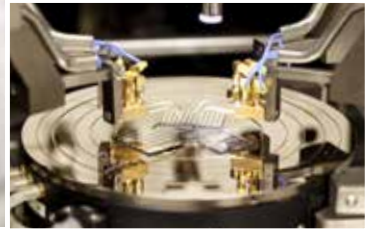

WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY FOR BUSINESS

BUSINESS COOPERATION OFFER

ARCHITECTURE AND URBAN PLANNING
AUTOMATICS AND ROBOTICS
BIOCYBERNETICS AND BIOMEDICAL ENGINEERING
BIOLOGY
BIOPHYSICS
CHEMICAL ENGINEERING
CHEMICAL TECHNOLOGY
CHEMISTRY
CIVIL ENGINEERING
COMPUTER SCIENCE
ELECTRICAL ENGINEERING
ELECTRONICS
ENVIRONMENTAL ENGINEERING
ENVIRONMENTAL PRESERVATION
FINANCE
MACHINE CONSTRUCTION AND OPERATION
MANAGEMENT
MATERIALS ENGINEERING
MATHEMATICS
MECHANICS
MINING AND GEOLOGICAL ENGINEERING
PHYSICS
POWER ENGINEERING
PRODUCTIONENGINEERING
PSYCHOLOGY
TELECOMMUNICATIONS

Wrocław University of Science and Technology

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WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

FOR BUSINESS

BUSINESS COOPERATION OFFER

Dear Reader,

It is with great satisfaction that we present to you the Wrocław University of Science and Technology for Business offer. This catalogue provides an overview of potential fields for cooperation. We hope it will inspire future joint projects.

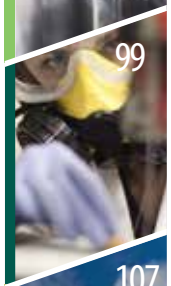
What differentiates us? We are ranked among the top technical universities in Poland. We have excellent scientific staff and experts. For our comprehensive range of services we have state-of-the-art facilities and high-tech laboratories at our disposal. We understand the needs of entrepreneurs and we speak the language of business.

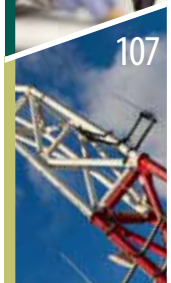
For more information contact us at
biznes@pwr.edu.pl *(for business partners)*
research@pwr.edu.pl *(for academic partners)*

CONTENTS

CONTENTS

CONTENTS





STUDIES OF ROOM ACOUSTICS

RESEARCH

Studies of room acoustics parameters, including T30 reverberation time, early decay time (EDT), C80 clarity index, D50 definition, in 1/1 or 1/3 octave ranges. The frequency range of 1/3 octave mid ranges: 50 – 5,000 Hz. The method of impulse response integration. Reverberation time T20 in 1/1 or 1/3 octave ranges - also with the use of the interrupted noise method. Studies in compliance with the standards PN-EN ISO 3382-1:2009, PN-EN ISO 3382- 2:2010, and PN-B-02151-4:2015-06.

APPLICATION

Studies verifying compliance with acoustic property requirements of the following room types:

- **concert, opera, theatre, multi-purpose halls and assembly rooms,**
- **audio engineering and production studios, lecture halls,**
- **teaching rooms.**

PHYSICO-CHEMICAL STUDIES IN CIVIL ENGINEERING AND PRESERVATION OF MONUMENTS OF ARCHITECTURE

RESEARCH

Practical performance of services in the area of technological, construction and restoration-oriented studies of historical structures: technological studies of building materials (brick, stone, wood), restoration materials (pigments, paintings supports, backgrounds, gilts, silver-plates), and typical technological studies (stratigraphy, salinity, dampness, microbiology):

- **studies of the composition of paint layers, vehicles and varnish; analysis of natural and artificial stones, plaster,**
- **masonry and stuccowork mortar, paint layers, build-up identification,**
- **degree of the salinity of porous materials (natural stones, brick, masonry, plaster and stuccowork mortar),**
- **quantitative and qualitative analysis of soluble salts; studies of walls and interiors' dampness;**
- **studies of the absorbability of porosity of porous materials,**
- **resistograph analyses of wood condition and petrographic analyses,**
- **restoration-related evaluations.**

APPLICATION

Technological studies of construction and conservation materials aim to complement the knowledge enabling identification of a historical structure's history and function, establishment of materials technologies applied to construct it, establishment of the condition of historical structures as well as development of a diagnosis, design and works schedule for the purpose of conservation, or restoration - if need be.

INTERDISCIPLINARY EVALUATION OF THE QUALITY OF BUILDINGS AT THE STAGE OF USAGE VERSUS DESIGN ASSUMPTIONS

EVALUATION

The proposed studies of buildings aim to verify whether design assumptions comply with the actual state, what is the cause of possible discrepancies, how to eliminate them in structures being researched, and how to avoid them in future development projects. The research methods enable a variety of study profiles - i.e. to attain goals related to energy performance, users' comfort, particular solutions' failure frequency, etc. Aspects verified at the stage of usage (depending on the studies' goal) are:

- **the manner of building usage and building hand-over to its users,**
- **physical properties of the internal environment, projected and attained parameters of sheathing and installed utility systems,**
- **location, manner of plot development.**

Data obtained through studies of buildings in use is compared to design principles, reviews of project delivery at the construction stage, commissioning, information provided to the building's users, and the manner of building maintenance.

APPLICATION

Interdisciplinary studies of buildings handed over for use can be conducted with a variety of scopes - from limited to in-depth. Depending on the scope of the study, it can provide understanding of a given building's current problems and advantages as seen from the users' perspective, causes of possible problems and recommendations aiming to improve the situation, and verification of the extent to which the design principles have been met. The studies are an essential tool improving the quality of services for all participants of the construction process (designers, contractors and suppliers) and perfecting construction regulations.

LANDSCAPE SHAPING

EVALUATION

Delivery of identification and design studies in the field of structural and landscape architecture, with special emphasis on sustainable development issues:

- **planning and sustainable management of landscape resources,**
- **landscape studies,**
- **preservation plans in spatial planning, implementation of the European Landscape Convention,**
- **integrated design of sustainable cities, residential estates and buildings,**
- **shaping of public spaces and inner-city zones, sustainable evaluation systems,**
- **eco-tech architecture.**

EVALUATING LOCATIONS OF STRATEGIC CAR PARKS IN CITIES BASED ON THE MATHEMATICAL FUZZY REASONING MODEL

EVALUATION

Analysis of the location of cities' strategic car parks, for both the P&R (park and ride) system and target car parks. Its outcome is a parameterised, comparative evaluation of a group of selected locations. When evaluating a given location, parameters provided by an expert are taken into account, with respect to the structure's location relative to:

- **main communication routes, traffic intensity,**
- **quality of road access,**
- **extent of the service ensured to the location by public transport**
- **distance of the structure from destination.**

A mathematical inference model based on fuzzy logic is applied to establish the location quality index. The result obtained is given as a set of three parameters - the territorial index, the public transport quality index and the overall location quality index. Presentation of indirect results in this manner also provides information on how the quality of the location being researched can be improved. The method enables obtainment of a large number of results over a relatively short period of time.

The offer targets institutions planning to establish optimal locations for car parks in their cities.

3D SCANNING AND MODELLING

TECHNOLOGY

Unique measuring solutions offered by Leica Geosystems and a wide range of software for 3D modelling. Training sessions on 3D laser scanning with the use of the Leica Hds technology and data processing with the applications Leica Cyclone and CloudWorx. Training on 3D modelling in the Bentley MicroStation environment. Optional equipment rental, with an experienced operator provided. Additionally, optional processing of data collected in this manner with the use of the unit's workstations and software. Necessary training and consultancy.

APPLICATION

- **road construction and civil engineering** – data acquisition and development of digital DTM models being a basis for design and stock-taking of road structures; stock-taking of roads and railways, grade separated interchanges, bridges and overpasses, as well as tunnels and hydrotechnical facilities,
- **processing, chemical and petrochemical industries** – 3D stock-taking and modelling of complex installations, mining industry – 3D stock-taking and modelling (including DTM) of open pit mines, spoil banks, shafts and underground chambers,
- **construction industry** – stock-taking of existing structures under renovation or or computer strength simulations,
- **conservation of historical structures and archeology** – fast stock-taking of complex historical structures and archeological stations for research purposes, and development of archive or design documentation,
- **spatial planning and management of urban complexes** – 3D scanning technology is currently one of the most effective, time-and finance-wise, tools for acquisition of data needed to generate 3D models of cities and residential estates, crisis management – fast stock-taking of structures which have undergone a failure or have become inaccessible for direct measurement due to contamination,
- **the military sector** – acquisition of data to create a virtual battlefield, which enables integration of all kinds of reconnaissance and combat actions at the command level,
- **criminology** – documentation of crime sites and simulation analyses.

OPTIMISATION ALGORITHMS IN TRANSPORT AND PRODUCTION SYSTEMS

TECHNOLOGY

Own-developed, high efficiency optimisation algorithms rated highly in international literature. Algorithms available in the form of a software engine embeddable in any IT system.

APPLICATION

ERP and ERP II systems, systems supporting production planning, transport, scheduling, as well as OPT and JIT systems. Implementation and start-up.

IMAGE PROCESSING ALGORITHMS

TECHNOLOGY

Algorithms of digital image and video sequence fault reduction. Algorithms of lossless video compression. Algorithms of resolution improvement. Algorithms of passive and active reconstruction of 3D scenes in the visible and thermal vision range.

APPLICATION

Improvement of view quality/effectiveness and quality monitoring.

AUTOMATION AND ROBOTISATION

TECHNOLOGY

Scientific, research and service activity in the area of development and integration of automation systems, robotised cells, mechatronic systems, modelling and simulation systems, as well as application of artificial intelligence methods and development of computer software. The unit undertakes research and development projects in the following fields: comprehensive development of automated technological lines, design of new products, development of process technologies and design of appliances.

APPLICATION

- **construction of control systems for machines and devices, automation of industrial processes, as well as design, development and programming of automation systems,**
- **integration of automation sub-systems, and machines' and automated systems' security issues,**
- **design and programming of robotised cells and mechatronic systems,**
- **programming of industrial robots, modelling an simulation of workstations with the use of CAD, FEM, MBS and CACE systems.**

DEDICATED INNOVATIVE SYSTEMS FOR CONTROLLING DEVICES AND TECHNOLOGICAL PROCESSES

TECHNOLOGY

- **concept analysis of the control system structure for indicated/dedicated devices or technological processes,**
- **feasibility studies of control concepts,**
- **analysis of solutions with the use of simulation studies,**
- **analysis of devices'/systems' functional security,**
- **development of control and support algorithms for designed control systems/devices,**
- **development of software applications for designed devices,**
- **development of control systems' structures through integration or dedicated microcomputer controllers,**
- **development of a technical design of a control/controller system dedicated to technological processes or devices,**
- **operation of measurement sensors, data analysis and Internet of Things systems,**
- **development/adaptation of SCADA and HMI type systems for device automatics and technological processes,**
- **development of diagnostics, telemetry (GSM/GPRS, radio technology) and redundant (safe) systems for dedicated devices/technological processes,**
- **construction of models/prototypes/PCB's of control systems for dedicated devices or technological processes,**
- **author's supervision and support of control system start-up.**

APPLICATION

- **process/structure/technological process designers,**
- **manufacturers of specialised devices requiring sophisticated control systems,**
- **integration companies operating in the automation sector,**
- **investors intending to launch the manufacture of dedicated control systems,**
- **users of devices or technological processes which require supplementation/extension through automatic remote control, monitoring or diagnostics solutions.**

More information available at **biznes@pwr.edu.pl**

INNOVATIVE OBJECT POSITIONING AND IDENTIFICATION SYSTEMS

TECHNOLOGY

- development of a concept project of object positioning and/or identification indicating predisposed and innovative measurement technologies, feasibility study of an object positioning and/or identification system,
- measurement techniques with the use of laser technology,
- measurement techniques with the use of vision technologies,
- measurement techniques with the use of geo-location technologies,
- techniques of object identification based on bar or mosaic codes,
- RFID technologies,
- algorithms for processing measurement data, images, simulation models for the purpose of determination of geometrical/location coordinates,
- software applications performing object positioning and/or identification algorithms,
- HMI systems supporting object positioning and/or identification applications,
- pilot installations for select objects,
- author's supervision and support of positioning and/or identification systems' start-up

APPLICATION

- constructors of machine and mobile systems,
- companies performing experiments which involve motion of objects,
- technologies related to safety issues,
- designers and users of warehouses, including high storage facilities,
- automation of mobile objects and remote control systems.

ROUTING AUTONOMOUS FLYING VEHICLES

RESEARCH

The few past years have brought a considerable increase in the number of applications of autonomous flying vehicles (or so-called UAVs - unmanned aerial vehicles). UAV's are applied in various areas, also civilian ones, including video filming or monitoring facilities. They are also used for tasks related to logistics and transport. Currently, the flight process of a UAV is almost entirely automated or to a very large extent controlled by automation systems. The unit's offer involves development of solutions for many applications, particularly those related to monitoring, stock-taking of facilities or developing logistics. The tasks consist in automatic planning of flight routes, in mind with a number of constraints such as flight time (battery capacity), terrain obstacles and atmospheric phenomena (wind, air currents). As a result of the technologies developed, it is possible to perform autonomous UAV missions, also in difficult conditions. Moreover, the solutions developed enable transmission of live image to a so-called ground-based station.

APPLICATION

- **video filming of objects, monitoring facilities,**
- **facility inspection (conveyor belts, mines, any difficult-to-access areas),**
- **logistics.**

MATHEMATICAL MODELS OF OBJECTS AND THEIR APPLICATION IN CONTROL SYSTEMS

RESEARCH

Construction and verification of simple models of objects' dynamics based on phenomena description and/or identification experiment, as well as development of control algorithms for the object being researched.

APPLICATION

The dynamics model developed may be applied to develop and/or optimise the control of a technological facility - it mainly concerns heat generation and air conditioning facilities.

MECHATRONICS, ELECTROMECHANICAL AND AUTOMOTIVE INDUSTRIES, MAINTENANCE DEPARTMENTS

RESEARCH

- **analytical studies of the operation of basic mechanisms,**
- **measurements of the characteristics of hydrostatic propulsion systems,**
- **planning and supervision of the operation process and repairs of machines,**
- **design, integration and modelling of a simple mechatronic system.**

APPLICATION

Planning and supervision of machine operation and repair processes, and measurements and readings of hydrostatic propulsion systems' characteristics.

MODELLING, SIMULATION AND OPTIMISATION OF THE THERMAL ENERGY BALANCE IN CIVIL STRUCTURES

TECHNOLOGY

- **analysis of civil structures in the area of energy balance of the sources and losses of heat,**
- **development of simulations and mathematical models of thermal energy flows in civil structures, and simulation studies of energy efficiency,**
- **specialised applications of IT tools for simulation studies,**
- **development of algorithms of thermal energy management in civil structures,**
- **development of a concept of remote control of heat sources in civil structures,**
- **optimisation of control algorithms of heat sources in civil structures,**
- **application of optimisation methods in energy efficiency control,**
- **consultancy in the area of the design of heating, air condition and lighting systems in terms of energy efficiency optimisation,**
- **consultancy in the area of selection of unconventional sources in terms of civil structure energy efficiency,**
- **author's supervision of solutions implemented in the area of energy efficiency optimisation,**
- **support in the area of integration of the above mentioned systems with building automation systems.**

APPLICATION

- **designers/architects of civil structures, designers of heating installations, air conditioning, ventilation and lighting systems,**
- **investors in civil structures,**
- **users of civil structures (optimisation of energy and cost efficiency),**
- **manufacturers of heating, HVAC and lighting systems, producers of construction technologies, also in terms of energy,**
- **companies installing heating, HVAC and lighting systems, etc.**
- **companies applying renewable energy sources.**

MODELLING PROCESSES AND PROGRAMMING INTERFACES

RESEARCH

Wireless Sensors Networks-WSN, simulators of Wireless Sensors Networks, laparoscopic modelling and simulation, modelling and identification of human motion, 24/7 international project teams, tests of printing device efficiency.

APPLICATION

Modelling and simulation of Wireless Sensors Networks, training for doctors in the field of techniques of laparoscopic operations, modelling of human teams' work.

MODELLING NON-LINEAR DEPENDENCIES IN CONTROL AND MEASUREMENT SYSTEMS

TECHNOLOGY

Development of non-linear models of technological processes with the use of contemporary methods of identification of block-structured systems.

APPLICATION

Improvement of regulation systems' performance, linearisation of non-linear dependencies (predistortion algorithms).

MONITORING PRODUCTION QUALITY WITH THE USE OF VISION AND THERMAL VISION SYSTEMS

TECHNOLOGY

- **analysis of production processes (of every element and of ones working continually) in terms of possibilities of the application of production (or semi-finished products) quality monitoring with the use of vision systems in visible light and/or infra-red as well as other imaging systems, development of software and device concepts along with feasibility studies of such systems,**
- **development of dedicated image processing algorithms, supervision of equipment picking and system start-up.**

APPLICATION

Vision systems are currently applied to monitor production quality practically in all production areas, from the most advanced technologies in the automotive and electronic sectors to sorting apples. Vision and thermal vision systems have considerably decreased in price, thanks to which the profitability of their application in industries such as food, manufacture of construction materials, packaging and filling glass packaging has risen, too.

OPTIMISATION OF PRODUCTION PLANNING

RESEARCH

Contemporary ERP grade IT systems enable effective management of a very large amount of data and events generated when tasks are being executed in the production system. The core of such systems is the planning module, which is supported by optimisation algorithms in advanced systems. The main goal of the optimisation process is to increase the capacity of the production system while maintaining the technological and time-related constraints stemming from cooperation with business partners. The research conducted involves development of computational models as well as optimisation algorithms designed and implemented for a wide range of production systems.

APPLICATION

Optimisation algorithms implemented in the form of modules may be used (integrated) in various IT systems supporting management of the production process (strategies such as just-in-time, lean manufacturing, etc.) They are dedicated, first and foremost, to production systems featuring pipeline and cell frameworks, unitary, short-batch and mass production requiring frequent real time planning (prioritised production).

OPTIMISATION IN DATA UNCERTAINTY CONDITIONS

RESEARCH

In the real world, one often has to make decisions without the full knowledge of the process being optimised. The studies' main goal is to:

- **develop models of systems operating in data insecurity conditions,**
- **design optimisation and supporting algorithms for decision-making in data insecurity conditions.**

APPLICATION

The algorithms designed may be incorporated into existing IT systems in the form of implemented modules. Modules optimising and supporting decision-making will recommend solutions which are:

- **best in statistical terms,**
- **most robust to unknown, unsteerable parameters of the outside world.**

DESIGN AND OPTIMISATION OF PRODUCTION MACHINES AND DEVICES

RESEARCH

The studies conducted concern issues being part of broadly understood design methodology:

- **application of modern simulation tools in design-construction processes of manufacturing machines and mechanical systems,**
- **implementation of artificial intelligence methods into the design practice by building expert construction systems.**

APPLICATION

Application of simulation systems enables automation and optimisation of design processes. The works focus on the development of a model of simulation tools' integration to ensure their effective use at the early stage of construction development, based on its virtual models. The studies carried out concern issues such as: evaluation of the possibility of applying expert systems at various stages of the design process, selection of their architecture, and the way they cooperate with CAD software.

PROTOTYPING AND MEASUREMENTS OF ELECTRONIC AUTOMATION DEVICES

TECHNOLOGY

Testing the systemic concept, execution of electronic assembly, as well as launch and basic electrical test and prototype measurements of automation devices.

APPLICATION

- **cooperation with industry as well as innovation companies and research institutions seeking an opportunity to develop and test experimental arrays of electronic automation devices,**
- **studies of static and dynamic properties of automation systems and devices,**
- **studies of microprocessor regulators and regulation systems, studies of sensors, measurement converters and actuators.**

CONTROL SYSTEMS, MOBILE TECHNOLOGIES AND INTEGRATION OF CIVIL STRUCTURE AUTOMATION IN INTELLIGENT BUILDINGS

TECHNOLOGY

- **analysis of a civil structure for the purpose of application of building automation and mobile IT technologies,**
- **development of a concept design and a feasibility study of a civil structure's automation, development of a technical design of building automation along with its integration,**
- **development of the structures of control systems for technological subsystems, security systems (SSWiN, SAP, CCTV, KD), comfort and energy (including lighting) management systems, IT/AV systems, and development of a methodology of automation systems integration in intelligent buildings,**
- **design and execution of system integration (including software development) with the use of standard (KNX/EIB, BACnet, LonWorks, ModBUS) and own-developed communication protocols,**
- **support, in terms of certification, for devices with the KNX interface, as well as development of BMS/IBMS systems, visualisations and remote access in intelligent buildings, along with analysis of measurement data,**
- **development of dedicated energy and risk management algorithms, as well as algorithms for forecasting environmental parameters,**
- **author's supervision and support at systems start-up, design and manufacture of dedicated devices and systems,**
- **certification training on the KNX bus.**

APPLICATION

- **support of decisions on design/development of an intelligent building by investors and design/architecture studios,**
- **assistance for investors in the area of commissioning a dedicated study/design of a development project,**
- **assistance in selection of contractors for the technical design of building automation systems,**
- **support for manufacturers and designers of devices with the KNX interface,**
- **assistance for the contractor developing the development of an intelligent building through author's support as well as support of the system start-up,**
- **assistance in the delivery of the building's automation and integration of building automation systems.**

TRAINING IN THE KNX TECHNOLOGY

TRAINING

Training on the KNX system; examination authorising the certificate holder to design and launch the KNX system:

- **KNX BASIC COURSE,**
- **KNX ADVANCED COURSE.**

Additionally, introductory training on other systems and building automation system integration standards. The training sessions involve the use of complete KNX/EIB building automation stations. All elements of the KNX system are installed on portable boards, thanks to which it is possible to freely set up the station, adjusting it to the needs of the exercise being performed. Moreover, at the unit's disposal are stations presenting building automation based on other popular control systems: Crestron, X10, WAGO PLC, EasySens, Dupline, Luxor and Comfort Click.

APPLICATION

Companies operating in the field of assembly and start-up of building automation systems.


500
APPROX
400
300
200
100
50ml
150ml

BIOINFORMATIC DATA ANALYSIS

EVALUATION

Analysis of genomic and proteomic data - statistics, genetic proneness to hereditary illnesses, DNA and protein sequence analysis.

