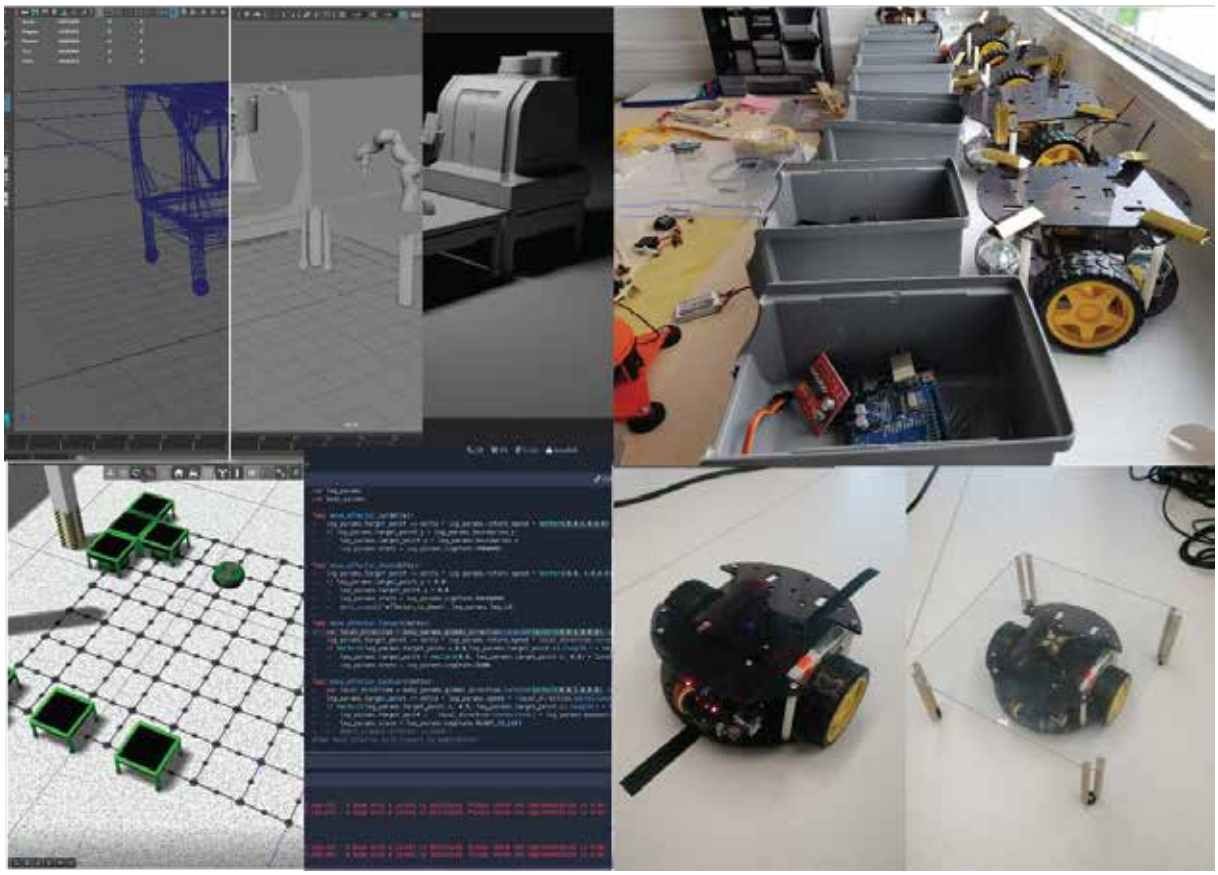
- design of production systems in a 3D environment with the support of augmented reality technology;
- pick by Vision: smart picking system using augmented reality in warehouse logistics;
- visualisation of production and assembly instructions with the support of augmented reality;
- interactive team design and improvement of production and logistics systems;
- virtual and augmented reality applications for mobile devices.