PHYSICAL SIMULATION OF THE HUMAN LUNGS

RESEARCH

Physical models of the respiratory system simulating changes during respiration support enable independent, dynamically controlled (as a function of flow, pressure, volume and time) alternation of respiratory resistances and compliances, characteristic of different pathologies. The physical models enable performance of simulations with standard ventilators and medical measurement instrumentation which are close to clinical conditions.

APPLICATION

Testing of the correctness of ventilator performance, testing new modes of mechanical ventilation.

MEASUREMENTS WITH THE USE OF THE HPLC METHOD, ELSD DETECTION, THE FLUORESCENCE METHOD AND UV-VIS

RESEARCH

Analyses with the use of liquid chromatography techniques, also for biological samples, in accordance with guidelines for the pharmaceutical industry (ICH, OECD). Studies of chemical and physico-chemical reactions with the use of differential calorimetry as well as isothermal titration calorimetry techniques. Determination of solubility heat. Identification of the elemental composition of solid substances with the technique of laser induced breakdown spectroscopy. Development of liposome formulations, including pharmaceutical and cosmetic ones. Measurements of the size and potential distribution of zeta suspensions. Determination of reaction kinetics based on the stopped-flow technique (medicine carriers, elemental impact)

APPLICATION

Medicine, pharmacy.

DESIGN OF TELEMEDICAL SERVICES WITH THE USE OF MOBILE TECHNOLOGIES

TECHNOLOGY

Organisational and technical analysis of the possibilities of the interoperational integration of tele-care and tele--rehabilitation systems with a medical facility's HIS systems. Design of an architecture of mobile solutions and system integration oriented towards remote transfer of biomedical data with regard to medical services.

APPLICATION

Medical services with the use of information-communication technologies. Basic Health Care centres and hospitals: remote medical consultancy, health care and rehabilitation.

INFRA-RED OPTICAL IMAGING

RESEARCH

Optical imaging with the use of own-developed fluorescent microscopes in the range of 400 - 1,600 nm. Also at the unit's disposal are optical markers operating in the spectral ranges given above.

APPLICATION

Imaging of biological structures in vitro and inorganic structures of all types.

MEASUREMENTS OF PROPERTIES OF THE EYE, OPHTHALMIC DIAGNOSTICS

RESEARCH

Measurements of geometrical, optical and biomechanical properties of the eye. Studies of eyeball movements. Coherent optical tomography of the eye, cornea topography - videokeratometry, measurements of the intraocular pressure - tonometry. Studies of tear film stability on the cornea and contact lens with the use of inferometry and videokeratometry. Studies of the eye's pulsating dynamics and its structures. Modelling of the eyeball's biomechanical properties.

APPLICATION

Development and application of new methods of modelling and analysis of the geometry of the eye's optical surfaces. Application of new tonometry methods to measure the intraocular pressure and the viscoelastic properties of the cornea. Determination of the topography of the cornea with the use of videokeratometry. Analysis of measurement data and the dynamics of their changes in time (ORA Analyser made by Reichert, CORVIS ST tonometer made by Oculus, Pascal digital tonometer made by Ziemer and OCT Coper optical tomograph).

BIOREACTORS

RESEARCH

Comprehensive testing and design of bioreactor processors. In particular, it concerns kinetics of enzymatic and microbiological processes and methods of immobilisation of biocatalysts. The unit also conducts studies oriented towards application of a multi-purpose bioreactor integrating reactor processes with membrane separation of reacting substances.

APPLICATION

The scope of studies being conducted ensures results adaptable in the conditions characteristic of industrial processes.

MEMBRANE PROCESSES

RESEARCH

Membrane processes constitute an interesting alternative to traditional methods of separation of substances provided by chemical engineering. They are characterised by large substance stability and favourable energy consumption rates. For this reason, in many areas, they replace conventional separation processes or are combined with them to provide a more effective process solution (so-called hybrid processes). Successful application of membrane techniques requires an experimental choice of membranes with their selectivity and effectiveness as key criteria.

APPLICATION

Separation of mixtures applied in the chemical, food and pharmaceutical industries as well as in environmental protection.

THE TECHNOLOGY OF DRY COATING OF MICROPARTICLES WITH A SPOUT-FLUID BED APPARATUS

TECHNOLOGY

The key element of the technology is the use of a device for coating fine particles from A, B and C groups in accordance with Geldart's classification with micropowders and nanopowders. The device works in a spout-fluid bed system with diluted bed circulating inside. The apparatus enables dry multi-layer coating of particles of a diameter less than 1 mm, at a low temperature and over a short time (from 1 minute), without any solvent. During coating, the dry powder is fed at a constant flow rate, which enables obtaining a homogeneous coat of the final product. The fast circulating diluted bed allows coating of the microparticles with nanopowders without excessively blowing them away from the column. The technology enables the obtainment of a high quality, homogeneous and loose product without any agglomerates.

APPLICATION

The technology may be applied in the production of medicines, in particular at the final stage of manufacturing of preparations containing substances sensitive to water and high temperatures, medicines characterised by delayed or prolonged release, in the form of microparticle cores or microcapsules with coating of controlled properties. The device could also be used in the food industry, agrotechnology and for production of chemical fertilisers and plant protection chemicals with delayed or prolonged (controlled) release.

ANALYSIS OF MATERIALS' POROSITY

RESEARCH

Comprehensive analysis of a porous texture of materials ranging from mesoporous (2-50 nm), microporous (<2 nm) to ultra-microporous (<0,7 nm) using the method of adsorption/desorption of practically any non-toxic and non-corrosive gas. A standard analysis of porosity includes determining the adsorption and desorption isotherms of nitrogen at a temperature of 77K and of carbon dioxide at a temperature of 273K. Another method used is analysis with the use of argon (77K), hydrogen (77 or 273K) and methane (273K). The material's specific surface, total volume of pores and the distribution of pore sizes in the materials are determined.

APPLICATION

Characteristics of carbon and aluminosilicate sorbents and catalysts.

ANALYSIS OF KEROSENE PRODUCTS

EVALUATION

- **calorific value and fractional composition of fuel, content of water and sulphur in fuel,**
- **flash point of middle distillates using the Pensky--Martens method,**
- **Reid vapour pressure of petrol,**
- **kinematic viscosity of oil products, pour point of fuel and**
- **technological oils,**
- **cold filter cloud and plugging point,**
- **particle contamination in oil products,**
- **ester content in oil in accordance with PN-EN 14078:2005,**
- **antioxidant additives (BHT),**
- **group composition, carbon content in aromatic structures,**
- **analysis of C1-C6 gases,**
- **composition and chemical structure of residues of petroleum oils in accordance with ASTM D4124, structural parameters of asphaltenes, colloidal stability using Pauli's method,**
- **rheological properties of asphalt and residues of petroleum oil: softening point; penetration at 25°C;**
- **penetration index; dynamic viscosity at 60-135°C; elastic reverse; RTFOT ageing test; change of softening and penetration point after RTFOT ageing,**
- **evaluation of susceptibility to biodegradation of organic compounds under aerobic conditions in water environment (ISO 14593 and OECD 310),**
- **technical analysis of solid fuels.**

STUDIES OF THE ADSORBTIVE CAPACITIES OF POROUS MATERIALS FROM SOLUTIONS

RESEARCH

The studies involve determination of adsorption isotherms and process kinetics. Processes are carried out in a water or organic solvent solution in static conditions at a temperature of 20-40°C. Balance state time is determined, as well as removal of compounds and adsorption mechanism. Adsorbed compounds can be ions or organic compounds such as: phenols, dyes and humic acids.

APPLICATION

The research allows us to determine the sorption capacity of a porous material and the possibility of using the material for treatment of solutions by absorption.

STUDIES OF GAS STORAGE CAPACITY

RESEARCH

studies of blocking sorbents, capable of adsorptive storage of gas under high pressure conditions at ambient temperature and cryogenic conditions, determining the storage capacity of methane, hydrogen, carbon dioxide and other gases up to 200 bar at temperatures of 77K, 203K, 273K and 298K for any material (including particulate).

APPLICATION

Characteristics of fillers of storage tanks for flammable gases; CO2 sequestration.

STUDIES OF PRESSURE-CHANGEABLE SEPARATION GASES

RESEARCH

Studies of sorbents used to separate gaseous mixtures with the use of the PSA method (Pressure Swing Adsorption). The analysis can be conducted under a temperature of 250°C and pressure of 10 bar. It is possible to work with gaseous mixtures with constituents such as CO_2, CO, H_2, N_2, etc.

APPLICATION

Separating gas products from technological processes.

ELECTROCHEMICAL STORAGE OF ENERGY

RESEARCH

Analysis of materials in terms of storing electrical energy in lithium-ion batteries (anode and cathode) and electrochemical condensers with an EDLC or pseudocapacitive electrode (water or organic electrolyte). The possibilities of diffusion electrodes in terms of electrocatalytic oxygen reduction in fuel cells and lithium–air batteries can also be analysed. Additionally, routine studies of small and medium-sized electrochemical cells at a charge/discharge current up to 4A and operating voltage up to 20V are conducted.

APPLICATION

Electrochemical power sources.

CATALYSTS AND ADSORBENTS: DESIGN, SYNTHESIS AND PROPERTIES

RESEARCH

- **properties of catalyst and adsorbent surfaces: acidity - with the use of the TPD-NH_3 and FTIR methods, susceptibility to reduction with TPR-H_2, hydrogen,**
- **susceptibility to oxidation, characteristics of carbon deposits,**
- **characteristics of the porous structure of sorbents and catalysts: actual density, adsorption isotherms, sorption properties of sorbents, sorption dynamics; parameters of porous structure,**
- **preparation of sorbents and catalytically active materials: selection and evaluation of materials for sorbent production; material modification; low- and high-temperature carbonisation, physico-chemical activation with the use of steam, CO_2, air + O_2; chemical activation,**
- **selection of adsorbents and assessment of their use in oil products purification and water purification of organic products,**
- **evaluation the activity of catalysts in model reactions and in processes with the actual substrates in flow reactors and autoclaves (pressures up to 15 Mpa, hydrogenation, hydrocracking, catalytic cracking, reduction of nitrogen oxides, VOC and Cl-VOC),**
- **evaluation of photocatalysts' activity.**

APPLICATION

- **obtaining sorbents of defined porous structure parameters,**
- **evaluation of the usefulness of organic materials for sorbent production,**
- **characteristics of sorption materials' porous structure and measurement of standardised sorption parameters (methylene number, iodine number, etc.)**

CRACKING WASTE POLYOLEFINS INTO LIQUID FUELS

TECHNOLOGY

Municipal and industrial waste plastics which cannot be mechanically recycled should be submitted to final utilisation. A large part of them, polyolefins, composed exclusively of carbon and hydrogen, constitute very good raw material for production of liquid fuels with use of the cracking method. The facility offers a technology for cracking waste polyolefins featuring a capacity of 150-200 kg of waste polyolefins per hour. The cracking process performed in this installation results in obtaining of 80-85 wt % of a liquid product (boiling in the temperature range of 20-360°C) and 7.5-10 wt % of a gaseous product (hydrocarbons C1-C5); the remainder is solid carbonaceous residue of heating value higher than 20 MJ/kg.

APPLICATION

Waste utilisation companies, fuel oil producers.

MASS CRYSTALLISATION FROM SOLUTIONS

TECHNOLOGY

Extraction of solid phase in a controlled way from water solutions in the batch or continuous crystallisation process. Determination of the impact of the composition of material and crystallisation parameters on the quality of the crystalline product: distribution of crystal size, homogeneity of the population, chemical composition. Three fully automated and computer-controlled laboratory experimental facilities are used (two with a continuous mode of operation, and one with a batch mode).

APPLICATION

Determination of the impact of the chemical composition of material and crystallisation parameters on solid phase extraction and the quality of the resulting product. Processing of data for the purpose of process design.

EVALUATION OF THE NEED TO REGISTER SUBSTANCES (REACH)

EVALUATION

The analysis evaluates the properties of manufactured substances and whether it is necessary to register them, in accordance with the guidelines of Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

EVALUATION OF THE USEFULNESS OF COAL AND BIOMASS FOR THERMOCHEMICAL PROCESSING

EVALUATION

- **determination of the properties of coal types and blends of coal, biomass and other solid fuels (technical and elementary analysis, determining forms of sulphur in solid fuels, heat of combustion),**
- **evaluation of the usefulness of various coal types and blends of coal for the coking process (plastic and dilatometric properties, sintering capability, slow swelling ratio),**
- **it is possible to carry out carbonisation and cocarbonisation processes with additives (process atmosphere: argon, nitrogen, hydrogen, air, process gases). Analysis of the properties and structure of solid products of coal carbonisation,**
- **pyrolysis and fast pyrolysis of biomass, with the possibility of basic characteristics of bio-oils,**
- **evaluation of the usefulness of biomass as solid fuel or material for different uses, e.g. production of adsorbents,**
- **determination of the properties and structure of solid and liquid products of carbonisation of coal, biomass and their blends.**

EVALUATION OF CHEMICAL SUBSTANCES' FLAMMABILITY AND EXPLOSIVENESS PROPERTIES

EVALUATION

Evaluation of susceptibility of chemical substances to combustion, especially flash fire, in technological processes and during storage and transport. Conducting an analysis of the causes of fires, explosions, and other dangerous events.

DESULPHURISATION AND ENRICHMENT OF BIOGAS

RESEARCH

Biogas from anaerobic digestion containing CO_2, N_2, CH_4 and sulphur compounds is compressed to the pressure of 4-5 bar and heated to 75°C. Then, the gas is desulphurised (removal of H_2S and RSH (organic sulphur) in adsorbers operating alternately and filled with a catalyst converting H_2S and RSH into elemental sulphur. The desulphurised gas is cooled and enriched with methane in a VPSA system. The resulting product is a high methane content gas with not less than 96% vol. of CH_4. Carbon dioxide is sucked from the system under vacuum desorption and ejected into the atmosphere through a gas exchanger.

APPLICATION

Biogas plants, municipal wastewater treatment plants.

RECOVERY OF PHOSPHATES FROM WASTE SOLUTIONS AND SEWAGE – PHOSPHORUS RECYCLING

TECHNOLOGY

Obtaining magnesium and ammonium phosphate, struvite (slow release NPMg fertiliser) from hexahydrate wastewater in the continuous precipitation crystallisation process. Magnesium and ammonium salts are the substrates. Research is conducted in two fully automated, computer-controlled laboratory experimental facilities. Determining optimal parameters for processes of recycling phosphorus from true waste solution.

APPLICATION

Developing technological and equipment principles for the process of recycling phosphor from true waste solution. Determining the influence of decision parameters of the precipitation crystallisation process on the quality of the extracted product.

SYNTHESIS AND MODIFICATION OF COAL MATERIALS

RESEARCH

Research in the field of controlled synthesis of conventional carbon materials (coke) by means of pyrolysis (up to 500°C), carbonisation (up to 1,300°C) or gasification/activation (up to 1000°C), and of nanostructural materials (nanofibres and nanotubes) using the CCVD method. Surface modification of carbon materials by means of CVD (methane, propane etc.), ammonisation/ammoxidation and hydrogen reduction. Analysis of the dynamics of carbonisation, gasification and activation processes in an atmosphere of air, nitrogen, carbon dioxide and steam up to a temperature of 1000°C, on the basis of the changes in mass of the material. Quantitative analysis of solid products (CHNS elementary analysis), liquid products (GC-MS and DSC) and gaseous products (TD/GC-MS).

APPLICATION

Production of cokes and carbon nanocomposites. Production of activated carbon. Biomass processing.

DETERMINATION OF PARAMETERS OF A SOLID SUBSTANCE'S SIZE DISTRIBUTION

RESEARCH

Determination of the following in a sample of a polydisperse material:

- **particle size distribution,**
- **average particle size (median),**
- **dominating size,**
- **homogeneity of the particle population (by calculating the so-called coefficient of variation – CV).**

Measuring range: 0.04 – 2,000 um. A Beckman Coulter LS 13 320 laser analyser is used for the analysis.

APPLICATION

Determining the characteristics of the grain composition of a polydisperse material.

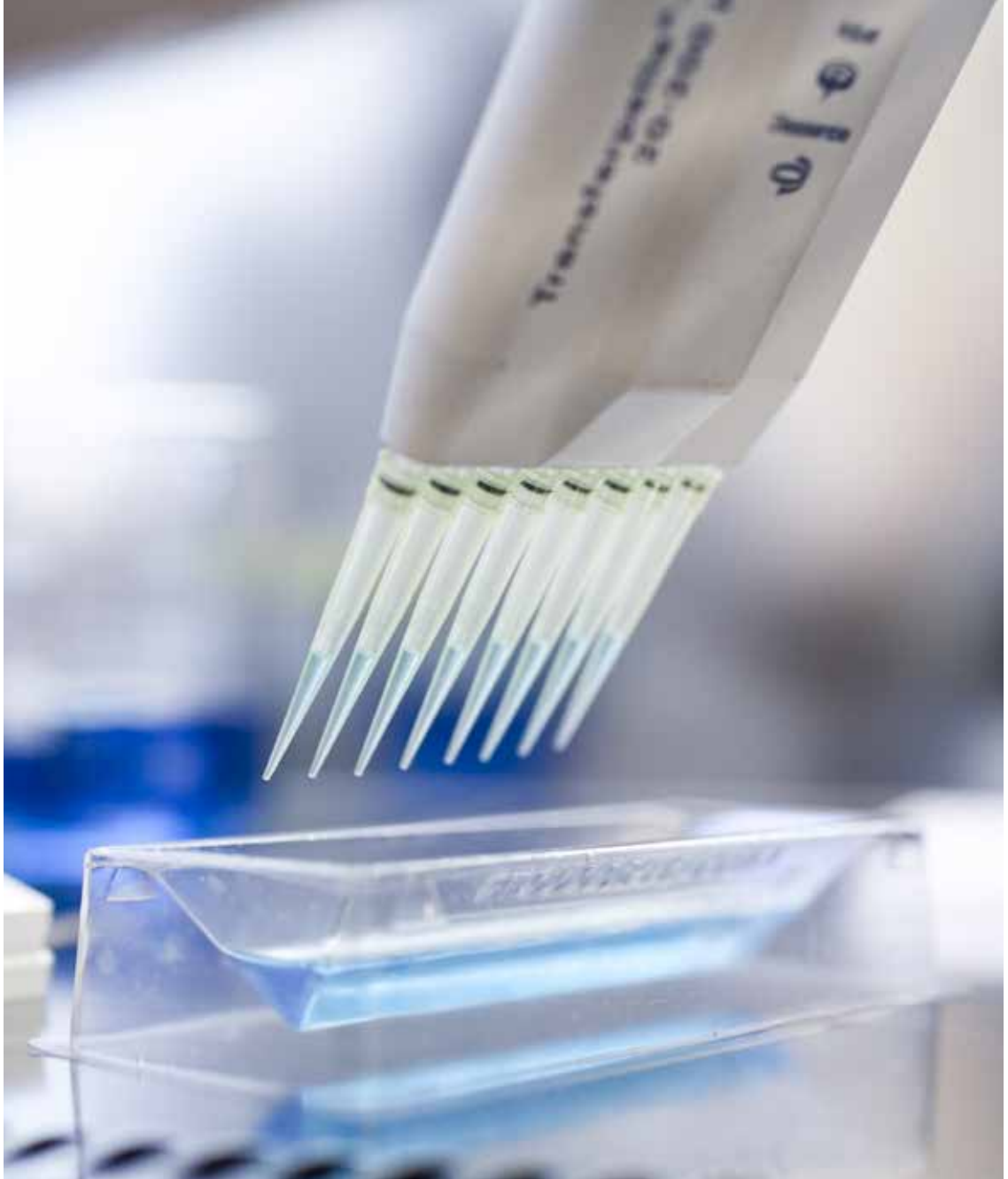
TRACE ANALYSIS OF MATERIALS

RESEARCH

Comprehensive analyses of elemental chemical composition of materials for the needs of chemical, food and pharmaceutical industries as well as environmental conservation and medicine. The offer entails analyses of samples delivered along with preparation of the materials for analysis, including homogenisation, mineralisation and/or extraction. Activities performed include determination with the use of atomic absorption spectrometry with atomisation in a flame and graphite absorption cell, atomic emission spectrometry and combined techniques dedicated to selected elements. In the case of As, Bi, Hg, Pb, Sb, Se and Sn, the technique applied involves generation of volatile compounds enabling determination of these elements at very low concentration levels (ppb). Determination, with high grade modern apparatuses applied, is carried out by a qualified and competent team boasting many years' professional experience.

APPLICATION

Comprehensive elemental analysis of materials, with special emphasis on samples featuring complex organic and inorganic matrices. Determination of metals, non-metals and semi-metals within a wide range of concentrations, in industrial, environmental, biological and pharmaceutical, as well as food samples.



MULTIELEMENTAL ANALYSIS

RESEARCH

Determination for the needs of the chemical industry, municipal services management, agriculture, medicine, veterinary medicine, animal husbandry and forensic medicine.

Analytical services in the area of determination of composition and form of inorganic products such as minerals, fertilisers, fodder additives, inorganic salts, waste, waste water, sewage, etc. The unit specialises in determination of trace quantities of elements (toxic substances, heavy metals, trace elements) in environmental and biological materials, including food, animal and products, as well as human tissue. Determination of substances' unknown composition according to the multielemental analysis system.

APPLICATION

Analytical determination of products and waste applied in agricultural production and environmental conservation, for the needs of the chemical, fertiliser and fodder industries, as well as municipal services management (sewage, sewage sediments, water), agriculture (soil, fertilisers, fodder additives), medicine (tissues, physiological fluids, bones), veterinary medicine, animal husbandry and forensic medicine.

STRUCTURAL STUDIES

RESEARCH

Structural studies with the use of the following apparatuses:

- **NMR 600 MHz spectrometer equipped with a TCI cryoprobe (three channel 1H/13C/15N probe with a z-axis gradient, operating within the temperature range of 0°C – 60°C), for applications requiring a high resolution and sensitivity,**
- **TXI - a triple resonance probe with a reverse coil system and a z-axis gradient (1H-observe, 13C/15N-decoupling, 2H-lock, temp. range of - 150°C – 180°C (5mm),**
- **TBO - a triple resonance probe with a z-axis gradient (BB-observe, 1H/13C-decoupling, 2H-lock), operating on BB channel within the frequency range of 31P to 107Ag; temp. range of -150°C to 180°C (5mm).**

APPLICATION

Structural studies with the use of the specialised apparatuses at the unit's disposal may have a basic character (scientific and research units), or be conducted in the field of application (production facilities). The unit delivers services in the field of execution of specialist high resolution and sensitivity NMR spectra. Structural studies are offered, e.g. of biomolecules and macromolecules of a biological significance. The unit's probes are applied to measure magnetic molecular resonance in solutions.

CHROMATOGRAPHIC ANALYSIS OF POLYCHLORINATED CONTENT IN ELECTROINSULATION OILS

RESEARCH

Determination of polychlorinated biphenyl content is performed with the gas chromatography method, in an apparatus fitted with an ECD detector, in compliance with PN-EN 12766-1.

APPLICATION

Basic analytical determination permitting the use of devices containing electroinsulation oils.

MEASUREMENT OF CHEMICAL SUBSTANCES' REACTIVITY WITH THE USE OF CALORIMETRIC METHODS

RESEARCH

- **measurement of reaction speed (thermal stability) of high-power materials in an adiabatic calorimeter APTAC264 made by Netzsch within the range of up to 500°C and 12MPa, with the temperature increase compensation of up to 400K/min and allowing samples of up to 100g.**
- **determination of the SADT parameter (Self Accelerated Decomposition Temperature) based on measurements,**
- **measurement of phase transformation heat as well as endo- and exothermic chemical reactions in an isothermal calorimeter C80D Setaram, at up to 300°C and 30MPa, allowing samples of up to 1g.**
- **measurement of adsorption heat, heat capacity and heat conduction,**
- **measurement of phase transformations and chemical reactions in solid materials, with the use of a scanning calorimeter STA409C Netzsch, at up to 1600°C, under atmospheric pressure in a neutral or reactive atmosphere, along with analysis of gaseous products with the mass spectrometry method.**

APPLICATION

Determination of chemical reactivity of chemical substances, with special emphasis on combustible and explosive properties.

ANALYSIS OF ASPHALTS AND MINERAL-ASPHALT MIXES

RESEARCH

The analysis of asphalts and mineral-asphalt mixes involves the following studies:

- **penetration of asphalts and asphalt binders with a needle, analysis of the softening point of asphalts and asphalt binders with the ring and ball method,**
- **bulk density of mineral-asphalt mixes with the use of the A and B method,**
- **soluble binder content in mineral-asphalt mixes,**
- **grain composition of the aggregate in mineral--asphalt mixes,**
- **stability and deformation of mineral-asphalt mixes with the Marshall method,**
- **rigidity of mineral-asphalt mixes with the IT-CY method as well as with the 4 point beam method,**
- **mineral-asphalt mixes' creep under static loads, with the NAT apparatus,**
- **mineral-asphalt mixes' resistance to permanent deformations with the rutting method (small apparatus, procedure B in the air),**
- **mineral-asphalt mixes' resistance to fatigue with the 4 point beam method.**

APPLICATION

Analysis of properties of asphalts, asphalt binders, mineral-asphalt mixes and mineral-cement-emulsion mixes. Design of the composition of mineral-asphalt mixes resistant to rutting and fatigue. Design of new road surface structures. Studies of waste materials (slags, power engineering ash, rubble). Development of technical specifications. Development of opinions and evaluations in the areas specified above (correct execution of road pavements' structural layers, qualitative and quantitative evaluation of composition, evaluation of innovative road construction materials, forecasting mineral-asphalt mixes' fatigue life).

ANALYSIS OF CONCRETE AND CONCRETE MIXES

RESEARCH

The analysis of concretes and concrete mixes involves the following studies:

- **concrete absorbability, concretes' frost resistance (regular method) and compression resistance,**
- **concretes' resistance to tension when splintered,**
- **concretes' resistance to bending,**
- **the rebound number for concrete in a structure with a non-destructive method,**
- **the speed of an ultrasonic wave for concrete in a structure with a non-destructive method,**
- **consistence of a concrete mix with the fall cone test,**
- **consistence of a concrete mix with the Vebe method, consistence of a concrete mix with the method of compactibility determination,**
- **air content in a concrete mix with the pressure gauge method.**

APPLICATION

Analysis of properties of road construction materials such as cement concretes, concretes in structures and concrete mixes. Design of concrete mix compositions. Studies of existing road pavements with the use of non-destructive methods. Development of evaluations and opinions within the specified scope (evaluation of road and tarmac pavements' execution correctness, evaluation of the existing structures' condition with non-destructive methods).

ANALYSIS OF SOILS AND SOIL SUBBASE

RESEARCH

- **soil bearing capacity (CBR),**
- **bulk density of soil with the water volumeter,**
- **grain composition of soil with the sieving method, optimal humidity and maximum bulk density of the granular soil structure with the Proctor method,**
- **subsoil's deformation module with the plate load method,**
- **cement-stabilised soils' resistance to compression,**
- **cement-stabilised soils' frost resistance.**

Moreover, on the basis of field and laboratory tests, the unit develops evaluations in the area of the bearing capacity of subsoils allocated for development, road and airport tarmac pavements, and other civil structures. Analysis of properties of soils and stabilised soils applied in road construction. Design and evaluation of reinforcements of existing subsoil.

APPLICATION

Analysis of properties of soils, cement-stabilised soils and subsoil allocated for road surface construction and other elements of road infrastructure. Evaluation of subsoil bearing capacity. Design of new road pavement structures and evaluation of existing road pavements' bearing capacity. Design of subsoil reinforcement solutions. Evaluations and opinions within the scope specified above.

ANALYSIS OF AGGREGATES

RESEARCH

- **studies of aggregates' absorbability with the pycnometer method, aggregates' frost resistance with a method involving freezing-thawing in water,**
- **aggregates' polishability with the PSV method,**
- **aggregates' resistance to comminution with the Los Angeles method,**
- **aggregates' grain composition,**
- **aggregates' density with the Le Chatelier flask method.**

APPLICATION

Analysis of properties of road materials such as aggregates and mineral mixes. Design of composition of mineral mixes for road pavements' structural layers (supplementary foundation, main foundation, layers of aggregates bounded/not bounded with a binder). Evaluations and opinions within the specified scope. (aggregates' and mineral mixes' usefulness in terms of their application in road construction, qualitative and quantitative evaluation of materials applied).

ANALYSIS OF ROAD PAVEMENTS

RESEARCH

- **studies of road pavements' deflections with the use of Benkelman beam deflection test,**
- **road pavements' deflections with the use of the impact deflectometer FWD),**
- **road pavements' lateral evenness with the wedge and rod method,**
- **road pavements' longitudinal evenness with the wedge and rod method,**
- **deflection module of road pavements' structural layers with the VSS plate load method.**

APPLICATION

Evaluation of road pavements' condition with the use of non-destructive methods. Design of new road pavement structures and evaluation of existing road pavements' bearing capacity. Evaluation of road and airport tarmac pavements' durability and load bearing, including the PCN evaluation. Evaluations and opinions within the scope specified above (design of road and airport tarmac pavements and reinforcement solutions, analysis of causes of damage to flexible, rigid and half-rigid pavements, dimensioning, evaluations of surface execution correctness).

ANALYSIS OF GEOLOGICAL, HYDROGEOLOGICAL AND HYDROLOGICAL CONDITIONS FOR AREAS WITH HYDROTECHNICAL FACILITIES AND DEVICES

EVALUATION

Development of scientific-technical evaluations and opinions concerning issues where hydroengineering, hydrogeology and engineering geology meet. Knowledge of the geological structure is indispensable both at the stage of design and operation of hydrotechnical facilities and devices. It is also significant for characterisation and proper interpretation of the function of terrains as elements of the environment and the existing water system, including direct protection.

NUMERICAL ANALYSES OF BUILDINGS AND WALL BARRIERS IN TERMS OF THERMAL-HUMIDITY

EVALUATION

- **analyses of the annual heat and electrical energy consumption in residential buildings as well as public utility and industrial facilities; optimisation of energy consumption,**
- **computer simulations and heat-humidity analysis of wall barriers in buildings serving different purposes, also at the stage of building design,**
- **numerical calculations of thermal bridges, computer calculations and analyses of temperature distribution in construction elements, including the stage of building design,**
- **analyses of heat exchange through barriers in contact with soil,**
- **analyses of heat exchange through so-called green roofs.**

ENERGY PERFORMANCE AUDIT, THERMAL MODERNISATION AND ENERGY CERTIFICATION OF BUILDINGS

EVALUATION

- **energy performance audits of buildings serving different purposes,**
- **designs of thermal modernisation of buildings, including historical buildings,**
- **energy certificates and energy performance certificates of buildings,**

- **consultancy in the area of design and execution of thermal sheathing for buildings serving different purposes, evaluations of the correctness of interior microenvironments in residential buildings, as well as public utility and industrial facilities,**
- **evaluations of buildings, building components and interiors in terms of heat, humidity, mycology and construction,**
- **consultancy in the area of design and development of buildings aiming to attain the standard of a building meeting technical requirements of an energy efficient, low energy and passive building,**
- **consultancy in the area of design and development of buildings partly or entirely earth-sheltered.**

TESTING OF LINTEL BEAMS

RESEARCH

- **dimensions and deviations from the intended shape, bending and shear resistance,**
- **measurements of mass.**

APPLICATION

Studies of lintel beams are applied during type studies and check-ups, as well as when performing product evaluations.

TESTING OF CONCRETE SETT

RESEARCH

- **dimensions, shape and appearance,**
- **tensile strength when splintered, resistance to freezing/thawing with defrosting salt, measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

TESTING OF CONCRETE PAVING SLABS

RESEARCH

- **dimensions, shape, appearance and resistance to bending,**
- **resistance to freezing/thawing with defrosting salt,**
- **measurements of mass.**

APPLICATION

Studies of concrete paving slabs are applied during type studies and check-ups, as well as when performing product evaluations.

TESTING OF CONCRETE PRESSURE PIPES, JOINTS AND FITTINGS

RESEARCH

- **dimensions, surface characteristics and crushing,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF CONCRETE PROPERTIES

RESEARCH

Analyses of concrete samples thrown or taken from structures. Drilling of concrete in monolithic and precast structures is also performed. The following studies are carried out with samples of concrete taken from structures:

- **resistance to compression,**
- **tensile resistance when splintered, concrete elasticity coefficient, resistance to bending and**
- **frost resistance.**

APPLICATION

Design of concrete mixes' composition, studies of precast concrete types and check-ups. Evaluations and opinions on monolithic and precast products and structures.

STUDIES OF CONCRETE PROPERTIES WITH THE USE OF THROWN SAMPLES AND PRECAST BORES

RESEARCH

- **concretes' resistance to compression,**
- **concrete samples' contraction with the linear change method,**
- **bulk density with the weight-volume method,**
- **density,**
- **abrasibility with the Boehme method, absorbability with the weight method, water penetrability.**

APPLICATION

Design of concrete mixes' composition, studies of precast concrete types. Evaluations and opinions on monolithic and precast products and structures.

STUDIES OF THE PROPERTIES OF SPUN CONCRETE IN POLES FOR POWER LINES AND THE LOAD CAPACITY OF SUCH ELEMENTS

EVALUATION

Evaluations of the technical condition of railway and electric tractions made of spun concrete. Studies of elasticity. Design and evaluation of new technological solutions.

STUDIES OF PHYSICAL AND STRENGTH PROPERTIES OF NEW GENERATION CONCRETES

EVALUATION

Studies of new generation concretes' physical and strength properties. Concretes with dispersed reinforcement.

STUDIES OF NATURAL STONE PROPERTIES

RESEARCH

Analyses of natural stone collected from a quarry or stone products such as sett, curbs, floor and stair slabs, road slabs, cladding slabs and others. The following studies are performed:

- **compression resistance, abrasibility with the Boehme method,**
- **density with the weight-volume method**

APPLICATION

Type studies of stone products. Evaluations and opinions.

STUDIES OF WALL ELEMENTS OF AGGREGATE CONCRETE (WITH REGULAR AND HARD AGGREGATES)

RESEARCH

- **dimensions**
- **resistance to compression,**
- **resistance to tension when bent, share (percentage) of drill surface in wall elements (based on impression on paper),**
- **measurement of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF NOISE IN BUILDINGS

RESEARCH

Studies of the mean sound level - A LAm, equivalent sound level - A LAeq, maximum sound level - A; the level of acoustic pressure in 1/1 and 1/3 octave ranges. Direct measurement method.

APPLICATION

Evaluation as to whether the noise in the room does not exceed permissible levels, according to PN-87/B-02156.

STUDIES OF ACOUSTIC INSULATING POWER

RESEARCH

Studies of approximate specific acoustic insulating power (R) and standardised level difference IDnT between rooms in 1/3 octave ranges - the method of field measurement in diffuse field conditions. Determination of the weighted index of specific approximate acoustic insulating power (R'w) and the weighted index DnT,w as well as spectrum adaptation terms C and Ctr, and RA1, RA2 indices. Studies compliant with PN-EN ISO 140-4:2000, PN-EN ISO 16283-1:2014, PN-EN ISO 717-1:2013-08 standards.

APPLICATION

Evaluation of compliance with regulations and standards of acoustic insulating power of barriers in existing buildings, including PN-B-02151-3:2015-10 standard.

STUDIES OF IRRIGATION DUCTS

RESEARCH

The following studies are performed: dimensions and surface characteristics, breaking load, measurements of mass.

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

CHECK-UPS OF PILES

RESEARCH

Design and execution of foundation piles inspections in the area of trial dynamic and static loads, studies of piles' continuity and length. The studies are conducted both in terms of foundation piles' and columns' load capacity and quality. The following apparatuses are applied for trial static loads:

- **load system: hydraulic actuator with a manual pump,**
- **measurement devices (dial displacement gauge providing 0.01 mm accuracy),**

- **precision levelling instruments Ni007 providing reading accuracy of 0.05 mm for control of anchor pile elevation and optional independent control of jack-in piles subsidence.**

For piles' and columns' continuity tests:

- **PIT - extended American-made (PDI) measurement system**

APPLICATION

Check-up tests of piles are performed to ensure independent evaluation of foundation pile installations and for commissioning of geotechnical works. They enable evaluation of the condition and usefulness of a pile to perform below a structure, which allows minimising the risk of a failure caused by a foundation pile's improper performance. The test may be performed on both piles bored in-situ and precast ones.

STUDIES OF CONCRETE CURBS

RESEARCH

- **dimensions, shape, appearance and resistance to bending,**
- **resistance to freezing/thawing with defrosting salt,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

LABORATORY STUDIES OF HYDROTECHNICAL AND TRANSPORT STRUCTURES

RESEARCH

Studies of hydrotechnical and transport structures with the use of large-size and sector models with a solid or washing-out area, with full representation of the required criteria of researched phenomena similarity:

- **checking of flow capacity along with determination of water discharge characteristics and indices; studies of conditions of flow around and hydrodynamic loads,**
- **studies of constructions' vibrations in the water medium (e.g. hatch closures),**
- **studies of conditions of energy diffusion at bottom stations,**
- **determination of parameters and duration of bottom washout below stilling basins and within bridgeheads and bridge piers; determination of conditions of ice float passage,**
- **studies of watercraft behaviour and their impact on waterways,**
- **studies of river rubble sedimentation processes: silting of water intakes, power plant intakes, outer harbours, etc.**
- **studies of river bed erosion, selection of bottom and bank protection solutions,**
- **studies of prototype regulation facilities, basic studies of hydrotechnical concrete:**
- **resistance to compression, frost resistance, water--permeability and absorbability,**
- **studies of of turbulence and its impact on the operation of hydrotechnical devices.**

APPLICATION

The regulations currently in force make it obligatory to perform studies of all designed grade I and II hydrotechnical facilities with the use of a physical model (in terms of flow capacity and conditions of energy diffusion at the lower water area). Model studies are conducted with the use of hydraulic research laboratory apparatuses compliant with the currently binding standard, including an electromagnetic PEMS sensor for measurements of water flow speed ensuring accuracy of 0.001ms-1.

LABORATORY STUDIES OF MATERIALS AND COMPONENTS OF BRIDGE INFRASTRUCTURE

RESEARCH

- **studies of concretes' resistance to compression, studies of reinforcing steel's**
- **tension resistance,**
- **studies of concrete absorbability,**
- **evaluation of concretes' resistance to compression with a sclerometer.**

APPLICATION

Determination of characteristics of materials applied in construction of bridge structures, evaluation of their usefulness and compliance with standards or other reference documents.

STUDIES OF CONCRETE MASTS AND POSTS

RESEARCH

- **dimensions and surface characteristics, resistance of a post measuring 40.0 m in length to bending,**
- **resistance of a post measuring 40.0 m in length to torsion,**
- **location and sheathing of construction steel and tension members with concrete,**
- **measurements of mass.**

APPLICATION

Type studies of electrical power posts of concrete, telecommunications towers and masts as well as check--up tests. Evaluations and opinions on products.

STUDIES OF CONSTRUCTION COMPOSITE MICROSTRUCTURE WITH THE USE OF COMPUTER MICROTOMOGRAPHY

RESEARCH

A non-destructive test with the use of a tabletop, high resolution micro-nano computer tomograph involves submitting the tested material to x-ray radiation resulting in a set of projections. This enables reconstruction of a three-dimensional image of the composite medium's microstructure with a resolution of up to 500 nm.

APPLICATION

Tests with a computer microtomograph allow qualitative and quantitative analysis of the morphology of the tested composite medium's microstructure. As a result, it is possible to identify microstructural measures including:

- **fraction shares of particular constituents (including open and closed porosity),**
- **density of particular constituents,**
- **statistical distributions (e.g. distribution of pores' sizes), functions of 1- and 2-point correlation, and 3D imaging of microstructure**
- **destruction mechanisms.**

STUDIES OF MODEL AND LIFE-SIZE SCALE PROTOTYPE SOLUTIONS

EVALUATION

Studies of models and life-size objects related to prototype solutions for constructions or construction components.

STUDIES USING NUMERICAL MODELS. EVALUATION OF STRUCTURES' EFFORT

EVALUATION

Numerical analyses of concrete, reinforced concrete and prestressed structures. Evaluation of structures' effort.

NON-DESTRUCTIVE TESTING OF CONSTRUCTION MATERIALS AND COMPONENTS

RESEARCH

Non-destructive laboratory and in-situ tests of construction materials and components:

- **studies of concrete with the ultrasonic method, studies of concrete with a sclerometer,**
- **studies of concretes' resistance to compression with the pull-out method,**
- **evaluation of concretes' resistance to compression with a sclerometer,**
- **evaluation of concretes' resistance to compression in structures and precast concrete products, studies of concretes' and finishing layers' resistance to tear-off with the pull-out method,**
- **studies of construction materials' humidity with non-destructive methods,**
- **studies of reinforcement arrangements in a structure with the electromagnetic method,**
- **studies of surface morphology with the 3D laser scanning method,**
- **studies of concrete and location of faults in concrete elements with the impulse-response method,**
- **studies of concrete and location of faults in concrete elements with the impulse-echo method,**
- **studies of concrete and location of faults in concrete elements with the ultrasonic tomography method.**

APPLICATION

Comprehensive studies, technical evaluations and reports on civil structure's technical condition Non-destructive tests of materials and structures. Reinforcing buildings and brick, wooden as well as reinforced concrete system structures. Evaluation of usefulness and efficiency of anti-damp protection methods applied in civil structures. Evaluation of the methods of researching construction materials; methodology of humidity tests. Evaluation of the efficiency of forced drying of damp brick walls.

FIELD TESTING OF HYDROTECHNICAL AND TRANSPORT FACILITIES (BRIDGES AND CULVERTS)

RESEARCH

- **hydrometric measurements, including measurements of speed and water flow rate in natural watercourses and canals,**
- **hydraulic studies of sewage treatment facilities,**
- **non-destructive tests of concrete and steel hydrotechnical structures,**
- **measurements of dislocations and deformations and completion surveys of various engineering, particularly hydrotechnical structures,**
- **geodesic and photogrammetric survey aiming to determine hydrotechnical structures' safety.**

APPLICATION

The studies enable determination of loads and operational conditions of hydrotechnical structures under design, as well as establishing existing structures' technical condition and evaluating their safety, and verifying the scope of necessary maintenance or repair works.

STUDIES OF IMPACT SOUND LEVELS

RESEARCH

Studies of weighted normalised impact sound pressure level L'n,w and the weighted standardised impact sound pressure level L'nT in 1/3 octave ranges - the field measurement method in diffuse field conditions. Determination of weighted normalised impact sound pressure level (L'n,w) index and the weighted standardised impact sound pressure level (L'nT) index, as well as the spectrum adaptation term CI. Research in compliance with standards PN-EN ISO 140-7:2000, PN-EN ISO 140-14:2006 and PN-EN ISO 717-2:2013-08.

APPLICATION

Evaluation of compliance with regulations and standards of acoustic insulating power of barriers in existing buildings, including PN-B-02151-3:2015-10 standard.

STUDIES OF PRECAST STRUCTURAL CONCRETE UNITS

RESEARCH

Analyses of of precast concrete products for which harmonised technical specifications have not been determined. The following studies are performed:

- **dimensions and surface characteristics,**
- **resistance to compression, bending and torsion, location and sheathing of construction steel and tension members with concrete, measurements of mass.**

APPLICATION

Analyses of precast concrete products for which harmonised technical specifications have not been determined. Evaluations and opinions on products.

STUDIES OF CEMENT SAMPLES

RESEARCH

Analyses of cement samples - studies of cements' resistance to compression.

APPLICATION

Test check-ups of cement batches. Evaluations and opinions.

STUDIES OF METAL AND STEEL SAMPLES FOR CONCRETE REINFORCEMENT AND PRESTRESSING

RESEARCH

- **tension test in ambient temperature to determine mechanical properties such as conventional plasticity limit, upper plasticity limit, resistance to tension, total and unit elongation with maximum force,**
- **bending test where susceptibility to plastic deformations is evaluated when bending the sample by 180 degrees.**

APPLICATION

Test check-ups of steel rod and section steel. Evaluations and opinions on products.

STUDIES OF MORTAR SAMPLES

RESEARCH

Analyses of regular mortars, wall mortars, materials for blind floors, mortars for tail pointing and repair mortars. The following studies are performed:

- **resistance to compression,**
- **resistance to bending,**
- **absorbability with the weight method,**
- **humidity with the weight method,**
- **bulk density with the weight-volume method,**
- **contraction by measurement of linear changes to queen closures,**
- **adherence to the base by tearing off a disk from the base with a DYNA Z-16E dynamometer.**

APPLICATION

Type tests of sacked mortar, test check-ups. Evaluations and opinions on products.