RECONFIGURABLE MANUFACTURING SYSTEMS LABORATORY

The laboratory is dedicated to research into and development of reconfigurable manufacturing systems that provide the basis for new generation manufacturing systems. Their characteristic features include adaptive behaviour, the ability to adapt their capacities in consideration of fluctuations in demand, or shorter lead times. For research and development purposes various simulation, emulation and 3D visualisation software tools are used. The laboratory also has a wide range of hardware to put the proposed concepts into practice.

EQUIPMENT

- Arduino, Raspberry Pi, Orange Pi microcomputers;
- Autodesk Maya, 3Ds Max and AutoCAD software for creating 3D digital content and visualisation;
- Godot game cores and Ella Software Platform;
- physical models of elements of a reconfigurable manufacturing system.



APPLIED RESEARCH ACTIVITIES

- visualisation, emulation and simulation of reconfigurable manufacturing and assembly systems with the support of augmented and virtual reality;
- creation of a reconfigurable logistics system prototype;
- creation of a basic concept of a modular production line;
- focus on the application of principles that lead to the implementation of production islands.

DEPARTMENT OF TRANSPORT AND HANDLING MACHINES

tel.: +421 (0)41 513 2551, **web:** kdmt.uniza.sk, **e-mail:** kdmt@fstroj.uniza.sk

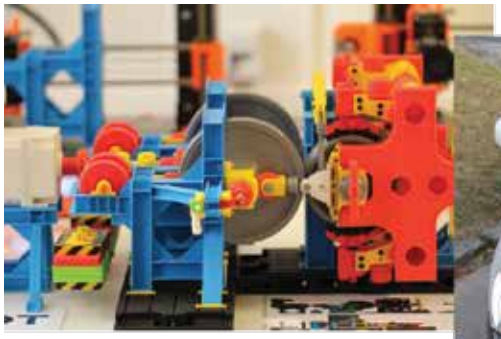
FOCUS OF THE DEPARTMENT

The department is focused on pedagogical and scientific-research activities in the field of design, maintenance, diagnostics and testing of transport machines. It provides education for designers and engineers in practice, specializing principally in motor vehicles, railway vehicles, transport and handling equipment and their main subsystems. The department is well-known for its activities in the field of lifelong education of managers in road and rail vehicles, track management and maintenance of technical systems.

PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Computer Mechanical Design and Simulation**
- 2nd level – Master of Science degree in **Computer Modelling and Simulation in Mechanical Engineering**
- 3th level – PhD degree in **Computer Modelling and Machine Mechanics**



SCIENTIFIC PROFILE OF THE DEPARTMENT

- analysis of rail wheelset and track contact;
- testing, reliability and durability of mechanical parts for brake systems of rail vehicles;
- structural analysis of the structural nodes of rail vehicles and analysis of dynamic performance of vehicles using simulation calculations on virtual models;
- design of rail vehicles and track machines;
- development of technical support for combined transport and transport and handling equipment;
- development of scientific principles of maintenance and their practical application in industrial production;
- design and analysis of properties of combustion engines.

HEAVY LABORATORY OF TRANSPORT AND HANDLING MACHINES

The laboratory is located in a specialized laboratory hall equipped with a bridge crane with a carrying capacity of 12.5 tons. In the hall there are upgraded power grids adapted to high-voltage power take-off. The hall is directly intended for use for heavy laboratory purposes - high-performance testing equipment, large test specimens and intensive long-term mechanical loading using electro-hydraulic, pneumatic and other equipment.