STUDIES OF PIPES AND FITTINGS OF NON-REINFORCED CONCRETE, STEEL FIBRE CONCRETE AND REINFORCED CONCRETE

RESEARCH

- **dimensions and surface characteristics,**
- **resistance to crushing,**
- **resistance to longitudinal bending moment,**
- **concrete pipes' resistance to squeeze-through,**
- **location and sheathing of construction steel and tension members with concrete,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF CONCRETE LIGHTING POSTS

RESEARCH

- **dimensions and surface characteristics, resistance of a post measuring 40.0 m in length to bending,**
- **resistance of a post measuring 40.0 m in length to torsion,**
- **resistance to impact,**
- **location and sheathing of construction steel and tension members with concrete,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF MANHOLES AND WELLS USED FOR OTHER PURPOSES MADE OF NON-REINFORCED, STEEL FIBRE AND REINFORCED CONCRETE

RESEARCH

- **dimensions and surface characteristics**
- **resistance to crushing,**
- **resistance to vertical loads,**
- **strength of manhole step irons' mounting,**
- **location and sheathing of construction steel with concrete,**
- **measurement of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF RAILWAY AND TRAMWAY TRACK GEOMETRY

RESEARCH

- **measurements of track width (spot and continuous metering), measurements of track superelevation, measurements of vertical and horizontal irregularities of rails,**
- **measurements of weld and joint straightness,**
- **measurements of vertical and lateral wear of rails and frogs,**
- **measurements of corrugations of rail's rolling surface.**

APPLICATION

Diagnostics of railway and tramway tracks, identification of areas and sections of the track requiring immediate repair.

FIELD STUDIES OF MATERIALS AND COMPONENTS OF BRIDGE INFRASTRUCTURE

RESEARCH

- **acceptance tests of bridge structures, including test loads,**
- **studies of bridge structures' technical condition, evaluation of degradation state based on inspections of steel corrosion progress, chemical threat, scratching, deformations and other types of damage,**
- **studies of paint coat's thickness and efficiency, evaluation of concrete strength in structures with a non-destructive method (sclerometry),**
- **studies of concrete strength in structures with the Pull Out method,**
- **studies of concrete strength in structures with the Pull Off method,**
- **studies of deformations and technical condition of special structures, e.g. soil-shell structures,**
- **continuous measurements related to the condition of bridge structures with the use of apparatuses installed on the structure (monitoring).**

APPLICATION

Evaluation of existing structures' technical condition, in the context of decisions on maintenance strategies. Special inspections of engineering structures and other evaluation works.

FIELD STUDIES OF THE RAIL TRACK SUBSTRUCTURE

RESEARCH

- **measurements of primary and secondary deformation module of track substructure with the VSS static plate method,**
- **measurements of the dynamic deformation module of track substructure with the dynamic plate method,**
- **measurements of track substructure vibrations (displacements and accelerations) caused by railway traffic and a rotary exciter.**

APPLICATION

Evaluation of mechanical properties and load capacity of track substructure soil. Monitoring of track substructure concentration with indicator methods. Design of track substructure reinforcement layers. Evaluation of track substructure vibrations' propagation and harmfulness.

STUDIES OF BUILDINGS WITH THE USE OF THERMOVISION

RESEARCH

- **thermal vision measurements of buildings: exterior walls, balcony-wall joints, roofs, slab roofs; evaluation of the quality of thermal insulation; studies of heated floors, etc.; identification of linear and single-point thermal bridges,**
- **studies of defects caused by a lack of thermal insulation, moistness of materials or excessive air infiltration**
- **studies of historical buildings for purposes including identification of materials built into barriers in different times,**
- **detection of the location of water pipes inside walls and in**
- **floors, as well as location of failures in water pipes inside walls and floors,**
- **studies of heat distribution and water supply networks, studies of central heating installations, inspection of devices' operation correctness.**

APPLICATION

Detection of faults in thermal insulation: excessive air infiltration, wall moistness, failures of central heating installations; location of thermal bridges, etc. Studies of buildings which have undergone thermal modernisation.

STUDIES OF THE TECHNICAL CONDITION (AS SERVICE OR EVALUATION) OF LINEAR AND ENCLOSED UNDERGROUND INFRASTRUCTURE STRUCTURES

RESEARCH

- **video inspection of pipelines,**
- **3D inspection of pipelines of a circular section,**
- **studies of leaktightness of joints, service pipes and pipelines' sections,**
- **studies of concretes' resistance to compression with the pull-out method,**
- **studies of concretes' resistance to tension and adherence of layers coated on concrete with pull-off method,**
- **non-destructive defectoscopy of concrete with the IMPACT ECHO method; non-destructive thickness measurement of concrete slab elements accessible only from one side, non-invasive determination of the diameter and spacing of reinforcement and sheathing thickness,**
- **measurement of construction materials' humidity with the microwave method,**
- **inspection and studies of the technical condition of hard-to-reach areas of structures and devices with the use of a borescope,**
- **studies of concrete elements' strength with the use of Schmidt's hammer,**
- **studies of the leaktightness of hardened CIPP sleeves, studies of pipe construction materials' and reinforcing lining's elasticity module,**
- **studies of pipes' perimeter rigidity and resistance to crushing,**
- **measurement of changes to crack width with the use of feeler gauges, determination of steel elements' thickness with the use of an ultrasonic thickness gauge.**

APPLICATION

Studies of existing network infrastructure structures in terms of evaluation of their technical condition and development of solutions to failures. Studies of enclosed structures related to water supply and sewage systems in terms of evaluation of their technical condition and development of solutions to failures. Non-destructive studies of materials and constructions.

STUDIES OF THERMAL PROPERTIES OF GEOMATERIALS WITH THE USE OF A NEEDLE PROBE

RESEARCH

Studies with the use of a KD2Pro meter made by decagon Devices. Application of appropriate sensors enables determination of the following thermal properties: thermal conductivity coefficient, specific heat.

APPLICATION

The study is applied to determine thermal parameters of materials' such as concretes, soils, and certain liquids and suspensions.

STUDIES OF THE PROPERTIES OF MICROSTRUCTURAL COMPOSITES AND DETERMINATION OF THEIR MACROSCOPIC PARAMETERS

EVALUATION

Studies of of heterogeneous materials (including composites) in a nanohardness tester - along with development and analysis of results. Such studies may be used to test the effectiveness of admixtures in concrete or to research biocomposites' properties. Additionally, studies of materials in a high resolution computer microtomograph are performed. Analysis of a digitally reconstructed microstructure enables determination of its basic geometrical measures, including fraction shares in particular constituents (porosity) or static distributions of sizes, including pores' sizes, or their shape coefficient. An in-depth analysis of this non-destructive test enables evaluation of the quality of glued joints (adhesion rate, coarseness of surfaces joined) or determination of advanced measures of microstructures' geometry applied to identify composites' effective parameters (1- and 2- point correlation functions).

STUDIES OF SEWER INLETS IN BUILDINGS

RESEARCH

- **dimensions and surface characteristics, static load,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF WELDED MESH FOR CONCRETE REINFORCEMENT

RESEARCH

- **tension test in ambient temperature to determine mechanical properties such as conventional plasticity limit, upper plasticity limit, resistance to tension, unit elongation, total elongation with maximum force,**
- **bending test to evaluate susceptibility to plastic deformations in sample bending time by 180 degrees,**
- **shearing test where the force shearing the welded joint is determined.**

APPLICATION

Test check-ups. Evaluations and opinions on products.

STUDIES OF INSPECTION CHAMBER AND INLET CAPPINGS FOR PEDESTRIAN AND ROAD TRAFFIC PAVEMENTS

RESEARCH

- **dimensions and surface characteristics, static load,**
- **measurements of mass.**

APPLICATION

Type studies and check-ups. Evaluations and opinions on products.

STUDIES OF THE IMPACT OF TURBULENCES ON THE HYDRAULIC BEHAVIOUR OF FLOWS ON OPEN CHANNELS

RESEARCH

Hydraulic conditions can be simulated with considerable accuracy with the use of models and laboratory canals, which enables precise measurement of various physical phenomena. They are performed with an appropriate probe allowing tests of turbulence parameters affecting the ecosystem, hydrotechnical structures' safety, etc.

APPLICATION

The contemporary requirements of development and maintenance of river beds, regulated by the EU Water Framework Directive, are closely related to ensuring a proper condition of the water-land ecosystem comprising a water body or watercourse with its valley. The above requirements can be analysed, understood and met thanks to such studies.

THERMAL DIAGNOSTICS OF BUILDINGS

EVALUATION

- **studies of buildings with the use of thermovision,**
- **thermal and humidity diagnostics of wall barriers, separating heated cubage of buildings serving different purposes,**
- **studies of physical, chemical and biological corrosion of materials and wall barriers,**
- **measurements of thermal resistance of wall barriers in real-life conditions.**

IDENTIFICATION OF THE PARAMETERS OF MECHANICAL COMPONENTS OF COMPOSITE MATERIALS' MICROSTRUCTURE WITH THE USE OF THE NANOINDENTER

RESEARCH

Studies with the use of the nanoindenter involve forcing a diamond intender tool into the material inspected while measuring the force and dislocation values. The device enables setting parameters of load change shifts, pause duration, penetration depth, as well as it makes it possible to define force increment models: single-cycle, multi-cycle with a possibility of choosing consecutive load values and pause durations, linear force increment, or square increment. The sample under study is first fused in resin in a negative pressure chamber. The sample's surface, the so-called microsection, is prepared with the use of a grinder-polisher. The last stage of preparation entails cleaning the sample in an ultrasonic washer operating at 45 kHz, 120 W.

APPLICATION

Studies in the nanoindenter enable evaluation of the elasticity, creep and relaxation modules, as well as hardness of the constituents making up the composite material's microstructure. Additionally, it allows identification of the microstructure constituents' work of elasticity and plasticity.

TRAFFIC ENGINEERING AND DESIGN OF ROADS, STREETS AND INTERCHANGES

EVALUATION

Evaluations of traffic conditions and modelling. Analysis of vehicle traffic intensity and forecasting its changes. Evaluation of the correctness of design and execution of road and airport infrastructure elements. Analyses of shaping public transport and mobility in urban agglomerations. Evaluation of vehicle and pedestrian traffic safety. Development of designs in the area of geometrical solutions for roads, streets, intersections and interchanges.

THERMAL INSULATING POWER OF WALL BARRIERS

RESEARCH

- **measurements of heat resistance of wall barriers in real-life conditions (in existing buildings) with the use of the Hukseflux TRSYS01 set (measurement of air temperature on both sides of a barrier and on its boundary surfaces as well as measurement of density of the heat stream penetrating through a barrier; calculations of barriers' heat resistance).**
- **measurements of meteorological data with the use of a Davis weather station, including actinometrical data,**
- **measurements of wall barriers' heat resistance in climatic chambers, with set thermal and humidity parameters.**

APPLICATION

Analysis of of thermal insulating power of wall barriers. Measurements of thermal resistance of existing wall barriers. Measurements of thermal resistance of wall barriers in climatic chambers. Measurements of meteorological and actinometrical data. Evaluations and opinions in the field described above.

HUMAN VISUAL COMFORT IN ROOMS

RESEARCH

- **measurements of day light intensity in rooms, measurements of artificial light intensity with the use of the Sonopan L-100 luxmeter.**
- **simulations of day light intensity distribution in a room with the use of the DesignBuilder software.**

APPLICATION

Analysis of human visual comfort in rooms - measurements of day and artificial light intensity; computer simulations. Evaluation of correctness of architectural solutions in terms of ensuring visual comfort in buildings serving various purposes.

COMPUTER MODELLING OF COMPLEX HISTORIC ARCHITECTURAL STRUCTURES

RESEARCH

Analysis of geometrically complex historical wall structures in static-strength terms. First and foremost, the analysis entails tension-deformation characteristics in complex tension states. When evaluating such structures' load capacity, a numerical model is developed allowing identification of mechanical states. Depending on the required level of accuracy, the analysis can be performed on micro or macro levels. As a result of the analysis performed, the method of structure reinforcement and the load capacity of structures reinforced with composite materials are determined.

APPLICATION

Determination of load capacity and permissible dislocations of vaults, pillars, posts, walls and rafter framings in structures, including historical ones, with the use of appropriate numerical FEM models. Presentation of methods of structure reinforcement with the use of composite materials and possible reconstruction solutions.

LABORATORY STUDIES OF SOILS

RESEARCH

Studies of the following geotechnical parameters of natural, made and organic soils:

- **resistance to shearing in a 3-axial compression and direct shearing apparatuses,**
- **resistance to compression in a 1-axial stress state,**
- **deformability and consolidation in an oedometer and Rowe's consolidometer,**
- **swelling and free swelling pressures, basic physical properties,**
- **Atterberg limits,**
- **consolidation extent and coefficient,**
- **granulometric composition of soils, organic substance content,**
- **filtration coefficient with constant and variable hydraulic gradient.**

APPLICATION

Description of soils; determination of geotechnical parameters of subsoil, determination of mechanical parameters of soils, evaluation of soil material's compactibility; evaluation of load capacity and deformability of subsoil for construction purposes.

ROOM MICROCLIMATE AND HUMAN THERMAL COMFORT

RESEARCH

- **measurements of values characterising the microclimate of rooms (air temperature, average radiation temperature in rooms, operational temperature, relative humidity and air movement velocity), determination of combined indices of thermal loads,**
- **determination of thermal comfort indices.**

APPLICATION

Evaluation of correctness of rooms' microclimate in terms of of human comfort in residential and public utility buildings, and industrial facilities. Tests in buildings of various energy performance standards: i.e. standard, energy efficient, low energy and passive buildings.

NUMERICAL MODELLING OF THE ANNUAL THERMAL BALANCE OF BUILDINGS

RESEARCH

- **construction of a numerical model of a building with the use of computer software,**
- **calculations of a building's annual energy balance (simulation and balance calculation software),**
- **determination of energy efficiency of solutions applied (energy economy, thermal comfort, solar protection),**
- **calculations of a building's energy characteristics,**
- **calculations of linear coefficient of heat transfer for thermal bridges in critical detail sections, determination of mould risk and surface condensation risk in critical detail sections,**
- **calculations of windows' or doors' heat transfer coefficient in compliance with PN-EN ISO 10077.**

APPLICATION

Development of buildings' projected energy characteristics. Calculations of thermal bridges' linear heat transfer coefficient. Determination of mould risk and surface condensation risk in construction details. Calculations of the heat transfer coefficient U for windows and doors.

MODELLING OF THE SURFACE WATER FLOW

EVALUATION

- **in rivers and open canals for steady and unsteady motion (1D, 2D i 3D),**
- **modelling flood wave transformations - non-linear models based on St. Venant's 1D and 2D equations,**
- **determination of hydrodynamic loads with the use of numerical (3D) models,**
- **modelling of water flows and levels in natural and artificial flumes as well as in flood plains (with the use of the GIS method),**
- **modelling of flood hazard zones and modelling of rubble transport in rivers; development of flood risk and hazard maps,**
- **training on numerical modelling in hydrotechnics for young experts.**

MODELLING OF VIBRATIONS AND NOISE

RESEARCH

Monitoring of vibrations serves the purpose of measuring the level of dynamic impacts on buildings neighbouring a structure under development. The unit also carries out observations of the technical condition of civil structures. The purpose of the studies is to record the level of vibrations generated during geotechnical works. The results obtained are referred to values which are defined as safe by standards. The device applied for monitoring of specialist works is the Minimate Pro4 vibration and noise sensor and recorder.

APPLICATION

The measurements performed before the commencement of geotechnical works make it possible to observe what impact geotechnical works have on the environment, including buildings and people. Monitoring of vibrations enables exclusion of a risk of damage to buildings.

EVALUATION OF THE SAFETY OF STRUCTURES INTERACTING WITH SOIL

EVALUATION

Theoretical analyses related to structure-soil interaction. Construction designs are developed and evaluated in the area of foundation engineering, in terms of safety and failure risk assessment. The results of theoretical analyses may be used to design, optimise and properly operate structures founded in difficult conditions (soil and hydrology-wise), as well as to optimise structure foundation designs lacking standardised safety level guidelines.

EVALUATION OF PRECAST CONCRETE, REINFORCED CONCRETE AND PRESTRESSED COMPONENTS

EVALUATION

Evaluations related to precast concrete components' load capacity. Analysis in the area of geometry, reinforcement arrangement, sheathing, build quality, as well as ULS and SLS at the fitting and operation stages. Studies of prototype solutions, modelling and type studies, as well as studies related to certifications and approvals; studies of rod, flat and coating elements.

EVALUATION OF THE IMPACT OF BLAST-INDUCED ACCIDENTAL ACTIONS ON STRUCTURES

EVALUATION

Evaluations related to impacts and consequences of accidental loads such as: paraseismic and seismic loads, explosions in concrete structures, fires, floods and hurricanes. Evaluation of facilities' and structures' resistance to such impacts. Studies of failures and construction disasters in terms of materials and construction solutions.

EVALUATION OF THE SUBSOIL AND DETERMINATION OF PHYSICO-MECHANICAL PROPERTIES OF SOILS AND OTHER GEOMATERIALS

EVALUATION

- **detailed programming of field and laboratory studies of physical and mechanical properties of soils, made and dumping grounds, and debris,**
- **programming of studies of soils characterised by atypical behaviour, e.g. swelling, collapsibility and fluidisation,**
- **programming of studies conducted with the history of input force response,**
- **evaluation of study results, statistical reports and interpretation of results in terms of tasks specified by the ordering party,**
- **development of geotechnical documentation based on geotechnical studies carried out,**
- **evaluation and interpretation of geotechnical study results,**
- **determination of thermal properties of soils and other materials.**

EVALUATION OF RHEOLOGICAL DEFORMATIONS IN CONCRETE STRUCTURES

EVALUATION

Evaluations of long-term loads and rheological deformations related to concrete contraction and creep as well as steel relaxation. Evaluation of the results of contraction and creep during structure development and due to long-term loads. Evaluation of contraction and creep coefficient for set temperature and humidity-related parameters (e.g. in the axial compression test conducted for design purposes).

EVALUATION OF ULTIMATE LIMIT STATES, SCRATCHING AND DEFORMABILITY OF CONCRETE STRUCTURES. EVALUATION OF THE STATE OF FAILURE FREQUENCY AND REPAIRS OF STRUCTURES

EVALUATION

Evaluations of ultimate limit and serviceability states, failure frequency and repair status of enclosed industrial facilities, residential and public utility buildings, loose material silos, liquid containers, swimming pools, cooling towers, prestressed structures, smokestacks, masts, utility poles and other; underground and surface mining facilities as well as existing concrete structures under repair or reinforcement.

EVALUATION OF THE TECHNICAL CONDITION OF STRUCTURES WITH A REVITALISATION CONCEPT

EVALUATION

Evaluations of structures' ULS and SLS (mainly for industrial purposes) - in particular cooling towers, including mechanical draft cooling towers, and industrial smokestacks. Development of variant concepts of structure modernisation and construction. Analyses of the impact of dynamic loads on the structure and mechanical devices' operation.

EVALUATION OF THE HARMFULNESS OF VIBRATIONS TRANSFERRED FROM THE SOIL TO BUILDINGS

EVALUATION

Measurements and analysis of vibrations aiming to determine their harmfulness to buildings.

EVALUATION OF THE CONDITIONS OF GEOTECHNICAL STUDIES IN THE AREA OF SOLIS' SUITABILITY FOR THE FOUNDATION OF CIVIL AND ROAD STRUCTURES

RESEARCH

Evaluation of geotechnical conditions is carried out in the area of field studies of mineral, organic and made soils. Inspections of subsoil - bores (in piping) and dynamic probing of all types of soil. Apparatuses applied are as follows:

- **plate load tester allowing quick diagnosis of geotechnical parameters of subsoil in structural and road embankments,**
- **drilling set,**
- **set for borehole piping, light dynamic probe with a winch, ZFG set with complete accessories.**

Additionally, geological-engineering documentation is developed and evaluated. Other services delivered by the unit include opinions (incluing opinion for courts of law) concerning the suitability of land for structure foundations or necessary operations aiming to prepare land for foundation of structures. The

works are performed by staff qualified in geology, engineering and construction. The geology-engineering documentation developed at the unit can be a significant factor to a construction project at the stage of investment valuation.

APPLICATION

The field studies performed enable determination of the suitability of land for the needs of civil engineering and road construction. One of the most important applications of field studies is determination of subsoil properties. It particularly applies to reinforced or replaced soils.

EVALUATION OF THE IMPACT OF VIBRATIONS ON PEOPLE IN BUILDINGS

EVALUATION

Measurements and analysis of vibrations are performed to determine their impact of people inside buildings.

EVALUATION OF TECHNICAL CONDITION

EVALUATION

Comprehensive evaluations of the technical condition of sewage and water supply ducts (CCTV inspections, studies of parameters of construction materials applied in ducts, evaluation of load capacity and safety status, guidance in relation to repair works, duct renovation projects). Evaluations of the technical condition of water supply and sewage facilities as well as other enclosed underground structures (studies of construction material parameters, evaluation of load capacity and safety, guidance in relation to repair works, and renovation projects).

EVALUATIONS OF THE TECHNICAL CONDITION OF CIVIL ENGINEERING AND INDUSTRIAL STRUCTURES INCLUDING HISTORICAL STRUCTURES

EVALUATION

- **evaluations of civil structures' technical condition including determination of the degree of technical wear,**
- **verification of ULS and SLS of existing structures, also related to projected modernisation works (redevelopment and conversion projects, etc.),**
- **determination of the impact of deep excavation on neighbouring development, along with guidance concerning monitoring during construction works,**
- **design of repairs as well as reinforcement and protection solutions for damaged civil structures.**

DETERMINATION OF MODAL DYNAMIC PROPERTIES OF CONSTRUCTIONS AND STRUCTURES

EVALUATION

Application of EMA and OMA in experimental determination of dynamic modal characteristics of structures: frequency and modal forms, as well as modal attenuation.

OPINIONS FOR COURTS OF LAW IN THE AREA OF CONSTRUCTION ACOUSTICS

EVALUATION

Opinions for courts of law in the area of barriers' acoustic insulating power involve:

- **evaluation of compliance and insulation power,**
- **resources necessary to ensure compliance with requirements.**

MEASUREMENTS OF VIBRATIONS TRANSFERRED FROM THE SOIL TO BUILDINGS

RESEARCH

Studies of velocity and acceleration of vertical and horizontal vibrations in 1/3 octave ranges. Studies compliant with standards including PN-88/B-02171.

APPLICATION

Evaluation of soil vibrations occurring at the site of a planned construction project, performed to design appropriate protection of the building against the vibrations; possible vibration sources include roads, underground and surface railway lines, etc.

INCLINOMETRIC MEASUREMENTS

RESEARCH

Inclinometric measurements in set-up measurement points along with interpretation of results. Setting up measurement points in retaining structures (closed sections welded to steel elements and inclinometer pipes mounted to reinforcement) and in boreholes. An inclinometry set-up with a probe (made by SISGEO) is used to conduct the measurements.

APPLICATION

Based on inclinometric measurements, it is possible to evaluate sizes of deformations in retaining structures, the extent of an excavation's impact, and construction performance. They also allow location of slip areas, as well as the reach and directions of dislocations which the landslip is undergoing. They serve to determine deformations of the construction embankment's body. They indicate values of structures' deformations or dislocation of soil in places which are „invisible" to geodesic measurements.

DEVELOPMENT OF COMPUTER SOFTWARE

EVALUATION

Development of computer software supporting evaluation and project works, complex engineering constructions in particular.

DESIGN OF ACOUSTICS FOR THEATRE AND OPERA HALLS, AND AUDIO PRODUCTION STUDIOS

EVALUATION

Development of guidance in the area of room acoustics for architectural and construction designs of facilities including:

- **auditoria,**
- **drama and music theatres, concert and opera halls, assembly halls,**
- **acoustic measurement laboratories, schools of music,**
- **cinema screening rooms,**
- **recording studios, classrooms.**

NOISE PROTECTION DESIGN IN ROOMS AND BUILDINGS

EVALUATION

Development of guidance in relation to protection against noise for architectural and construction designs of facilities including:

- **auditoria,**
- **drama and music theatres, concert and opera halls, assembly halls,**
- **acoustic measurement laboratories, schools of music,**
- **cinema screening rooms,**
- **recording studios, classrooms.**

DESIGN AND SAFETY OF HYDROTECHNICAL STRUCTURES

EVALUATION

- **verification and selection of optimal solutions for hydrotechnical or transport facilities under design or redevelopment,**
- **comprehensive evaluation of hydrotechnical facilities' technical condition and safety,**
- **modelling of surface water flows in rivers and canals for for steady and unsteady motion (1D, 2D i 3D), as well as modelling of rubble transport,**
- **modelling flood wave transformations - non-linear models based on St. Venant's 1D and 2D equations,**
- **analysis and evaluation of consequences of dams and other hydrotechnical structures disasters,**
- **modelling of flood threat areas, development of flood risk and threat maps, development of geodesic documentation based on field measurements, development of numerical models of terrain and spatial information systems (GIS).**

CIVIL AND ROAD STRUCTURE FOUNDATION DESIGN

EVALUATION

Design of the foundation of structures in difficult geotechnical conditions, involving complicated soil structure, impacts of dynamic loads, or in areas experiencing mining activity impacts. Also designed are reinforcement solutions for foundations with the use of advanced technologies, i.e. stream injections (jet-grouting), micropiles, as well as dislocation and bored piles. Additionally, designs of steening can be developed along with a 3D analysis, with the use of the sheeting and cavity walls technologies. Available measurement techniques enable evaluation of the foundation reinforcement executed and repair methodology recommendations.

The designs and evaluations developed may be applied for investment costing purposes and constitute an independent opinion on contentious issues related to a construction project. Professional software is used for numerical calculations related to foundation engineering.

REINFORCEMENT ADHESION IN STRUCTURES SUBMITTED TO CYCLIC LOADS

EVALUATION

Evaluations of structures' durability and reinforcement anchorage and adhesion in structures submitted to cyclic and dynamic loads. Evaluation of the impact of load levels on changes to adhesion.

IDENTIFICATION OF SOIL PARAMETERS WITH FIELD METHODS

RESEARCH

- **static probing with CPTU probes - depths of up to 25 m and with SCPTU probes - depths of up to 15 m, with real-time measurement recording,**
- **penetration drilling - depths of up to 20 m, with spiral rods of 80 mm in diameter,**
- **penetration drilling - depths of up to 6 m, with light manual sets and mechanically propelled sets,**
- **collecting of B and C type soil samples when drilling as well as A type samples with the use of a downhole probe,**
- **dynamic probing with DPSH and DPH probes - depths of up to 20 m.**
- **dynamic probing with SL and SD-10 mechanically propelled probes - depths of up to 6 m.**
- **tests of the state of surface water concentration with an SL probe with a load plate or an SD-10 probe with a small conical tip,**
- **measurements of the piezometric level and porous pressure of water during static probing.**

The studies are performed in accordance with the procedures specified in the Eurocode 7 PN-EN 1997-2:2009, Polish standrads PN-B-04452:2002, PN-B-04481:1988 i PN-EN ISO 14688, as well as the English BS 1377, the German DIN 4094, and the American ASTM:C D 4547-93 standards.

APPLICATION

Description of soils' macroscopic properties during drilling; evaluation of a soil profile along with collection of soil samples; determination of physical and mechanical properties of subsoil in-situ through static CPTU probing and probing with seismic SCPTU module; evaluation of the state of consolidation and consistence of virgin and made soils with in-situ field methods; evaluation of soils in deposit soils' suitability for earthworks; evaluation of embankments' state of consolidation.

NUMERICAL SIMULATIONS OF STRUCTURE BEHAVIOUR. EVALUATION OF STRUCTURES' SAFETY

EVALUATION

- **determination of deformation and stress states inside structures as well as subsoil and bedrock,**
- **evaluations of the effort of structure elements embedded in soil,**
- **evaluation of the stability of geotechnical structure, determination of ground water filtration states (stationary and non-stationary issues).**

2D and 3D analyses are performed with the use the finite elements method (FEM) and the finite volume method (FVM). Application of advanced computation software such as Flac, Flac3D, ZSoil and FlexPDE enables analysis of linear and non-linear issues. Thanks to the above, materials' characteristics such as strength (or more generally: plasticity) are allowed for in the calculations. It also allows resolving the issue of flow through partly saturated media. Moreover, application of appropriate theories of coupling of field quantities makes it possible to allow for factors including the impact of temperature changes on structures' deformation and effort and the influence of variable filtration conditions on a given structure's subsidence or stability.

ACTIVE THERMOGRAPHY

RESEARCH

- **identification of shallow material inclusions occurring in wall barriers or building elements, with the use of a thermovision camera and infra-red radiators,**
- **location of material heterogeneity in barriers or building elements with the use of active thermography in laboratory tests conducted in climatic chambers (chamber no. 1, capacity: 30 m3, temperature range: from –30 °C to +80 °C, relative air humidity: 10 to 95%, chamber no. 2: capacity: 30 m3, temperature range: -45 °C to +85 °C, relative air humidity: 10 to 95%),**
- **studies of historical building's walls.**

APPLICATION

Location of material inclusions in wall barriers or structural elements in the form of: air voids, reinforcement rods, rebuilds, and materials of thermal parameters other than homogeneous area. Non-destructive tests of historical structures.

RADIATION PROPERTIES OF CONSTRUCTION MATERIALS' EXTERNAL SURFACES

RESEARCH

- **measurements of solar radiation (wavelength: 0.3-3.0 µm) and longwave radiation of immediate environment (wavelength: 3.0-100.0 µm),**
- **measurements of the absorption coefficient (a) for solar radiation and the emissivity coefficient (ε) for longwave radiation, studies of these characteristics' stability in time.**
- **monitoring and evaluation of the extent of roofs' external surface heating for various coating materials,**
- **evaluation of the extent of interiors' heat gains decrease in summer (interiors such as industrial sheds, supermarkets, etc.),**
- **monitoring and evaluation of microclimate parameters in summer in select interiors with slab roofs.**

APPLICATION

Studies of the impact of coating materials on heat gain decrease in summer. Impact on microclimate and heat comfort parameters.

REINFORCEMENT OF CONCRETE, REINFORCED CONCRETE AND PRESTRESSED CONCRETE STRUCTURES

EVALUATION

Reinforcement of statically and dynamically loaded concrete, reinforced concrete and prestressed concrete structures with traditional and modern methods.

ANALYSIS OF PARALLELLY PROCESSED LARGE DATA SETS (MapReduce, BSP)

RESEARCH

Analysis of large data sets (Big Data) is associated with rapid development of new IT technologies for processing large data sets and development of knowledge extraction methods and algorithms for large data sets. Measuring and monitoring equipment as well as devices connected to the Internet and social media generate huge amounts of data, whose processing poses a new challenge for science and practice. One of such analytical techniques is parallel processing, a form of performing calculations in which multiple instructions are executed simultaneously.

APPLICATION

Analysis of large data sets is a process aimed at obtaining useful knowledge from databases. These types of technologies are used wherever a relation between phenomena is sought. Data mining methods can be used in many areas of life, such as business applications, medical diagnostics, meteorology, or every field of business or science in which large amounts of data are collected and examined.

ANALYSIS OF THE DYNAMICS OF COMPLEX, MULTIDIMENSIONAL AND MULTI-LAYERED NETWORKS

RESEARCH

Modelling of complex systems, which can distinguish interrelated components with a set input and output is associated with identification of individual elements while taking into account the complex relationships between them.

APPLICATION

The ability to simultaneously analyse different networks, e.g. those created from Facebook, Twitter, Instagram etc., in order to study complex processes and flows between different networks. An example would be an analysis of how an advertising campaign conducted on Facebook can propagate to other sites.

DATA ANALYSIS AND MINING

RESEARCH

Data mining, also known as knowledge discovery in databases or database mining, is the automatic discovery of non-trivial, hitherto unknown dependencies, relationships, similarities or trends – generally called patterns – in large data repositories. Patterns discovered in the process of data mining usually have the form of logical rules, classifiers (e.g. decision trees), cluster collections, charts, etc.

APPLICATION

The purpose of exploration, generally speaking, is the analysis of data and processes for greater knowledge and understanding of said data and processes. Automatic data mining opens up new possibilities in the area of user interaction with the database system and data warehouse.

ANALYSIS OF SOCIAL MEDIA

RESEARCH

Social media analysis contributes to avoiding emergencies, planning and evaluating the effectiveness of communication with customers, and helping in planning marketing strategies and long-term identification of the needs and opinions of the customers.

APPLICATION

Analysis of social media sites such as blogs, news sites, Wikipedia, microblogs (e.g. Twitter), social networking sites (e.g. Facebook, Google+), photo and video sites (e.g. YouTube, Instagram), discussion boards, in order to study the moods, needs and opinions among its customers, as well as the impact of the product on the Internet users.

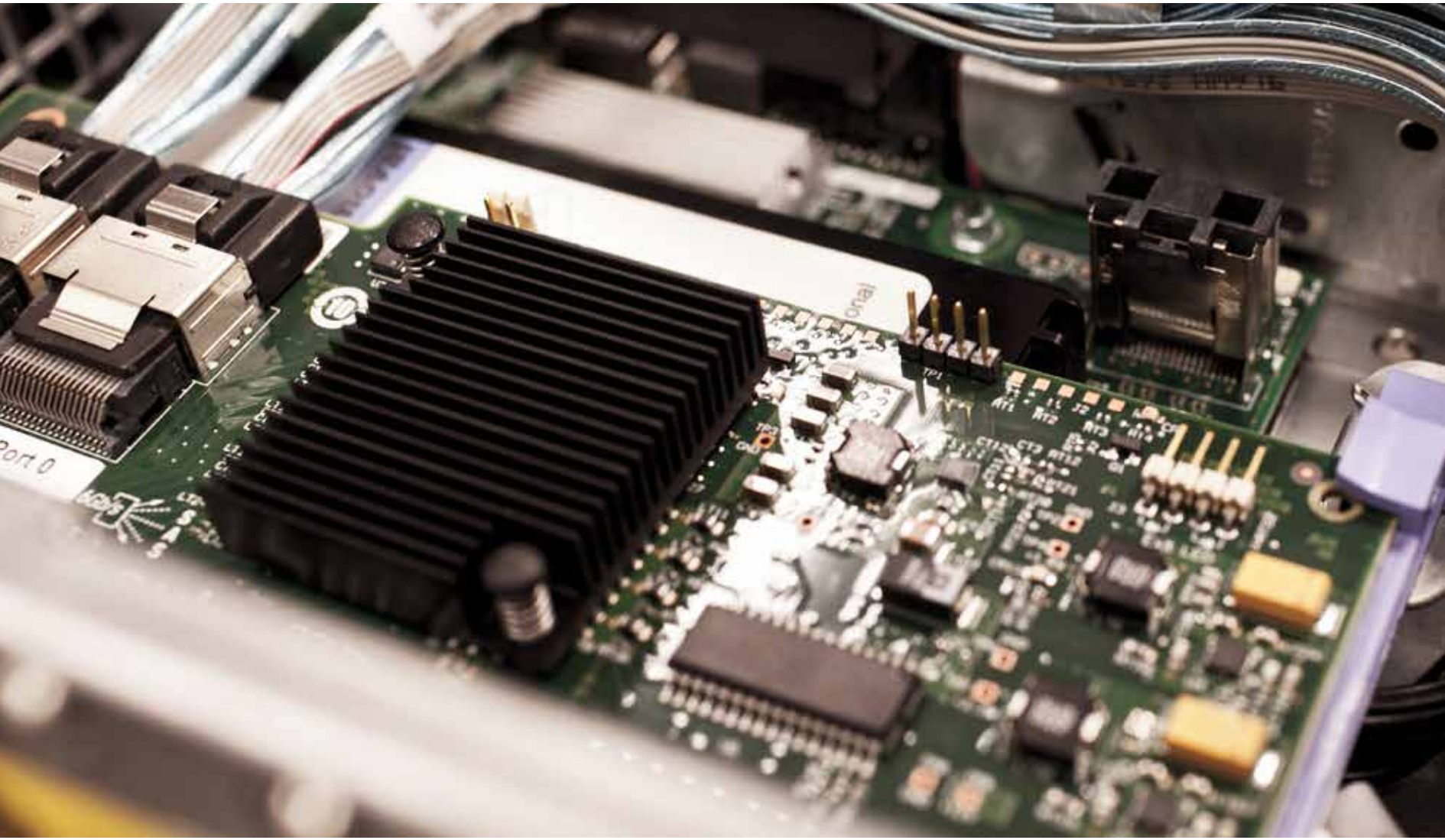
ANALYSIS OF OPINIONS, INCLUDING PROPAGATION OF OPINIONS AND INFORMATION

RESEARCH

Many micro-social processes, such as social impact, the flow of information or the spread of opinion, happen through social relations in interpersonal interactions. Patterns and structures of interaction and contacts are important for the spread (diffusion) of information, opinions and attitudes. The spread is a process in time, when the opinion is transmitted through specific channels of communication between members of a given social system. Analysis of patterns and structures is of paramount importance to the reach and speed of opinion dissemination.

APPLICATION

Identification of factors relevant to the speed and range of diffusion, such as identification of sources (seed selection), e.g. (on a tight budget) identification of persons and the order of their infection to maximise the range or speed of an advertising campaign. Blocking or limiting the spread, e.g. of rumours, negative opinions, viruses (natural or computer); when, for instance, we want to identify the key individuals who require inoculation to limit or stop the epidemic.



ANALYSIS OF SOCIAL NETWORKS, ANALYSIS OF SOCIAL GROUPS

RESEARCH

Social network analysis is a modern and increasingly popular tool which enables studying complex, i.e. multi-element and multi-level relationship structures between various types of social entities. This tool, which is rooted in the tradition of many disciplines (computer science, physics, mathematics, sociology, anthropology, chemistry, statistics, etc.) meets the challenges associated with the process of formation of the complicated structure of a network society and the creation of a knowledge-based economy.

APPLICATION

With the development of appropriate software, Social Network Analysis has become an important research tool, used not only in science but also in business – and in particular, in advisory services supporting various aspects of management; analysis of social media and customer trends; targeted advertising; the spread of information and opinions in customer networks; reducing customer retention; analysis of the behaviour and needs of customers.

ANALYSIS OF SENTIMENT, ATTITUDE AND EMOTIONS IN TEXT BASED DATA, SENTIWORDNET

RESEARCH

Sentiment analysis consists of identifying the emotional sentiment of a statement and classifying it into one of three categories – a statement can be positive, negative or neutral. The analysis is performed by specially designed computer software, while monitoring content found on the Internet.

APPLICATION

The results of sentiment analysis can serve as a basis for the evaluation of marketing campaigns, competitive benchmarking (comparing oneself to the competitors). Another application might be the study of the attitude of a community towards a product, brand or person (e.g. in politics). Surveying the community attitudes – including the definition of key words and phrases – allows us to determine which features of a product or person are perceived negatively, and thus improve quality management.

AUDIT OF HEALTH CARE CENTRES' COMPLIANCE WITH THE EXCHANGE OF ELECTRONIC MEDICAL DOCUMENTATION IN THE E-ZDROWIE NETWORK

EVALUATION

Auditing can be used for ICT integration, e.g. in the creation and sharing of Electronic Medical Documentation (initially, e-referrals, e-exemptions, e-prescription, e-orders) and further documents. Auditing examines the types and kinds of medical documents implemented in the unit system, their compliance with the standards and guidelines, and defines the scope of work to be carried out on part of the healthcare institution and the software provider.

AUTOMATIC SPEECH RECOGNITION

RESEARCH

Automatic speech recognition is a new quality in human-computer contact. It allows natural information input into the computer making it possible for the user to simultaneously perform other manual activities. Unfortunately, generally available software does not support speech recognition in Polish or it is impossible to apply it in certain domains of use or personalise it (adjust it to the user's speech characteristics). Hence the need for individual solutions suited to the user's needs and integration with the user's software. The technologies applied in speech recognition enable detection of specific speech errors, which may be helpful in fields including diagnostics of speech impediments in children, acquisition of foreign languages, assessment of the speaker's emotional state, etc. The unit employees' experience in this field facilitates quick creation of speech recognition systems with the use of own-developed software as well as available (paid and free of charge) tools, and their integration with the client's IT systems.

APPLICATION

- **automated conversation systems, e.g. call-centre type systems, shorthand development support,**
- **IT systems in medicine (using voice input for entering patient information),**
- **office work support systems (document dictation),**
- **teleconferencing systems (automation of conference report development),**
- **voice control,**
- **systems for surveillance and monitoring of people whose physical ability is decreased,**
- **support for blind people, support of the acquisition of the Polish language,**
- **automatic analysis of audio messages in the media.**

AUTOMATIC MONITORING OF THE SAFETY OF SENIOR AND/OR INVALID CITIZENS LIVING ON THEIR OWN

RESEARCH

The elderly who live alone are exposed to various dangers such as falls, asthma and heart attacks. The system, using a set of cameras and microphones installed in the apartment, can "observe" the behaviour of such a person on an ongoing basis (while respecting the right to privacy, not storing images and sounds beyond the required

minimum period of time necessary for the analysis of image sequences), and – depending on the automatically diagnosed danger – react appropriately by notifying the guardian or the emergency department. This diagnosis will be based on the analysis of the video signal (e.g. a dangerous fall), the audio signal (e.g. an asthma attack) or speech analysis (the monitored person's request for help).

APPLICATION

Monitoring people who live alone (or remain alone for long periods) in private homes. Care support system for people in institutions for senior citizens and nursing homes.

DEVELOPMENT OF KNOWLEDGE RESOURCES: LEXICAL SEMANTIC NETWORKS, ONTOLOGIES AND SETS OF TEXT WITH METADATA

RESEARCH

Large text collections may be the source of glossaries and formal semantic networks representing knowledge. Annotation is the process of describing the text using metadata, representing the language structures, content and references to knowledge regarding reality. The research makes use of vast experience in the construction of language resources and ontologies and annotated text corpora, such as PlWordNet – the world's largest bilingual Polish-English lexical semantic web, an enormous dictionary of Polish proper names, the great dictionary of multi-word expressions and WUST Corpora – a collection of Polish texts annotated on many levels. The developed systems support the work of large teams of linguists and annotators.

APPLICATION

Construction of ontologies (especially lexical ontologies) for different fields, as a basis for formalisation of knowledge and building Semantic Web-based systems. Improvement of semantic tagging, content indexing, developing methods of annotation and content analysis systems. Development of specialised tools for word processing or quality control of annotated text collections.

EVALUATIONS, ANALYSES AND CONSULTANCY IN THE FIELD OF BROADLY UNDERSTOOD IT AND TELEINFORMATICS

EVALUATION

- **opinions regarding the recognition of technological knowledge as a new technology within the meaning of Article 18b(2) of the Corporate Income Tax Act of 15 February 1992, pre-startup analysis of IT systems,**
- **analysis of informatisation, validation of concept and design assumptions for ICT technology deployments,**
- **analysis of user requirements, project evaluation and consultation and preparation of feasibility studies of IT systems,**
- **evaluation of technical bids for informatisation, assistance in the preparation of tender documents (ToR) in the area of developing requirements and criteria for IT and ICT system selection,**
- **comparative analysis of hardware and software IT solutions,**
- **development of decision support systems using intelligent methods and other optimisation techniques, among others, for problems associated with planning ICT networks, resource allocation, and the stages of the production process,**
- **design and deployment of Business Intelligence class systems,**
- **organisation of IT and ICT training.**

EVALUATIONS OF IT SYSTEMS AND TECHNOLOGIES

EVALUATION

Determination of IT system properties (structure, hardware, configuration, software, data processing algorithms, security procedures) and computer networks in terms of performance, reliability, validation, safety and efficiency. This allows you to issue opinions on the innovation of an IT system, or its design and deployment correctness. Providing recommendations for implementing changes.

KNOWLEDGE EXTRACTION FROM MASS DATA

TECHNOLOGY

Analysis of dependencies in large scale numerical data sets using statistical methods. Detection and description of dependencies. Software implementation of algorithms and procedures.

APPLICATION

Evaluation of preferences of customers of internet networks (shops, portals, etc.), analysis of the information flow in computer networks, analysis of medical data, detection of anomalies.

COMPUTER GRAPHICS AND IMAGE PROCESSING

RESEARCH

Research in the area of analysis, modelling and visualisation of 3D scenes. There are ongoing works in the field of data mining regarding: association rules, data clustering, predictive modelling, and applications of data mining methods in biomedical issues.

APPLICATION

Modelling and visualisation of 3D scenes. Analysis of large data sets for hidden dependencies.