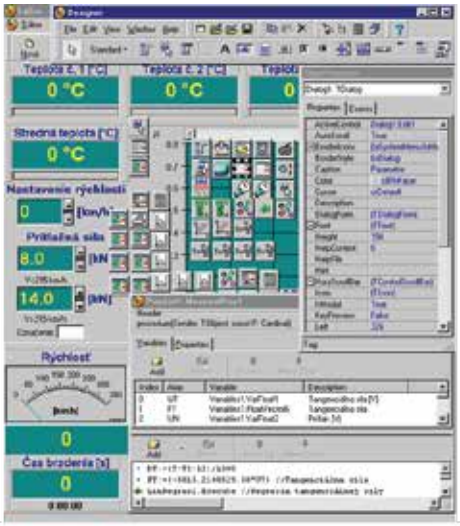
EQUIPMENT

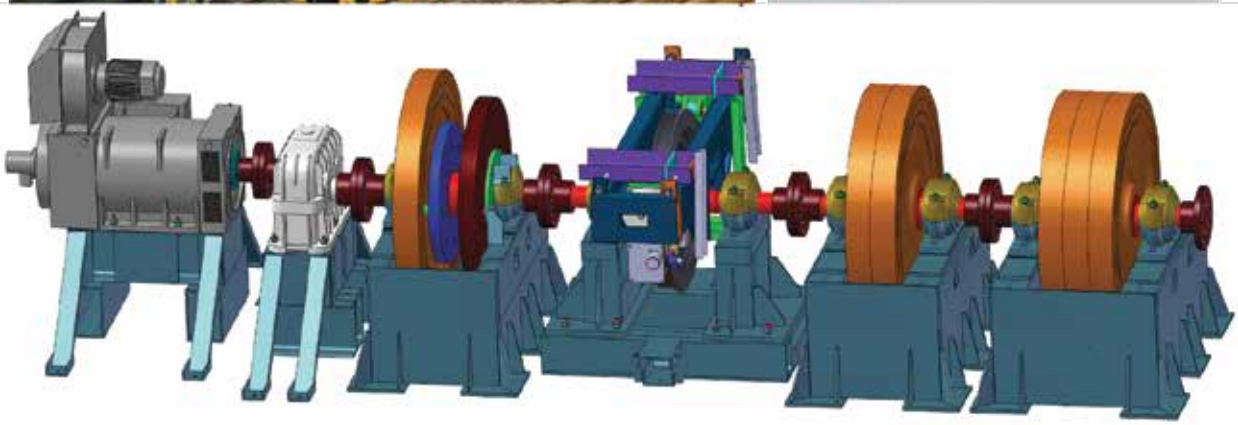
- Test stand for brake components RAILBCOT: the original testing device (prototype), with defined options of railway experimental research;
- Control room equipped with measuring and evaluation technology as well as the core of the information and communication facilities of the whole laboratory.
- Measurement system of the test stand: force sensors, speed sensors, thermocouples. The core consists of two data buses, which mediate communication from the test stand to the control computer.
- The control computer in programmed way controls the actions of driving electromotor, electro-pneumatic valves and servomotors for simulation of wheelset angle of attack and in general all action of the test stand.
- Compressed air power supplies and storages with computer control.

HEAVY LABORATORY OF RAIL VEHICLES

Laboratory is focused on testing the reliability and durability of mechanical parts for brake systems of rail vehicles. The basis of the scientific and research activities in the laboratory is the UIC flywheel brake test stand accredited for two types of brake tests for homologation of brake pads and brake shoes. The facility is well known among European research teams as well as among European manufacturers and operators of rail brake components.

Modular interchangeable brake stands of block and disc brakes are composed of its own measuring frames fixed on the shaft. They are equipped with strain gauge sensors of tangential contact force. On the frame, a brake unit of disc or block brake with a pneumatic brake cylinder is placed. Compressive force of friction elements is measured by strain gauge force sensor placed at the junction of brake lever mixer.