SCHEDULING AND CONTROL IN TRANSPORT AND SERVICE SYSTEMS

RESEARCH

Application of IT tools, e.g. Matlab, Python, LINGO, Wonderware InTouch, Step7 MicroWin, S7 TIA Portal, PCAccess for:

- **analysis and visualisation of computer-modelled and actual control systems based on Siemens PLC drivers, PCs and Modbus, AS-i, Profibus networks,**
- **design, implementation and simulation of task scheduling algorithms, including heuristic and intelligent algorithms.**

APPLICATION

Scheduling and optimisation of production, service, and transport processes (the work of drivers, timetables and passenger/cargo transport schemes in road and rail transport). Designing and testing of human-machine interface systems based on Siemens PLC drivers (creating HMI using Wonderware InTouch for PC, implementation of HMI as a Web interface or in the form of a mobile application). Experimental evaluation of the effectiveness of intelligent control algorithms and scheduling.

INTEGRATION OF DATA AND KNOWLEDGE FROM AUTONOMOUS SOURCES

TECHNOLOGY

Knowledge management systems can use different kinds of data or knowledge sources, and in particular retrieve the data from external applications and databases. These sources may have a heterogeneous structure, for example object-oriented and relational databases. In such cases, combining them requires employing advanced methods and algorithms for data and knowledge integration, which will allow you to use them within a single coherent system. Data sources can also function independently of each other, which requires additional functionality to ensure the operation of an entire system. Such functionality includes appropriate communication protocols and integration methods for incomplete or inconsistent data and knowledge. Despite these additional requirements, the use of a system with autonomous data and knowledge sources increases the resistance of the system to unusual conditions and allows you to obtain new results in the application process.

APPLICATION

Integration and fusion of data from autonomous and heterogeneous sources. Inference based on knowledge from different sources. IT systems supporting knowledge management.

INTEGRATION AND MAPPING OF ONTOLOGIES

TECHNOLOGY

In business environments, there is an increasing need for integration of independent computer systems which enables the exchange of data used by these networks while ensuring their accuracy and consistency and independence of the source systems. Commonly used relational databases may not be sufficiently expressive and flexible, and the data to be stored in them is characterised by its size, as well as increasing diversity in terms of content and structure. One solution to the above problems may be the use of ontology, which is a method of knowledge representation in computer systems. It can be used in a very simplified form, containing only the hierarchy of certain concepts, as well as complex and semantically rich descriptions of the adopted area of expertise. Related issues that are of great practical importance are mapping methods (namely the determination of fragments of two ontologies, which refer to the same objects of a modelled segment of reality in the most similar manner), as well as their integration (namely algorithms which enable combining several independent ontologies into a single resulting ontology).

APPLICATION

Enterprises whose business is based on the frequent exchange of data with other enterprises. Enterprises using several independent computer systems, where communication is required not only on the physical data exchange, but also semantic knowledge exchange.

MULTI-LABEL CLASSIFICATION

RESEARCH

Multi-label classification refers to a situation in which each of the observed objects is described using explanatory variables and responses (usually binary) called labels. A model which allows label prediction for new objects described by certain features is developed based on learning data.

APPLICATION

Multi-label classification methods are used in such fields as: text categorisation, automatic annotation of images, genomics and many others.

BUSINESS MODELLING AND SYSTEM ANALYSIS

RESEARCH

Business modelling is the first stage in the manufacturing process of software systems designed to support business activities of enterprises.

It allows description and understanding of the context in which the system is meant to operate. It provides a basis to identify software requirements. In addition, business modelling allows improvement (reorganising) of existing business processes.

Analysis of the system follows the requirement identification phase. The result is the specification of

software requirements in terms of interaction scenarios, definitions of interface prototypes and information models. In this sense, specification can serve as a basis for design decisions, defining test cases, or writing user manuals.

APPLICATION

Development and evaluation of business models specified in the selected notations and modelling languages (e.g. BPMN, UML, OCL, ERD). Specifications and evaluation of business rules (e.g. RuleSpeak, SBVR, UML, OCL). Development and evaluation of analytical models specified in the selected notations and modelling languages (e.g. UML, OCL, SysML). Examination of compliance of analytical models with business models.

EVALUATION OF SOFTWARE AND TEST QUALITY, AND PREDICTION OF SOFTWARE FLAWS

RESEARCH

Recent advances in software engineering and artificial intelligence allow, among others, comprehensive assessment of selected aspects of software quality, the quality of unit testing (not limited to the degree of code coverage) and prediction of these variables in the area of software engineering (e.g. the number of defects in software within particular classes or methods, or effort associated with the project or its parts), whose prediction poses a challenge. For example, prediction of software flaws enables indication of places in the code which should be the focus of quality assurance activities, e.g. in the form of code reviews and thorough testing to minimise the number of flaws in the software supplied to the customer and reduce the time needed for testing. Using the most advanced software engineering and artificial intelligence solutions, and development of specialist tools in the form of mutation testers or prediction models allows you to achieve significant improvements in the quality of developed software and tests.

APPLICATION

Evaluation of software quality and testing; software quality improvement; prediction of, e.g. software flaws.

OPTIMISATION AND AUTOMATION OF INDUSTRIAL PROCESSES

RESEARCH

Every industry has production processes and problems which are solved by people, but can be automated. Examples of such problems include: designing production lines, supervision of industrial processes which require expert knowledge, and elimination of bottlenecks in the production process. All these problems can be solved by developing an appropriate calculation model, and then solving the task (e.g. designing a production line) using artificial intelligence methods.

Solutions to complicated problems occurring in industry proposed by artificial intelligence methods are usually of much higher quality than those proposed by humans. This allows a significant increase in enterprise performance and reduction of its costs.

APPLICATION

Applications are possible in enterprises which are ready for automation and optimisation of the manufacturing process at the production and logistics stages. The proposed methods not only accelerate and reduce the cost of the planning process, but also have a positive impact on the manufacturing process itself by indicating potential areas of cost optimisation within the enterprise.

OPTIMISATION AND AUTOMATION OF COMPANIES' PLANNING PROCESSES

RESEARCH

In each enterprise, prior production planning based on customer orders or production volume assumed to be reached at a certain time is necessary. The use of any resources (machines, people, premises, etc.) may be subject to planning. The production plan must take various constraints into consideration, e.g. time, raw materials available, possible temporary exemptions of certain machines or people from the production process. The nature of planning issues (a huge number of possible solutions and a large number of factors affecting the acceptability of the plan) results in people not being able to solve them in an effective manner. The quality and execution time of a given plan will always be better when supported by automatic scheduling methods.

With the support of automated methods, the planner's task work time will decrease significantly, the enterprise efficiency will increase (better quality of the plan), and so will the resilience to crises (e.g. it is easier to substitute ill planners if their work is automated).

APPLICATION

Applications are possible in enterprises which are ready for automation and optimisation of the manufacturing process at the production and logistics stages. The proposed methods not only accelerate and reduce the cost of the planning process, but also have a positive impact on the manufacturing process itself by indicating potential areas of cost optimisation within the enterprise.

OPTIMISATION AND AUTOMATION OF TASKS IN WAREHOUSING SYSTEMS

RESEARCH

In producing enterprises, warehouse management is key. Current WMS systems (Warehouse Management System) have built-in algorithms for warehouse management. For various reasons, especially in large enterprises, they can prove insufficient, e.g. if the factory has several warehouses in remote locations. In addition, artificial intelligence methods taking the download history from the store and current production plan into account, which also have a sufficient computational model, can significantly reduce the average time of downloads. By reducing the download and upload time of material to the warehouse, the optimisation methods offered reduce the enterprise operating costs and increase the efficiency of the warehouse.

APPLICATION

Applications are possible in enterprises which are ready for automation and optimisation of the manufacturing process at the production and logistics stages. The proposed methods not only accelerate and reduce the cost of the planning process, but also have a positive impact on the manufacturing process itself by indicating potential areas of cost optimisation within the enterprise.

BASIC LANGUAGE TOOLS AND RESOURCES FOR THE POLISH LANGUAGE

RESEARCH

The key to processing text information is the use of language technology, i.e. resources and language tools – knowledge bases and programs for the analysis of linguistic expressions. CLARIN-PL Language Technology Centre is developing a publicly accessible system of basic Polish language tools and resources released on open source licenses. They can be combined with other solutions for the Polish language for an even richer process of analysis of Polish text and speech. It allows you to switch from text to formalised representation, which can be further processed within IT systems. Among other things, language technology enables recognition of words and their grammatical properties, grammatical functions performed by particular words in the text, partial recognition of the syntactic structure of sentences, analysis of the meaning of words, recognition of proper names and their semantic classes. Analysis of the meaning of words is based on the largest publicly available dictionary of the Polish language called plWordNet (www.plwordnet.pwr.edu.pl) – a formalised lexical semantic network. Thanks to being projected onto Princeton WordNet for English, plWordNet is also the largest Polish-English dictionary available.

APPLICATION

Language resources and tools can be used in text processing systems. They have already been used in systems for information retrieval and extraction, question answering, classification and grouping of educational texts, indexing text collections, etc. It is possible to customise and extend the language tools for specific needs. PlWordNet provides opportunities for bilingual (Polish-English) applications, e.g. it is already being used in the most popular machine translation system.

RESIDUAL PROCESSORS

TECHNOLOGY

Extremely fast processors based on residual arithmetic. Integrated circuit design and chip manufacturing.

APPLICATION

Fast signal and image processing.

DESIGN OF SECURE IT SYSTEMS

RESEARCH

Research subjects include the wider issues of safety and reliability of IT systems, and in particular:

- **monitoring and ensuring security of data in information systems,**
- **reliability and security of data transmission in computer networks,**
- **information hiding methods,**
- **organisation of access and the means of protecting IT systems,**
- **security of IT projects management, hardware and software reliability, constructing reliable and secure IT systems (including the use of quantum technology in quantum computers, quantum cryptography and computing, security, reliability, and application of intelligent system techniques, biometric systems, the use of probabilistic methods in technology, statistical research, methods and characteristics of quality and performance, diagnostics and operation of distributed systems, logic unit theory, metrology and diagnostics of logic units and computer devices).**

APPLICATION

Designing secure and reliable system software and reliable IT systems.

DESIGN AND OPTIMISATION OF TELEINFORMATIC SYSTEMS AND NETWORKS

RESEARCH

The design and optimisation of ICT systems and networks is a complex endeavour. The steps necessary to design an ICT system or network are: the analysis of user needs, stocktaking, design assumptions, logical design, physical design. In the case of designing large systems and networks, development of a mathematical model is necessary. The next step is the development of an algorithm to optimise this model using exact or heuristic methods in order to obtain

optimal or suboptimal results. This allows you to achieve a solution which minimises the cost of developing a system or network which meets the user's essential requirements, including those related to quality of service and reliability. The support offered applies to the design and optimisation process of ICT systems and networks – including the development of an ICT system or network from scratch and the modernisation of existing ICT systems and networks. Extensive knowledge and experience in the use of advanced modelling and optimisation is employed in the works to guarantee very good quality of the end result.

APPLICATION

Issues of system and network design and optimisation are widely applied in many areas of the economy. Among others, they are used by telecom operators; companies and institutions with their own ICT systems and networks; providers of distributed computing, including cloud computing; consulting companies offering expert services in the area of ICT systems and networks; companies offering services on the Internet.

DESIGN OF SMART DATA ANALYSIS SYSTEMS

RESEARCH

Design and tuning of so-called "big data" analysis algorithms, including the analysis of large volumes of data and streams, while taking into account the variability of model parameters over time, as well as designing methods of machine learning which take the heterogeneity of data into account. Analyses are carried out on a dedicated computing cluster using distributed data structures and computational systems.

APPLICATION

Analysis of complex, rapidly changing data, e.g. on customer profiles. Designing automatic classification systems, including data stream classification, e.g. to improve the traffic safety in computer networks. Designing predictive systems, e.g. those estimating energy consumption.

IMAGE DATA BASE SEARCHES - SIMILAR IMAGE SEARCHES, AUTOMATIC IMAGE DESCRIPTION

RESEARCH

A visual measurement of the similarity between images can detect identical or nearly identical portions of multiple images and build effectively functioning visual content search engines. One technique of similarity measurement is a method based on the so-called bag-of-words, namely histograms representing a single image and built from a number of visual words. Visual word is a single feature vector representing an image, subjected to lossy compression to a single number. This number represents the number of a group (cluster) and is formed by grouping vectors representing images. The basic measurement of similarity between the images amounts to measuring similarity between histograms. Another technique is the use of various image transformations, usually the affine transformation of two images. When analysing the similarity, this transformation is automatically recreated, so that the images which were subjected to transformation are paired together as well as possible. Automatic image description using keywords uses the visual similarity between the images and image set data, described with the words from a given dictionary. The system learns to describe images on the basis of their visual similarity.

APPLICATION

Automated control and quality measurement systems based on visual analysis, e.g. production lines. Visual identification of objects (e.g. on the basis of a captured image of the packaging or the product itself, the system is able to identify the product and provide the user with available information on its subject). A system suggesting the monuments from a given region, which may be of interest to a particular tourist on the basis of a photo of a sample monument and/or other data (e.g. keywords).

VIDEO PROCESSING AND ANALYSIS

RESEARCH

In connection with the increased capabilities of cameras, the problem for solutions based on image data is not the lack of equipment, but the lack of specialised software. The offer applies to the creation of algorithms for capturing and processing the video signal. For image capturing, apart from real-time recording, the interpolation of raw data from the sensor, noise reduction, colour correction and lossless or lossy compression have to be included. In addition, it is possible to assess and improve the quality of 3D videos. The works are performed on the basis of practical experience in designing image capture systems, codecs and video transmission systems.

Video signal analysis includes detection and object tracking, object segmentation, obtaining from the video signal, creation of video sequence summaries – both in text form, as well as that of a new sequence, which is a condensed combination of clippings from the main sequence. Video signal analysis is based on feature extraction and classification and tracking of objects and events using AI-based systems. Deep neural networks, which currently provide the best results, are widely applied here.

APPLICATION

Video capture and transmission systems, including remote or custom systems, such as 3D or infrared video systems. Quality measurement and remote control systems. Systems requiring video signal improvement, for example, remoteness, poor lighting. Systems for obtaining information from videos: recognition of objects, people's actions, emotions, identification of people, crowd behaviour analysis, anomaly detection, environment recognition for robots and cars, also based on the LIDAR signal, etc.

PARALLEL OPTIMISATION ALGORITHMS

TECHNOLOGY

Multithreaded algorithms (both parallel and distributed) are a natural extension of sequential algorithms developed for decades, and so far implemented primarily in single processor computing. The introduction of readily available parallel architectures in the form of multi-core processors and GPU and MIC computing processors in the last decade requires a new way of constructing algorithms in order to take full advantage of the considerable computing power of computer equipment. This trend is clearly visible in the field of discrete optimisation. The basic problem is a sufficiently effective adaptation of strong sequential single processor computing to its appropriate parallel, multiprocessor variant.

The research employs MIC (Intel Xeon Phi) and multi-GPU (nVidia Tesla) class devices, possessing more than 4,000 cores, used for real-time scheduling and optimisation (CUDA, OpenMP technologies). The designed algorithms are also executed on a large computing cluster (MPI).

APPLICATION

The application of research includes the design and implementation of high-speed parallel algorithms for optimisation problems, such as matrix computations, task allocation, production scheduling (very large instances of a problem or real-time planning); transport optimisation; operational planning which takes data uncertainty into account.

STYLOMETRY AND SEMANTIC CLASSIFICATION OF TEXT

RESEARCH

Stylometry deals with the analysis of features common to a collection of texts which may come from broadly-defined styles: personal, literary, resulting from the period in which they have been written, their place of origin, the native language of their translators, gender, etc. Style can be defined based on a set of sample documents representing it or documents which we want to investigate with regard to consistency. Stylometry methods have been generalised to text classification based on the manner in which the texts were written and analogous grouping. A system based on dozens of types of text-describing features (from words, through morphological forms, to meanings and semantic classes – generalised meanings, as well as the emotions and the emotional attitudes) and many methods of processing information expressed by these features, construction of classifiers and grouping has been developed. The methods of classification and grouping already developed have been combined with methods of extraction of features particular to text groups or explaining the classification criteria (either used by the classifier or re-observed in the results of its operation). Generalised stylometry methods may be used on a large scale for very large text collections.

APPLICATION

Methods of generalised stylometry can be used as a basis for knowledge management systems, information filtering, semantic indexing of documents and parts of documents, advanced analysis of plagiarism (at the level of the similarity of content and not just form), the analysis of style and linguistic complexity of documents, detection of texts which are a manifestation of certain phenomena (e.g. hatred, mental states of the author), detection of texts with a particular function, etc.

NATURAL LANGUAGE QUESTION ANSWERING SYSTEMS

RESEARCH

Natural language question answering systems allow their users to describe what they are looking for by means of posing a question expressed in a natural manner. Such systems often allow one to ask entire coherent sequences of questions or questions accompanied by additional descriptions. When searching the entire Internet, such systems have difficulty competing with general search engines, especially due to their slower response time, but in the case of closed or controlled collection, question answering systems can achieve greater precision than general search engines. The operation of question answering system is based on the analysis of the question structure and matching a formalised description of the content of the question to semantic representations of particular sentences or parts of the document.

APPLICATION

Question answering systems can be the basis for building advanced information systems providing the ability to accurately identify the needs, find accurate answers, and conduct semantic searches. The module matching questions to answers, namely determining the semantic match of short text fragments, can be used also as a part of knowledge management systems, for grouping short text passages or filtering text messages.

MEDICAL DECISION SUPPORT SYSTEMS

RESEARCH

Clinical decision support systems provide physicians with the information and knowledge used in the process of medical diagnosis. Such systems employ modern data mining technologies and advanced, intelligent medical image processing techniques in order to extract clinically useful information. These systems significantly help in the daily work of physicians and have an impact on the quality of medical diagnoses. An important advantage of the system is the ability to process incomplete and/or uncertain knowledge.

APPLICATION

Medical institutions conducting diagnostics.

DEVELOPMENT OF PERSONAL AND ADAPTIVE E-LEARNING COURSES

TECHNOLOGY

Studies show that adjusting educational material to the needs and preferences of users increases their motivation to learn, and consequently leads to students achieving better learning outcomes in a shorter period. The offer applies to

the personalisation of the learning process at every stage of the education process. For this purpose, information pertaining to the user is collected, and their needs, preferences, learning styles, interests and personality traits are identified at the initial stage. Then, based on the user data collected, the system, with the use of appropriate methods, generates a learning script (choice of teaching materials, their order and form of presentation) best tailored to the student. The learning process is closely associated with the knowledge evaluation process, which is also personalised. Properly designed adaptive tests which adapt to the current state of knowledge of the student provide a reliable assessment of progress in teaching. If a student has a problem with mastering the material, methods of altering the learning script to the current characteristics of the student are also available.

APPLICATION

In educational institutions (schools, universities), as an alternative to traditional classes in classrooms, as a part of remedial classes for weak students, for outstanding students, as an additional way of developing their skills and expanding knowledge which cannot be conveyed during traditional classes.

In every company, as a way of conducting employee training which saves time (employees can improve their education at a time that suits them) and money (once prepared, the training can be used for many years, for many employees, and without the help and supervision of additional people).

MACHINE LEARNING AND CLASSIFICATION

RESEARCH

Machine learning or learning systems is a relatively young and rapidly developing field, which is a part of the science dealing with artificial intelligence (AI). It is an interdisciplinary science, with particular emphasis on areas such as computer science, robotics and statistics. The main objective is the practical application of achievements in the field of artificial intelligence to development of an automatic system, capable of self-improvement through accumulated experience (i.e. data) and acquisition of new knowledge on this basis. Machine learning is a consequence of the development of the idea of artificial intelligence and methods of its practical implementation.

APPLICATION

Machine learning constantly finds new practical applications. In the future, every aspect of technology will include some form of implementation of machine learning algorithms, for example speech recognition, machine translation, navigation and control of vehicles, finding one's way, automation of manufacturing and mining systems, disease diagnosis on the basis of symptoms, drug therapies modelling, handwriting recognition and prediction of trends in the financial markets on the basis of economic data.

INFERENCE FOR NETWORK DATA

RESEARCH

Probabilistic inference is based on revising the belief regarding the truthfulness of hypotheses based on certain observations (indications). Regardless of the network structure, a distinction between special (determining the probability distribution for a single hypothesis) and general cases of inference (determining the probability distribution of all hypotheses) is made.

APPLICATION

Relational learning allows us to complement the knowledge regarding a given network and, in particular, knowledge regarding the user profile (gender, age, interests, characteristics, etc.) when we have the knowledge of a limited number of user profiles within the network.

INFORMATION EXTRACTION AND TEXT MINING

RESEARCH

It is increasingly difficult to find the required messages in information streams. Information extraction systems (IE) are based on partial semantic analysis to extract the information from the text. The most common purpose is to extract information on: entities (e.g. people, companies, products, etc.); properties (e.g. size, price, etc.); semantic relationships (e.g. works at) and complex relationships, meaning situations (events, conditions, processes involving multiple entities, e.g. selling something to someone). References to places and spatial relations, temporal expressions (point, interval, multiplicity) and temporal relationships (e.g. consequence) can be recognised. IE is accomplished using selected language tools which guarantee the required level of accuracy, e.g. proper name recognition software (including Liner2), coreference and anaphora detection (pronouns), recognition of semantic, spatial, and temporal relationships. The extracted partial information is then combined based on lexicons and pattern databases and machine learning-based methods. Extracted information can be transformed into knowledge using Data Mining methods.

APPLICATION

Information extraction can be used for tracking events in time and space, automatic gathering of analytical information, creating lists, semi-automatic filling of databases, web sources monitoring and obtaining information. Knowledge extraction methods can be used in analytical work, creation of business plans, reasoning and planning based on collections of texts.

APPLICATION OF SEMANTIC METADATA TO ANALYSE DATA FROM NEW PERSPECTIVES

TECHNOLOGY

An identifier beginning with http:// can be used to name not only www documents but also people, companies, products and events. An association is made by creating a hyperlink from one object (identifiable by URI) to another. Even by secretly selecting friends or films in a social service, one creates associations, i.e. Linked Data. WWW analysis in terms of coherence and compatibility can be performed on many levels. By creating a specific case of application of analysis methods for reranking, it was determined that in many critical locations it was necessary to select one of many paths so that the experiment was feasible. The very selection of three types of object, as www representatives, is already a constraint. Currently, not only documents, authors, terms and the links between them can be discriminated. One would have to take into account events (and, in general, the time aspect), objects, projects, companies, groupings, etc. distinguished with the use of URI. The technology was demonstrated with the example of a www browser featuring analytical capabilities, a so-called "analyser." The application allows correlating query results with the context assumed, determining the coherence and compatibility of the resulting collection on the basis of set relevance thresholds, grouping collection documents, and improving document ranking.