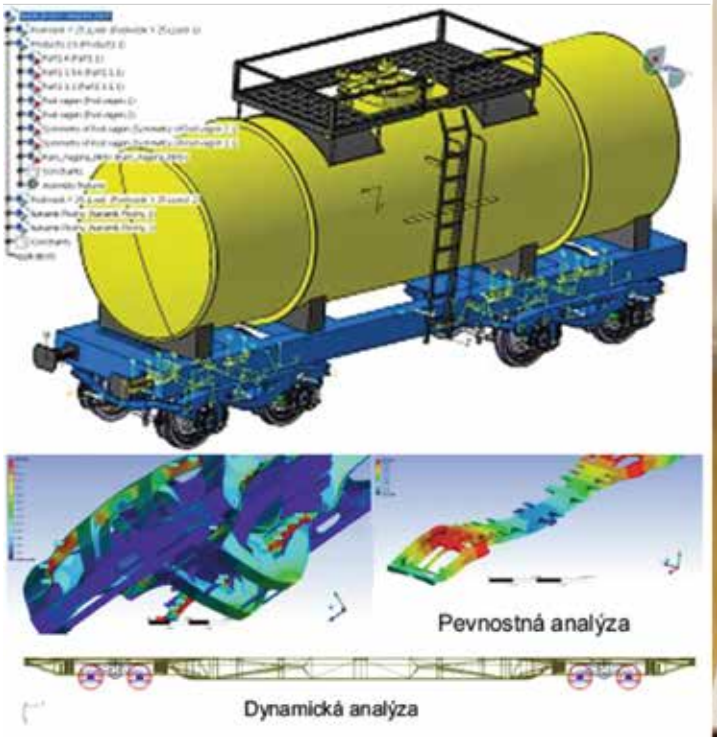


EQUIPMENT

- UIC flywheel brake test stand.
- bridge crane with a carrying capacity of 12.5 tons;
- control room of the test stand. Measurement system of the test stand: force sensors, speed sensors, thermocouples.
- control computer control computer in programmed way controls the actions of driving electromotor and electro-pneumatic valves
- sources and storage of compressed air, rainwater, air distribution.
- system for controlling the flow of air and the amount of water for the computer controlled addition of liquid to the brake process.
- The floor is equipped with a sprung steel grate.

LIGHT LABORATORY OF RAIL VEHICLES
SPECIALISED WORKPLACE OF CA-X TECHNOLOGIES

Light Laboratory of Rail Vehicles. A specialised workplace for CA-X technology for creating and analysing virtual computational models. Performing structural analyses, dynamic analyses and flow analyses, especially on models of transport technology, vehicles and engines.at the junction of brake lever mixer.



EQUIPMENT

- modern, powerful computer system;
- software to support computer-aided design for creating virtual models to generate design production drawing documentation DASSAULT SYSTEMS CATIA;
- software to perform structural analysis and flow analysis ANSYS;
- software for performing dynamic analyses on computational models DASSAULT SYSTEMS SIMULIA SIMPACK;
- 3D printers PRUSA i3 to print functional spatial structural models.

HEAVY LABORATORY OF RAIL VEHICLES

The laboratory consists of three independent test positions – stands. Their structure and installed technical and information-communication networks (together with the ability to move loads using the portal crane) predetermine stands for testing of combustion engines and their accessories. Experimental testing of engines in these sites is controlled from common soundproof control centre.

The laboratory provides a basis for the preparation and implementation of scientific or applied research in the field of combustion engines and their components. Carrying-out of tests on order (not official tests): force parameters – power, torque, revolutions; operating values – pressures, temperatures, flow rates, consumption, all in steady regimes, properties of accessories, air pollutants, indicating of the spark ignition engine directly on a vehicle. Piston engines: spark-ignition and Diesel engines, range of parameters: determined by the dynamometer VD 110/6 – 110 kW, 6000 m^{-1}

EQUIPMENT

- measuring equipment for test of vehicle dynamics;
- set for serial and parallel diagnostics of motor vehicles;
- mobile kit for the indication of vehicle combustion engines.

SPECIALIZED LABORATORY OF TECHNICAL ACOUSTICS

Equipment of laboratory enables experimental analysis of noise and vibration in the first level of the measuring accuracy in the frequency range from 0.2 to 20 000 Hz in real time. Measurements satisfy standard of relevant legislation – TSI Noi, Notice No. 115 / 2006 Z.z., Notice n. 549 / 2007 Z.z. and STN EN ISO 3381:2005 „Railway – Acoustics – Measurement of noise rail vehicles".

EQUIPMENT

- Brüel & Kjær - system PULSE model 3560B, precision integrating sound meter 2236,
- FFT analyser Ono Sokki, other accessories including calibration devices.

Based on the measurements results we work-out the proposals for noise and vibration reduction in engineering practice, determination of technical or technological procedures to reduce them in order to improve the quality of environmental management in companies and organizations.