APPLICATION

Analysis of commonly available information about businesses. Grouping internal documents.

APPLICATION OF MATLAB AND LABVIEW PROGRAMMING ENVIRONMENTS

RESEARCH

- **processing and analysis of signals from wireless kinematic and biomedical quantity sensors included in the Shimmer platform (measurements from the accelerometer and gyroscope and EMG, ECG, skin conductance, heart rate signals) using MATLAB and LabView environments,**
- **designing decision support systems for monitoring and supporting technical and endurance training of athletes (running, swimming, tennis, speedway riding),**
- **modelling the course of phage therapy and development of realistic computer simulations in MATLAB,**
- **simulation of biologically realistic neural networks for modelling the learning process by way of rewards and punishments in humans,**
- **application of machine learning methods, and deep learning methods in particular, and their implementation, e.g. in prediction of cancer recurrence, credit risk prediction, automatic drug design, image analysis and computer vision.**

APPLICATION

Processing and analysis of nonlinear and non-stationary kinematic and biomedical signals. Modelling, analysis and computer simulation of dynamic systems of a biomedical nature.

AGILE BUSINESS ANALYSIS IN SOFTWARE DEVELOPMENT

EVALUATION

Identification and selection of business analysis elements for drawing up software specifications (with the use of agile methodologies of developing a software prototype) handling the business process in the company. The aim of the analysis is drawing up software specifications in a rapid manner which solves the decision problem in the business process of the company.

Services in the area of computer science are also provided by the Wrocław Centre for Networking and Supercomputing. The WCSS offer can be found **on page 112 .**

ANALYSES OF STEADY STATES OF THE ELECTRICAL POWER ENGINEERING SYSTEM

RESEARCH

Research into static voltage stability into a transmission and distribution network. Determination on the steady state based on the Newton-Raphson method, with the use of sparse arrays. Determining critical areas of voltage control in a heavy current system, development of technically optimal solutions of wattless power compensation. Analyses of power distributions in a heavy current system with FACTS systems based on own-developed software for distribution calculations with FACTS systems.

APPLICATION

Operators of transmission and distribution systems, electrical power engineering industry.

AUTOMATION OF INDUSTRIAL PROCESSES

RESEARCH

Design and modernisation of industrial control systems. Programming of PLC drivers, industrial robots, as well as vision and visualisation systems with the use of operator panels and SCADA software. Design of microprocessor-based measuring, monitoring and controlling devices. Training in the field of programming and servicing of OMRON PLC drivers, confirmed with a certificate issued by OMRON Electronics upon completion of the course.

APPLICATION

Mechanical and electrical engineering, production and processing plants with automated technological lines, water and sewage plants, innovation and implementation oriented companies, training for automation engineers and maintenance workers.

STUDIES AND EVALUATION OF ELECTRICAL RISKS

RESEARCH

Research in the field of electric shock protection techniques, testing electric appliances with respect to security of use, testing electric shock risk and efficiency of electric shock protection measures of electric systems and appliances, model tests of different types of earths and earth systems, studies of the impact of dispersed renewable energy specificity on electrical security.

APPLICATION

Analysis of electric shock protection systems' efficiency at the stage of technical design. Studies and evaluation of low voltage systems' technical parameters. Evaluation of the impact of the dispersed system of power sources on parameters crucial for electrical safety. Evaluation of the possibility of applying adaptive (intelligent) electric shock protection systems to control electrical safety.

STUDIES OF ELECTROMAGNETIC COMPATIBILITY IN TERMS OF ELECTRICAL ENERGY QUALITY

RESEARCH

Studies of quality parameters of supply voltage and analysis of current and power. The scope of research into power supply units includes electrical tests specified in chart 3 of the N-ISO 8528-5:1997 standard (items 16.1, 16.2, 16.5-16.16). Studies of interference emissions of the following types: harmonic interferences of current, voltage fluctuations and light flickering, as well as receivers' resistance to voltage dips and short breaks in power supply, and voltage and frequency changes.

APPLICATION

Studies related to compliance with standards and performed according to the following standardised procedures: EN 50160, EN 61000-2-4, EN 61000-3-2, EN 61000-3-3, EN 61000-4-7, EN 61000-4-11, EN 61000-4-13, EN 61000-4-14, EN 61000-4-28.

STUDIES OF MATERIALS - NEW INSULATION MATERIALS

RESEARCH

Studies of electroenergetic insulators (insulator cores and interfaces) by means of steep-front impulse voltage, studies of dynamics of losses in composite insulator surface properties under clean fog or rain conditions (recording of leakage current increase), studies of electrical insulators' silicone coatings, studies of modern multiphase high-voltage systems in terms of optimisation of these systems' technological parameters and diagnostics, studies of thin-film plasma coatings on unwoven fabrics in mind with applications in the electromagnetic field screening technique.

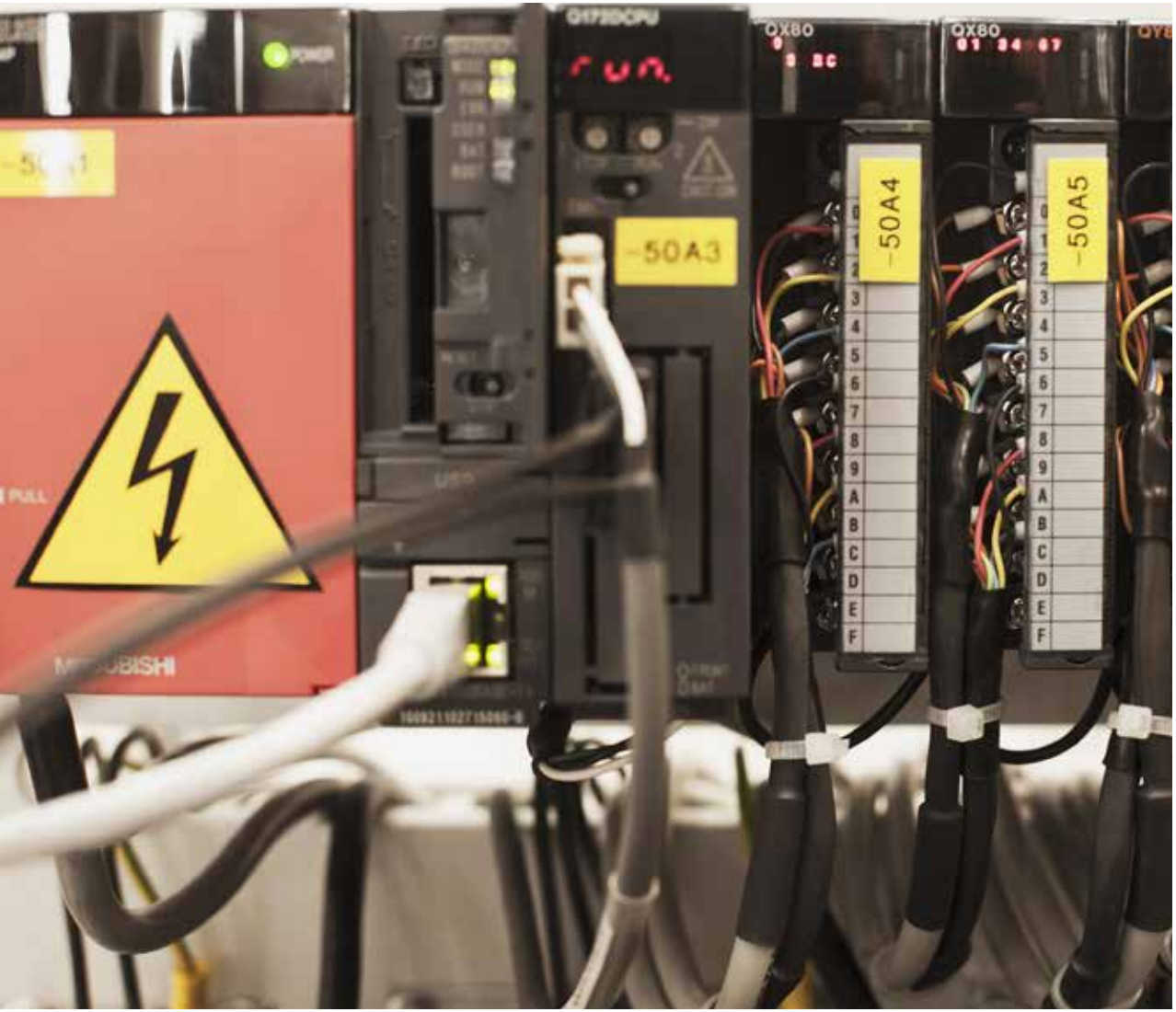
APPLICATION

Commercial power engineering, facilities producing high-voltage equipment

STUDIES OF THE ELECTROMAGNETIC FIELD IN THE 0-400 KHZ FREQUENCY RANGE

RESEARCH

Measurements of the intensity of electric and magnetic fields of 50 Hz frequency generated by power lines and substations, measurements of the intensity of magnetostatic field; as well as electric and magnetic fields of frequencies ranging 5 to 400 kHz generated by industrial, medical and scientific equipment; computational identification of electromagnetic fields of 50 Hz frequency near electric and electrical power engineering devices.



APPLICATION

Computational and measurement based identification of electromagnetic fields of 50 Hz frequency near aerial and cable power lines, power substations and other power engineering appliances. Analysis of threats to people and the environment caused by electromagnetic fields generated by power engineering devices. Analysis and evaluation of work conditions in constant electromagnetic fields and those of frequencies ranging 5 to 400 kHz.

STUDIES OF THE OPERATION OF ELECTRICAL POWER ENGINEERING PROTECTION AUTOMATICS

RESEARCH

Analyses of operational characteristics of protection automatics devices, analyses of solutions related to protection systems for relay protection of separate power engineering facilities; simulation analyses of the operation of electrical power engineering protection automatics systems.

APPLICATION

Studies and analyses of sensitivity and deviations of current and voltage transformers and converters. Measurement of specific characteristics of current and voltage relays and transformers. Testing of operational criteria for electrical power engineering protection automatics.

STUDIES IN THE AREA OF DIGITAL ALGORITHMS FOR ELECTRICAL POWER ENGINEERING PROTECTION, REGULATION AND CONTROL AUTOMATICS

RESEARCH

Development of modern algorithms for estimation of criteria quantities of digital protection automatics systems; development of new decision-making algorithms and operational criteria for digital automatics (application of artificial intelligence methods); studies aiming to improve specific protection functions as well as regulation and control algorithms applied in electrical power engineering systems; simulation analysis of the operation of protection automatics systems, modelling and simulation of electromagnetic transient states in electrical power engineering networks.

APPLICATION

Implementation of algorithms designed at the unit in digital automatics and control systems applied in power engineering. Improvement of protection systems' speed, sensitivity, reliability and effectiveness.

DIAGNOSTICS OF INSULATION SYSTEMS FOR HIGH VOLTAGE DEVICES

RESEARCH

Studies of electrical power engineering insulators and overvoltage limiters, silicone coatings for electrical power engineering insulators; periodic tests of protection equipment (rods, plates, voltage meters, gloves, etc.); studies of modern multiphase composite high voltage systems in terms of optimisation of technological parameters and diagnostics.

APPLICATION

Commercial power engineering, facilities producing high-voltage equipment.

ENVIRONMENTAL EVALUATIONS RELATED TO THE PROTECTION OF PEOPLE AND THE ENVIRONMENT FROM THE IMPACT OF ELECTROMAGNETIC FIELDS

EVALUATION

Reports on environmental impact in relation to electromagnetic field for various electrical power engineering facilities; expertise involving analysis of problems related to the environmental impact of electromagnetic fields generated by power lines and substations; expertise involving evaluation of possible impact of electromagnetic field of people near its various sources; expertise related to health and biological impact of electromagnetic fields of 50 Hz frequency. Expertise is performed by an accredited laboratory.

EVALUATION OF THE IMPACT OF DISPERSED SOURCES APPLYING RENEWABLE ENERGY ON THE DISTRIBUTION NETWORK

EVALUATION

Analyses of the distribution network operation status before and after inclusion of a power plant in the following areas: transformer regulator setpoint at the switching station, power flows, wattless power compensation, identification of line sequences' connection parameters, impact on network load and losses, impact on voltage deviations, active power change depending on frequency, voltage fluctuations, light flickering nuisance indicators, harmonics level, and generator angle and voltage stability reserves. Analyses of operational conditions of electrical power engineering automation: earth fault issues (automatic active component enforcement, co-operation with ARC), security automation (ATSE, ALS) at the switching station, adjusting security automation and selection of setpoints.

EVALUATIONS OF THE OPERATION CORRECTNESS OF ELECTRICAL POWER ENGINEERING PROTECTION AUTOMATICS

EVALUATION

Analysis, involving simulations and measurements, of operational correctness of electric power engineering protection automation systems including: analysis of operational characteristics of protection automation devices; analysis of solutions related to relay protection systems of separate facilities; measurements of operational correctness of electric power engineering automation systems; and simulation based analyses of electric power engineering automation systems' operation.

EVALUATIONS IN THE AREA OF DESIGN, OPERATION AND DIAGNOSTICS OF CONVERTER RENEWABLE ENERGY SYSTEMS

EVALUATION

Expertise in the area of selection of the topology of systems, power and control algorithms of converter systems of wind power plants with permanent magnet based synchronous generators and induction generators in network and autonomous systems. Expertise in the area of operation and diagnostics of converter systems of wind power plants with synchronous and induction generators. Expertise in the area of breakdown states in a wind power plant system's operation, as well as meeting appropriate requirements related to the quality of electric energy.

ELECTRICAL ENGINEERING, LOW POWER ELECTRICAL COUPLERS

RESEARCH

Studies related to low-power arc discharge and glow discharge, allowing for various extinguishing media and various "climatic" conditions. The studies can be carried out in a vacuum and with the use of both negative pressure and overpressure of various technical gases. Allowing for the influence, type and technology of contact tips.

APPLICATION

Coupling devices, relay contacts, reed relays.

ELECTROMAGNETIC MATERIALS, APPLIED ELECTROSTATICS - MEASUREMENTS, PRODUCTION AND STUDIES OF ACTIVE AND MULTIFUCTIONAL DIELECTRIC MATERIALS

RESEARCH

Diagnostics of electrotechnical, insulation, electret, antistatic, polymeric and piezoelectric materials. Climatic studies of products and materials in the temperature range of -40 °C-180°C and humidity range of 10%-98%. Measurements of low resistance - from 0.1 mΩ with the resolution of 1 μΩ, and high resistance - up to 100 TΩ. Calibration of resistance metering devices and working standards of resistors in the range of 1 mΩ – 100 TΩ. Studies of electrical and electromechanical properties of active and multifunctional dielectric materials for the purposes of energy harvesting.

APPLICATION

Studies and evaluation of electric permeability, loss factor, volume and surface resistivity, high resistance, low currents, electrical charge diffusion (in compliance with PN-EN 61340- 2-1, PN-EN 61340-4-1 standard), electric field intensity, charge density (including the Q/m parameter), accumulated charge, evaluation of threats caused by ESD's, calibration of apparatuses for electric field metering, tests of "energy harvester" type micropower sources of electric energy, tests of vibration resistance, and sieve analysis.

ELECTRIC MACHINES - SIMULATION CALCULATIONS, DESIGN AND IMPLEMENTATION

RESEARCH

Simulation and experimental studies of new construction and material structures of electric devices. Field--circuit calculations for electric machines and devices; studies of propulsion systems featuring different rotational speeds, with the use of an engine test house, torque meters, pyrometers and portable recording systems for inspection of industrial facilities, e.g. electric machinery used in mines.

APPLICATION

Electromechanical and mining industries.

ELECTRIC MACHINES AND CONVERTER SYSTEMS FOR RENEWABLE ENERGY PROCESSING

RESEARCH

Studies of synchronous generators with permanent magnets operating in network and autonomous modes applied in wind power plant systems. Control ensuring maximum power generated by a wind turbine (MPPT). Studies of systems applying modern control methods and algorithms (vector control, sliding mode control and other methods of non-linear control). Studies of squirrel cage and ring induction generators operating in network and autonomous modes. Studies of energy processing converter systems with PV panels.

APPLICATION

Network and autonomous systems for processing wind energy; electromechanical, electrotechnical and power engineering industries, production facilities supplying power electronics machines and converters applied in the wind energy sector; production facilities supplying photovoltaic devices; innovation and implementation oriented companies; training for designers, engineers and other employees working in the areas of implementation, design and operation of RES systems and devices.

MONITORING AND ANALYSIS OF ELECTRIC ENERGY QUALITY

RESEARCH

Monitoring and evaluation of electric energy quality based on synchronous measurements of multi-point electrical power engineering networks. The measurements are performed in accordance with PN-EN 50160 standard. The analyses apply algorithms identifying the movement of interferences in electrical power engineering networks, e.g. studies of voltage dip directionality or determination of harmonic sources. In special cases, signal analysis using advanced digital processing methods is applied.

APPLICATION

Synchronous, multiple node monitoring of electric energy quality in electrical power engineering networks. Analysis of disturbances of energy quality in office buildings and industrial facilities. Analysis of cooperation between the electrical power engineering network and dispersed sources, including small and microinstallations. Unification of measurement data from various types of recording devices.

MONITORING AND DIAGNOSTICS OF MACHINES AND ELECTRIC PROPULSION SYSTEMS

RESEARCH

Development, tests and implementation of new methods of early detection of electric and mechanical failures in electric machines and converter propulsion systems based on advanced signal processing algorithms and artificial intelligence methods. Design and measurement of diagnostic systems facilitating monitoring of the work of propulsion systems and their diagnostics, also remotely, based on Ethernet and GSM technologies.

APPLICATION

Electromechanical and mining industries, industrial propulsion, power engineering, research and development centres.

EVALUATION OF DISTURBANCE EMISSION AND ELECTRIC RECEIVERS' RESISTANCE TO DISTURBANCES

EVALUATION

Studies of interference emissions of the following types: harmonic interferences of current, voltage fluctuations and light flickering caused by receivers, as well as receivers' resistance to voltage dips and short breaks in power supply, and voltage and frequency changes. The unit undertakes tests for conformity with standards as well as in compliance with normative requirements or recommendations included in the following: PN-EN 61000-3-2, PN-EN 61000-3-3, PN--EN 61000-3-11, PN-EN 61000-3-12, PN-EN 61000-4-11, PN-EN 61000-4-13 PN-EN 61000-4-14, PN-EN 61000-4-28. Compliance with the requirements of harmonised standards following the electromagnetic compatibility directive for electric energy receivers is mandatory for obtaining the right to mark products with the CE label. The studies confirm that products meet the requirements.

EVALUATION OF ELECTRICAL ENERGY QUALITY

EVALUATION

Studies of field quality of electrical energy, in accordance with the PN-EN 50160 standard. Evaluation of disturbances in energy quality in office, industrial and public utility facilities.

MEASUREMENT AND ANALYSIS OF PHOTOVOLTAIC CELLS' PARAMETERS

RESEARCH

Measurements of photovoltaic cells' current and voltage characteristics in standard test conditions. The 16-bit digital metering system applied performs measurement and advanced analysis of characteristics. The system is fitted with a grade C light source (in accordance with IEC 60904-9 standard). Sample surface: 15x15cm Measurement range of current: 100μA to 15A; measurement range of voltage: 0.65V to 10V.

APPLICATION

Studies of photovoltaic cells: measurements of light and dark characteristics, measurements with optional illuminance fluctuation compensation (up to ±2%), determination of the cell's series resistance in accordance with the IEC 60891 standard, correction of characteristics to STC conditions in accordance with the IEC 60891 standard, approximation of characteristics to a substitute diode mode, determination of temperature coefficients, open circuit voltage, short circuit current and the cell's maximum power.

PROCESSING, ANALYSIS AND VISUALISATION OF MEASUREMENT SIGNALS OF ELECTRICAL AND MAGNETIC QUANTITIES

RESEARCH

Studies of metrologic properties of analogue and digital industrial grade metering systems containing check charts and autonomous instruments. Issues related to measurement of industrial frequency current, with the use of new designs of current transformers and current-voltage converters. Measurements of active power with low power and reactive power factors. Issues related to calibration of electrometric instruments and ensuring resistors have a true conventional value.

APPLICATION

Studies of metrologic properties of metering solutions containing digital data processing systems. Determination of a class indicator for specific metering devices and converters. Development of metering devices. Development of two-core current transformers, also those containing active components as well as current-voltage converters with a homogeneous magnetic circuit or cylindrical coils. Calibration of electrometric instruments.

CONTROL OF MODERN PROPULSION SYSTEMS

RESEARCH

design, testing and launch of advanced control algorithms (linear control - PID and state regulators, non-linear control: predictive, fuzzy, neural, neural-fuzzy) allowing for estimates of state variables, designed for electric propulsion systems with various types of electric motor - in mind with the mechanical part's characteristics. Studies, tests and implementation of advanced control algorithms for complex industrial processes.

APPLICATION

Research and development centres, electrical engineering, industrial propulsion systems, automatics.

ANALOGUE, DIGITAL AND MIXED SIGNAL ELECTRONIC CIRCUITS AND SYSTEMS

TECHNOLOGY

Design, prototyping and implementation of analogue, digital and mixed signal electronic systems particularly for measurement and control applications. Applications can include special circuits, such as optoelectronic and photometric circuits, wireless data transmission and microprocessor systems, as well as programmable circuits. System and circuit design may include all stages - from the very idea all the way through the schematics to the PCB, as well as system start-up and testing, including microprocessor system software.

APPLICATION

The electronic systems and circuits designed are applied in numerous fields, while their functionality results from the expectations defined by the ordering entity.

STUDIES AND EVALUATION OF ELECTROMAGNETIC COMPATIBILITY OF DEVICES, SYSTEMS AND INSTALLATIONS

RESEARCH

Studies of electromagnetic compatibility (EMC) of devices intended to be used in home and industrial environments, in particular aviation, power engineering, automotive, naval engineering, medical, measurement and control devices. The research involves the following:

- **measurements of continuous conducted electromagnetic (EM) disturbances on the interface and mains lines, discontinuous disturbances (the so-called clicks), and radiated disturbances (up to 40 GHz),**
- **measurements of mains current distortion (harmonics and flickers) in AC supply networks (3-phase, 50Hz/60 Hz, up to 90 A/phase),**
- **studies of resistance to continuous (10 kHz – 400 MHz) and impulse electromagnetic disturbances generated in interface conductors as well as AC and DC power supply (e.g. in on-board power networks of cars and airplanes),**
- **studies of immunity to radiated disturbances (up to 200V/m, 80MHz-18 GHz),**
- **studies of immunity to conducted electromagnetic disturbances generated in power lines (frequency range from DC to 150 kHz).**

Devices for testing can be 3 metres in height/width and up to 3 tons in weight. The can be battery, DC or AC powered (typically, up to 32A/phase).