APPLIED RESEARCH ACTIVITIES

- design, planning and implementation of vehicle maintenance systems and management models of production and operational systems;
- design, planning and implementation of diagnostic models, systems and equipment;
- proposal of selection and deployment of vehicles into operation;
- implementation of computer-based maintenance information systems from initial analysis to selection and deployment in business conditions;
- solution of a-priori and a-posteriori reliability tasks at all phases of design, production and operation of vehicles;
- simulation of production processes and maintenance;
- time-domain analysis of maintenance processes using the methods of project management, the theory of constraints and critical path of a project;
- solution of FMEA, FMECA analyses by computer support;
- designing of maintenance content and extent using the RCM method (Reliability Centred Maintenance).

ECM CERTIFICATION
ECM – ENTITITY IN CHARGE OF MAINTENANCE

On the 10 May 2011 a COMMISSION REGULATION (EU) No. 445/2011 on system of certification of entities in charge of maintenance for freight wagons entered into force.

THE PURPOSE OF THE CERTIFICATION

- harmonization of assessment of competence of entities in charge of maintenance throughout the whole European Union;
- to prove that entity in charge of maintenance has its own system of maintenance amd is able to fulfil the requirements given in this regulation;
- ensure the safe operating condition of each freight wagon, for maintenance of which is responsible.

- Ministry of Transport, Construction and Regional Development of the Slovak Republic by decision No. 12309/2012 – SŽDD/z.22119 (in 2018 renewed and valid to 2022) authorized legal person, University of Žilina, to issue certification to:
  - entities in charge of maintenance of railway freight wagons;
  - maintenance workshops for the maintenance of freight wagons.
- Responsible and competent ECM certification body at the University of Žilina is represented by prof. Ing. Peter Zvolenský, CSc., head of the Certification team, from the Department of Transport and Handling Machines.
- The certification body has been assigned an identification number registered in the database of EU certification bodies (ERADIS), without which it is impossible to perform the ECM certification according to the EU Regulation 445/2011.

DEPARTMENT OF ENERGY ENGINEERING

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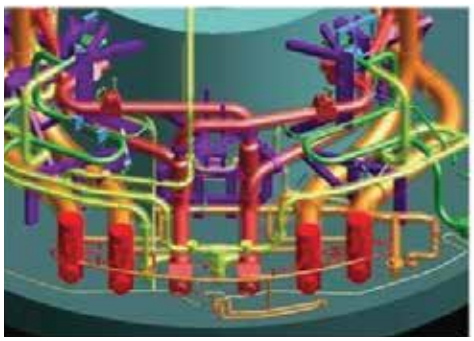
FOCUS OF THE DEPARTMENT

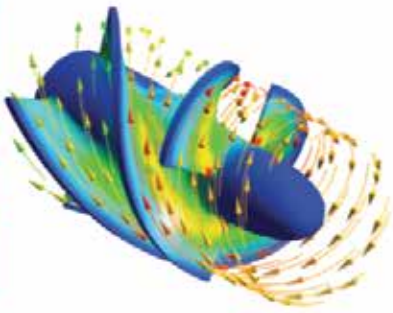
The main focus of the applied research is related to reducing the energy demands of buildings and technological processes, optimising energy consumption, waste heat utilisation, optimising fluid flow, heat transfer and simulation of materials, renewable energy, optimising heat sources, measurement of heat sources, heat pipes, measuring energy, measuring pollutants, energy audits, design of heating and ventilation equipment.

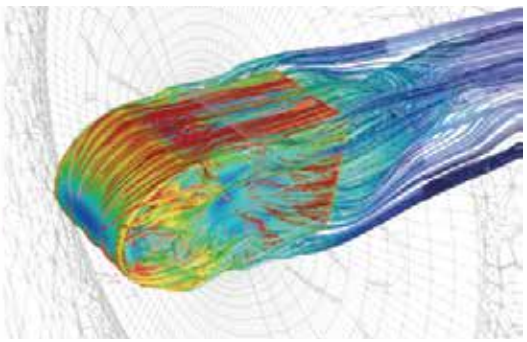
PEDAGOGIC PROFILE OF THE DEPARTMENT

The Department guarantees and provides education in the higher education three-level system in the programmes:

- 1st level – Bachelor of Science degree in **Energy and environmental technology**
- 2nd level – Master of Science degree in **Environmental technology**
- 3th level – PhD degree in **Power machines and equipment**







SCIENTIFIC PROFILE OF THE DEPARTMENT

- analysis of sources of thermal energy;
- energy audits of companies and technological processes;
- proposals on measures for reducing the energy demands of technological processes;
- research into new technologies for obtaining thermal energy from geothermal energy;
- expertise and design activities in thermal energy, heating systems, gas sectors, ventilation and air conditioning;
- expertise in special ventilation systems;
- the use of heat pipes for cooling in technological processes, electrical components and equipment;
- design of heat exchangers;
- measurement of heating sources using the corresponding STN EN standards;
- measurement of heating and cooling convectors using the corresponding SNT EN standards;
- measurement of emissions;
- numerical simulation and calculation in areas of fluid flow, heat and mass transfer.

SMALL HEAT SOURCES AND FUEL ANALYSIS GROUP

In this group, heat sources for the combustion of solid fuels with a thermal output of 150 kW are measured in accordance with the relevant STN and EN standards. The department has a flue gas analyser, an analyser for measuring organic hydrocarbon and an analyser focusing on solid particulate pollutants.

EQUIPMENT

- ABBAO2020 flue gas analyser;
- OGC analyser for the measurement of organic hydrocarbons;
- TZL ISOSTACK BASIC analyser of solid polluting particulates;
- LECPO AC500 device for measuring burnt heat;
- TEK Lignotester 6741-1Lignotester device for measuring abrasion resistance;
- Kern device for measuring fuel moisture.

APPLIED RESEARCH ACTIVITIES:

- analysis of flue gas;
- analysis of organic hydrocarbons;
- analysis of solid polluting particulates;
- measurement of the calorific value of solid fuels;
- measurement of the moisture content of solid fuels;
- measurement of pellet abrasion resistance.

ENERGY TECHNOLOGY GROUP

The group focuses on experimental measurements and tests in environmental engineering. It has a thermostatic chamber with dimensions of 4 × 4 × 4 m. The group measures heaters and coolers with power of up to 6 kW.

EQUIPMENT

- thermostatic chamber 4 × 4 × 4 m;
- simulators of 5 m geothermal boreholes;
- JULABO FL 2503 circulatory cooling with thermostat;
- YOKOGAWA MULTYMASS MMC2Coriolis flow meter;
- BINDER MKF 720 cryochamber.

APPLIED RESEARCH ACTIVITIES:

- research in the field of thermostatic experiments;
- simulation of geothermal wells;
- creation of conditions for rapid cooling circulation with high-power aggregate;
- testing of materials in cryogenic conditions with moisture regulation.

LOW-POTENTIAL HEAT GROUP

The group focuses on experimental measurements for obtaining low-potential heat from different backgrounds, such as water, air, soil and their mutual combinations. The work involves examining the power and heat transfer properties of geothermal wells and exploration heat pipes in vertical borehole.

EQUIPMENT

- biogas station;
- YOSHI exchanger station;
- AISIN 10 HP gas heat pump;
- JULABO 26 circulatory cooling thermostat;
- Viessmann BW 300 G, BWS 300 G heat pump.

APPLIED RESEARCH ACTIVITIES:

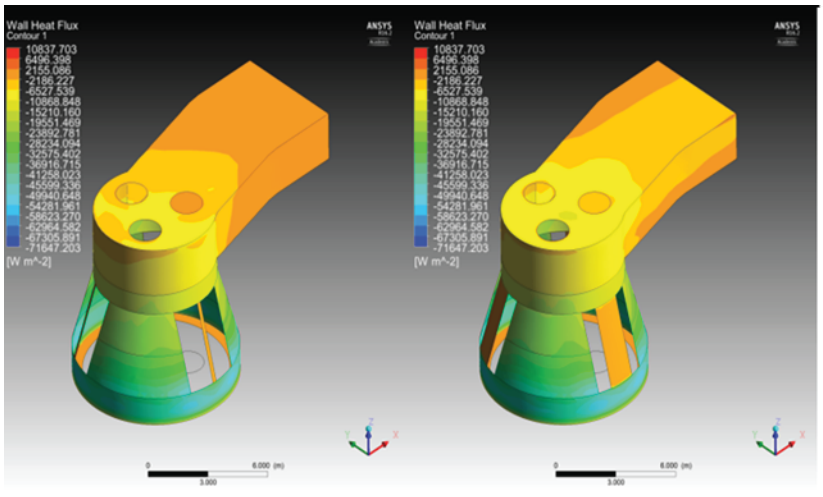
- measurements of the performance parameters of heat pumps: air-water, soil-water, water-water;
- measurement of the performance and heat transfer properties of geothermal wells;
- measurement of heat pipes for obtaining low-potential geothermal heat in a vertical borehole depth;
- research into obtaining biogas from dry fermentation.

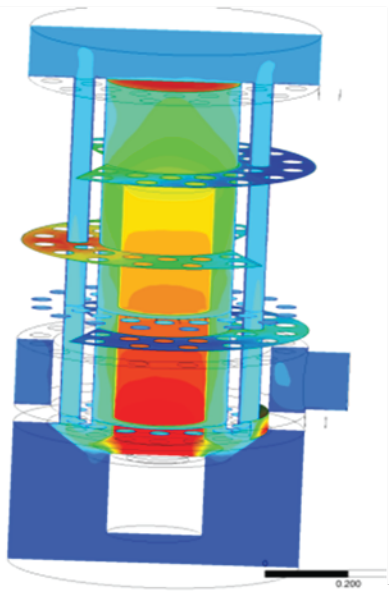
CFD SIMULATION GROUP

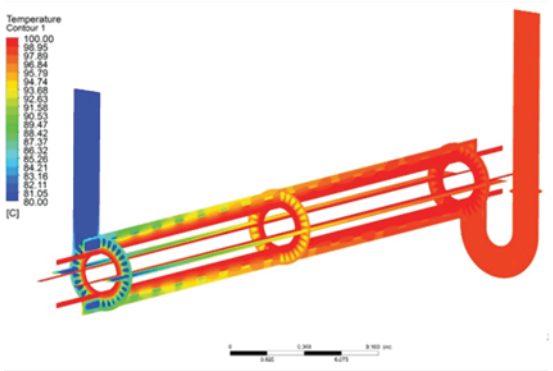
This group provides computer solutions for fluid flow, heat transfer and spatial modelling of the generation of homogeneous and hybrid meshes.

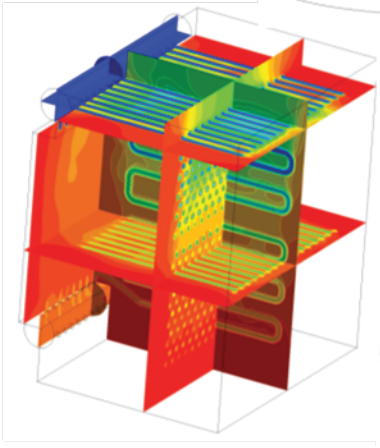
SOFTWARE AND EQUIPMENT

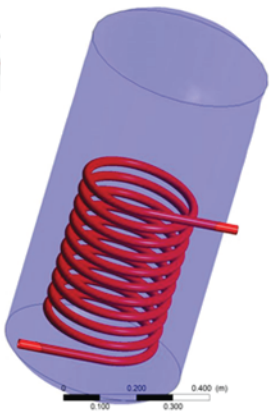
- ANSYS Workbench;
- CFD – FLUENT;
- Gambit 3D modelling program;
- TECHCON heat loss calculation program.
- Intel Core2Duo computer cores with modern LCD monitors;
- 8045C 3RB computational server.





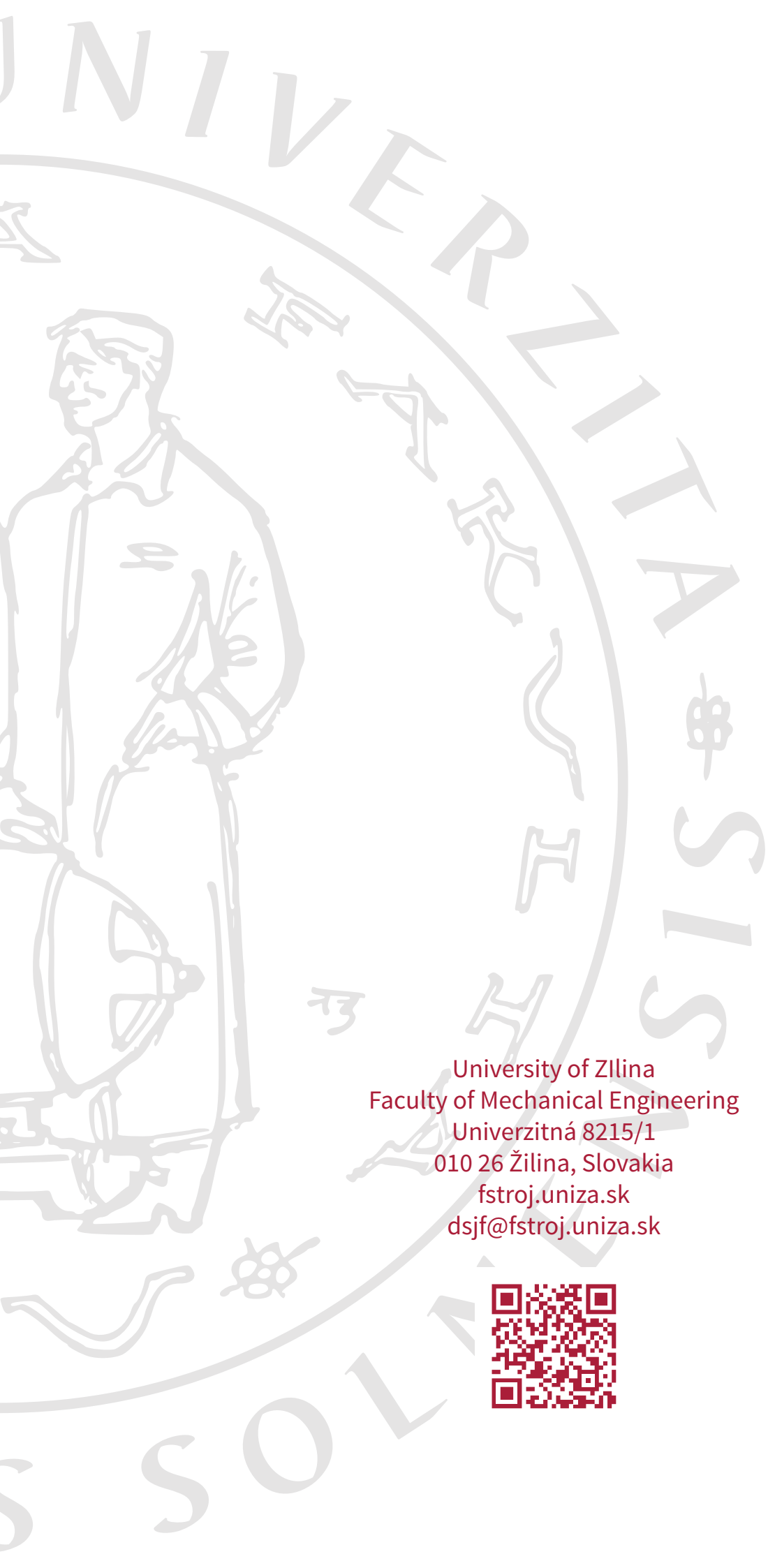






APPLIED RESEARCH ACTIVITIES

- simulation of fluid flow;
- simulation of heat transfer;
- 3D modelling enabling the automatic generation of all types of homogeneous and hybrid meshes for CFD and MKP calculations;
- design and preparation of central heating projects;
- calculation of heat loss from buildings, hydraulic balancing of heating systems, calculation and design of ventilation and air-conditioning;
- specification of elements together with the total price calculation.



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