APPLICATION

EMC are carried out by an accredited research laboratory (accreditation certificate AB 167 issued by the Polish Centre for Accreditation), in compliance with European harmonised standrads. The studies make it possible to determine whether essential requirements of the European EMC directive are met. In the conformity evaluation procedure, meeting the requirements is necessary for the manufacturer or its authorised representative to be able to submit a declaration of conformity and labelling for a product to be introduced to the EU market with the CE mark.

STUDIES OF AUDIO SYSTEMS

RESEARCH

Studies of electroacoustic systems in the areas of:

- **sound levels and acoustic pressure obtained,**
- **unevenness of sound level and acoustic pressure level distributions,**
- **frequency characteristics, impulse responses.**

APPLICATION

A basis for evaluation of systems' compliance with requirements of designs and standards, or normative documents (e.g. EBU 3276). A basis for development of guidelines related to a possibility of improvement of speech comprehensibility in interiors. Check-up and commissioning measurements .

THERMOVISION AND INFRA-RED IMAGING STUDIES

RESEARCH

Thermography literature offers numerous examples of applications of thermographic diagnostics for tests of medium and low voltage witching stations, measurement and control boxes, transformer stations, as well as electric and elctromechanical devices used in industry. The research conducted so far has shown that thermography can be successfully applied also for non-invasive diagnostics and evaluation of devices' and electronic components' lifetime or studies of modern hybrid materials.

APPLICATION

Determination of thermal parameters of thin layers (emissivity, heat diffusion, or evaluation of the efficiency of heat transport through layers made of nanomaterials, among others). Measurement of surface emissivity. Measurement of an object's temperature in the steady state (determination of permissible operation conditions, evaluation of a device's lifetime depending on environmental conditions). Measurement of the speed of temperature changes of an object in the steady state. Determination and analysis of temperature gradient. Measurement of point contact thermal resistance. Measurement of materials' thermal diffusivity. Evaluation of the efficiency of selection of thermal conductive material and the cooling system applied (optimisation, comparative analyses). Active thermography.

STUDIES OF ELECTROACOUSTIC DEVICES

RESEARCH

- **power amplifiers, integrated and voltage amplifiers,**
- **audio recorders and players (e.g. CD, DVD, Blu-ray), analogue-digital and digital-analogue converters (ADC, DAC),**
- **other electroacoustic devices.**

APPLICATION

Based on studies of electroacoustic devices, it is possible to develop their technical specifications, evaluate their compliance with standards (e.g. PN-EN 54-24) and normative documents, verify the correctness of their operation, test prototypes and various designs, carry out appropriate adjustments and develop computer models of devices.

STUDIES OF ELECTRICAL PROPERTIES AND ELECTRICALLY ACTIVE DEFECTS IN MATERIALS AND SEMICONDUCTORS

RESEARCH

Qualitative and quantitative diagnostic studies of semiconductors and semiconductor heterostructures with the use of the Deep-level Transient Spectroscopy (DLTS) as well as capacitance and current-voltage characteristics (C-V i I-V) measured in a wide range of temperatures (80-480K). The studies aim to determine basic parameters of the metal-semiconductor junction and electrically active faults in semiconductor materials, mainly based on AIIIBV, AIVBIV, AIIBVI, AIIIN and other semiconductors.

APPLICATION

The DLTS method enables determination of electrical parameters of faults, the deep-level concentration profile, or dependencies between faults' emission properties and electrical field and temperature. The application of the high-resolution DLTS Laplace technology enables differentiation of faults which have similar emission properties. The DLTS method can be used to study electrical properties and faults in Schottky and p-n contacts and MIS structures (Metal-Isolator-Semiconductor).

STUDIES OF SPEECH TRANSMISSION INDICES

EVALUATION

Evaluation at the stages of design, execution, as-built or for existing facilities and audio systems within the following scope:

- **evaluation of the compliance of obtained speech transmission indices with regulations (including EU regulations), design requirements, standards (e.g. PN-EN 60849), and normative documents,**
- **opinions on causes of too small values of speech transmission indices,**
- **development of guidelines related to a possibility of improvement of speech comprehensibility in interiors.**

STUDIES OF SPEECH TRANSMISSION INDICES IN ROOMS AND OPEN SPACES

RESEARCH

Studies of speech transmission indices (STI, STIPA, RASTI) in compliance with the N-EN 60268-16 standard and comprehensibility values, according to audio systems' CIS (including voice alarm systems) in facilities such as:

- **auditoria and multi-purpose facilities, theatres, concert and opera halls, assembly halls,**
- **schools of music,**
- **railway and coach stations and platforms, trains,**
- **shopping facilities (including supermarkets).**

APPLICATION

A basis for evaluation of systems' compliance with regulations (including EU regulations), design requirements, standards (e.g. PN EN 60849) and normative documents. A basis for development of guidelines related to a possibility of improvement of speech comprehensibility in interiors. Check-up and commissioning measurements.

STUDIES OF LOUDSPEAKER PROPERTIES

RESEARCH

Comprehensive services in the area of measurements of loudspeaker and loudspeaker array properties:

- **measurement of standard properties of loudspeakers and loudspeaker arrays, such as characteristics of acoustic pressure, phase characteristics, electrical impedance characteristics, harmonic distortion, measurements of equivalent circuit parameters,**
- **measurements of non-linear parameters of loudspeakers,**
- **measurements of loudspeaker and loudspeaker array properties with subjective methods.**

APPLICATION

The studies' results enable development of proposals aiming to improve loudspeaker and loudspeaker array properties, such as proposals related to changes to casing structure, muffling casings' interiors and walls, and improvement of loudspeakers' crossover network properties.

STUDIES OF THE QUALITY OF LOSSY-CODED AUDIO

RESEARCH

Studies of sound quality, audio coded in lossy and lossless ways, are based on objective and subjective tests. The former apply software modelling psychoacoustic phenomena, thanks to which it is possible to obtain a measure of lossy coded audio deformation, but in the domain of perception (i.e. the answer to the question whether a given deformation is perceived and to what extent). The subjective tests are a classic approach to audio signal quality assessment, where a qualified and big enough group of listeners (experts) is present. They are carried out in the form of audio listening tests whose results undergo comprehensive statistical processing.

APPLICATION

Testing of the quality of audio in digital audio broadcasting (DAB, hybrid radio) and online streaming. Measurement and evaluation of audio codec quality.

DIAGNOSTICS OF DEVICES WITH THE USE OF ACOUSTIC AND VIBROACOUSTIC METHODS

RESEARCH

Based on a product's characteristics and analysis of recommendations and standards of a given industry sector, a measurement system is designed and built allowing product diagnostics. Measurement systems may be applied during the design process or to control product quality.

APPLICATION

Measurements of noise and vibrations generated by products. Build quality control based on the characteristics of sounds and vibrations generated when using products. Evaluation of the quality of sound generated when using products (e.g. in the automotive industry). Support of the product design process. Control of the impact of changes to the design on noise generated by the finished product.

PHONOSCOPY - FORENSIC ACOUSTICS

EVALUATION

Studies of recorded speech, recording audio as evidence, denoising spoken word recordings, identification of people based on evidence recordings, audio monitoring of recordings - also with significant distortion and interference, transcription of recordings, verifying evidence recordings' authenticity, identification of equipment for recording and playback, studies of a recording's acoustic-technical conditions, determination of recorded event's time and place.

LOUDNESS OF RADIO AND TV PROGRAMMES

RESEARCH

Studies of radio and TV programmes' loudness consist in measurement of an audio stream's parameters. The measurements are performed in accordance with EBU and ITU recommendations. Based on the measurements' results, it is possible to establish the compliance of programmes being examined with recommendations in force in Poland.

APPLICATION

Measurements of loudness of radio and TV programmes. Consultancy in relation to organisation of production of materials intended to be broadcasted, in the context of audio stream shaping. Monitoring radio and TV broadcasters.

X-RAY INSPECTION AND SPATIAL IMAGING WITH THE USE OF THE X-RAY COMPUTER TOMOGRAPHY

RESEARCH

Miniaturisation of devices and electronic components results in changes to both assembly technologies and construction of components themselves. The research methods previously in use (e.g. visual evaluation based on microscopic examination) aiming to evaluate manufacturing processes being carried out are often inapplicable due to the location of connections (e.g. circuits in BGA casings with terminals placed under the casing), airtight sealing of devices (car components cast with resin), or the complexity of objects (buried elements, multi-layer assembly, multi-layer circuits), and are being replaced with X-ray methods (2D and 3D inspection, computer tomography).

APPLICATION

The broadly understood defectoscopy of objects damaged during use, after manufacturing processes, reliability tests (electronic systems and components, microsystems, as well as hydraulic, electromagnetic and mechanical elements). Studies of electronic elements and microsystems (construction quality evaluation, evaluation of compliance with manufacturer documentation, comparative analyses, reverse engineering, etc.) Evaluation of technological process results (all kinds of joining processes such as soldering, welding, glueing, sintering, bonding, as well as processes of printed-circuit board manufacturing, metal plating, etching, laminating, printing, cutting, drilling, threading, airtight sealing, moulding, etc.). Evaluation of objects and process compliance with international and domestic standards (e.g. IPC, JEDEC, PN, PN-EN etc.). Structural studies of modern materials (hybrid and laminated materials as well as materials containing nano - and microparticles).

LAB-ON-CHIP INSTRUMENTS FOR ELECTROPHORETIC DNA ANALYSIS

TECHNOLOGY

The Lab-on-chip technology utilises the newest micro-engineering solutions and allows development of miniature devices for fast, high efficiency analysis of DNA. Glass lab-chips with capillary flow channels allow automatic transport, dosing, separation and extracting DNA in volumes amounting to single nanolitres with the use of electropheretic techniques as well as they enable detection of DNA with the high sensitivity fluorometric method. The results of analyses are represented in real time and recorded in a digital data base. Glass lab-chips utilise standard biochemical reagents and are intended for multiple use.

APPLICATION

Analysis of DNA with lab-chip instruments allows a significant increase in the efficiency of DNA tests, most notably making it possible to improve sensitivity and shorten analysis times, decrease sample and reagent consumption, automate the test process and minimise the probability of human error. Compared to commonly applied plate instruments for electrophoretic DNA analysis, the developed lab-on-chip instruments' characteristics include ten-fold higher efficiency of DNA separation, approximately 80-fold shorter testing time as well as a higher degree of analysis automation.

MICRO- AND NANOMECHANICAL SYSTEM ENGINEERING

TECHNOLOGY

The advancing miniaturisation of devices often creates a need for quick "in vivo" modification of projects being executed, with nanometre-scale accuracy. Microelectronic processes which are cost- and time-consuming may be inappropriate. Application of a focused ion beam - along with the electron microscope - enable simultaneous observation and modification of devices, in both micro and nano scale. Additional equipment , i.e. the FIB/SEM Helios NanoLab™ 600i FEI COMPANY, allows electrical measurements of structures being examined and modified.

Measurement and technological works including:

- **sub-nm SEM imaging, high-resolution micromechanics,**
- **ion etching, plating conductive (platinum) and dielectric (REOS) layers,**
- **EDX (Enery Dispersive X-ray) analysis of materials, nanometre accuracy manipulation (Kleindiek Nanomanipulator).**

APPLICATION

Studies of micro- and nanomechanical systems. Comprehensive studies of materials' morphology and chemical composition Electrical measurements of micro- and nanomechanical systems. Preparation of samples for TEM.

COMPREHENSIVE EVALUATION OF BUILD QUALITY OF COMPONENTS, ELECTRONIC DEVICES AND TECHNOLOGICAL PROCESSES AGEING, AND FATIGUE TESTS, RELIABILITY ANALYSIS

RESEARCH

Comprehensive studies of electric and electronic components - starting with tests of materials, through manufacturing, as well as component and device assembly processes, to tests and reliability analysis.

APPLICATION

Metalography studies (microsections, studies with the use of a polarisation microscope, polishing for study purposes with the use of electron microscopes). Measurement of materials' thermal conductivity (measurement in the stable state in vacuum or with the use of a modified flash method). Measurement of the adhesion force, strength tests. Measurement of ion contamination of circuit boards. Evaluation of the content of the metallic fraction in soldering paste or soldering wire. Reliability and ageing tests in a climatic chamber (constant temperature + humidity, constant temperature or thermal cycles within the range of -40 + 180 ° C). Studies of resistance to vibrations (periodic and accidental vibrations).

COMPREHENSIVE STUDIES OF MATERIAL MORPHOLOGY AND CHEMICAL COMPOSITION

RESEARCH

When conventional microscopic methods fail, the contemporary technology makes it necessary to learn materials' properties not only in the macro scale but also in the micro scale. The unit offers both composition analysis and research into materials' properties, for which microscopic and spectroscopic methods are applied - i.e. electron, ion and atomic forces microscopy as well as x-ray diffraction.

Measurement and technological works including:

- **studies of electrical materials' property in terms of frequency and temperature function,**
- **measurements of biological and biochemical structures' impedance,**
- **phase identification, measurements of stress, determination of crystalline grain sizes,**
- **analysis of surface morphology with the use of advanced AFM techniques (EFM, KPFM, SThM, C-AFM, SSRM),**
- **studies of mechanical systems' resonance properties.**

APPLICATION

Material engineering.

COMPUTER SIMULATIONS OF AMPLIFICATION SYSTEMS

EVALUATION

Computer simulations of audio systems enabling determination of spatial parameters and distributions for parameters including:

- **speech transmission index,**
- **loss of consonant clarity, sound level,**
- **acoustic pressure level, reverberation time T20, T30,**
- **early decay time (EDT), C80 clarity index, D50 definition,**
- **Dietsch and Kraak echo criterion for speech and music.**

CONSULTANCY AND STUDIES IN THE AREA OF SPEECH AUDIO, MUSIC, AND VIDEO QUALITY EVALUATION

TECHNOLOGY

Subjective measurements of the quality of speech, music and video signal transmitted with different methods (rooms, digital and analogue telecommunications channels, the Internet, DAB, etc.), as well as subjected to various coding techniques. Objective measurements of speech transmission and coding quality.

APPLICATION

Ensuring reliable evaluations of audio amplification in assembly and conference rooms. Testing of the quality of speech, music and video signal transmission in various transmission systems.

LASERS AND OPTICAL FIBRE AMPLIFIERS

RESEARCH

Development of small-power lasers operating at 1,550 nm wavelength and generating ultrashort impulses with mode synchronisation, as well as sources of medium/high power of continuous and pulse operation - on the so-called MOPA set-up. The works include development of a single-frequency laser prototype (continuous power of 5W), as well as numerous solutions of medium and high power laser sources, offering both continuous and pulse operation and generating optical frequency combs of sub-picosecond pulse lengths, with materials including graphene as a saturable absorber.

APPLICATION

Optical fibre amplifiers and lasers operating at 1,550 nm wavelength are applied in optical fibre telecommunications, free space telecommunications, remote vibrometry, laser micromachining, laser rangefinders, laser spectroscopy, laser metrology, etc.

MICROFLUIDIC SYSTEMS FOR DNA ANALYSIS

TECHNOLOGY

Microfluidic DNA analysers utilise state-of-the-art biotechnological achievements in the area of diagnostics methods with use of molecular biology and microfluidic systems where diagnostics takes place. Microfluidic systems co-operate with optoelectronic circuits and an IT environment controlling the analysis process and responsible for its visual representation. The research competences of the unit make it possible to conduct comprehensive studies in the areas of designing, production and application of silicon, glass-silicon and entirely glass-based microfluidic systems and optoelectronic circuits as well as IT systems that comprise instruments dedicated for DNA analysis related applications.

APPLICATION

Portable diagnostic platforms for quick and inexpensive DNA detection. These platforms are applied in detecting and identifying food pathogens, biological hazards, bacteria- and virus-originated contagious diseases, non-invasive prenatal tests as well as detecting GMO food content.

TELEMEDICAL MONITORING

TECHNOLOGY

A telemedical monitoring system comprises devices located in the user's home and analysing their health safety (on request or automatically), a medical server supervising the system's operation by collecting, storing and analysing data, and system software. Communication is wire-based (the Internet) or wireless (GPRS), using websites, tablets, smartphones, etc. Essential organs and life functions related to the respiratory system, cardiovascular system, body mass, as well as a loss of balance or consciousness.

APPLICATION

Remote monitoring systems for chronically ill, disabled or elderly people being part of the health care system or integrated with an intelligent building.

EVALUATION OF COMPLIANCE OF TENDER BIDS WITH ELECTROACOUSTIC SYSTEM DESIGN DOCUMENTATION

EVALUATION

Verification of whether a bid is compliant with significant order terms or the requirements of other design or tender documentation.

OPINIONS FOR COURTS OF LAW IN THE AREA OF AUDIO SYSTEMS AND ELECTROACOUSTIC DEVICES

EVALUATION

- **verification of formal and substantive correctness of design documentation,**
- **compliance of execution with design documentation, execution correctness.**

OPINIONS ON THE INNOVATION OF DEVICES OR ELECTRONIC ASSEMBLY TECHNOLOGIES

EVALUATION

Opinions on the innovativeness of electric and electronic devices, or related manufacturing technologies, in the context of applying for EU subsidies for investments.

DEVELOPMENT OF ULTRASONIC CONVERTERS TO BE USED IN VARIOUS MEDIA

TECHNOLOGY

Development of various types of wide frequency range ultrasonic converters intended to operate in solid, liquid and gaseous media. Other, optional services include development of ultrasonic converters for different performance modes (continuous wave, pulse) and powers.

APPLICATION

Converters developed at the unit can constitute an essential element of apparatuses and devices intended for active (e.g. coagulation of liquids, production of emulsions or aerosols), and passive (e.g. non-destructive tests, measurement of liquid and gas flows, monitoring of precipitation levels, echo ranging measurements in all types of media, etc.) applications of ultrasound. Converters developed at the unit can be applied in various fields of science, technology and medicine.

MEASUREMENTS OF ELECTRIC PERMEABILITY OF DIELECTRIC MATERIALS

RESEARCH

Measurement of dielectric materials' complex permeability with the use of the resonance cavity method on 2.4 and 5.2 GHz frequencies.

APPLICATION

Determination of dielectrical materials' electrical parameters such as relative electrical permeability and loss.

MEASUREMENTS OF THE EFFICIENCY OF ELECTROMAGNETIC SCREENING

RESEARCH

Measurements of the efficiency of screening materials, cables, casings, telecommunications cabinets and rooms, aiming to determine the efficiency of their protection against electromagnetic radiation. Studies of screening efficiency are conducted within the frequency range of 10 kHz to 20 GHz - both at the stage of development of new constructions and qualification, requirement and compliance tests.

APPLICATION

Determination of materials' efficiency in the area of protection against electromagnetic radiation.

MEASUREMENTS OF VIBRATIONS WITH THE LASER VIBROMETRY METHOD, ANALYSIS OF VIBRATIONS AND NOISE

RESEARCH

Measurement of vibrations with the contactless method, with the use of the laser scanning vibrometer; analyses of emissions of sound/noise generated by these vibrations. Vibrations are measured with the use of a laser scanning vibrometer made by Polytec, while noise analysis applies advanced numerical methods (FEM and BEM) and Sysnoise software. Vibration measurements are conducted for objects of a few millimetres to a few hundred metres in size. The unit offers measurement of elements of very high or low temperatures, e.g. components of vehicles' exhaustion systems, bulb filaments, etc.); measurable vibration frequency range: from near 0 to 1 MHz. Measurements can be performed from a considerable distance (up to 150 m), with very high scanning resolutions and accuracy of more than 1%. Emission of sound/noise caused by vibrations is determined with the use of numerical methods, which enables identification of predominant elements, determination of sources' directivity and establishment of the effectiveness of modifications to tested devices' components. Also possible is modelling of an acoustic field in a closed volume and in an unlimited space, allowing for boundary conditions with respect to pressure, velocity or impedance, as well as allowing for environmental impedance load on thin, vibrating structures.

APPLICATION

Measurements and analysis of parameters of electroacoustic transducers including: speakers, microphones and loudspeaker sets; parameters of ultrasonic transducers; parameters of light vibrating structures, e.g. foil, microprostheses, bone tissue and biological structures. Measurements and analysis of distribution of vibrations on miniature objects; distribution of

vibrations on large-size objects, e.g. turbines, casings, and even buildings; vibrations of hard-to-access structures, e.g. at high temperatures or exposed to hazardous radiation. Measurement and analysis of diffusion of sound on geometrically irregular objects or objects of irregular acoustic impedance, as well as vibration attenuation efficiency and limitation of noise emissions.

MEASUREMENTS OF ELECTROMAGNETIC FIELD INTENSITY IN THE OPERATING AND GENERAL ENVIRONMENTS IN DC-90GHZ RANGE

RESEARCH

Determination of field intensity in areas surrounding certain types of devices or installations, optional solutions related to limitation of exposure to electromagnetic field, theoretical analyses of distributions of electromagnetic field in areas surrounding devices or installations (Accreditation PCA AB-361).

APPLICATION

Evaluation of employees' and population's (general environment) exposure to electromagnetic field of devices and installations, e.g. high-voltage lines, medical and industrial devices (induction heaters, welding machines, high frequency and microwave dryers, microwave drying and mineralisation installations), radio communication systems, including mobile telephony stations, radio and television transmitters, Wi-Fi hot spots, and other radio communication systems.

MEASUREMENTS OF BASIC ELECTRICAL QUANTITIES

RESEARCH

Measurements of basic electrical quantities: voltage, direct and alternating current intensity, power and energy, impedance and RLC elements' parameters, frequency and period of periodic signals, duration of phenomena, parameters of electronic and electrochemical (storage cells) sources of voltage and current. Measurements can be performed with the use of direct or indirect methods, depending on specific needs, and the character of the object of measurement. The unit offers its apparatuses to be used over an agreed time by the client or by the laboratory's qualified staff.

APPLICATION

Measurements of basic electrical quantities for business entities dealing with electronic equipment, interested in verifying their devices', or their components' operation.

DESIGN OF ELECTROACOUSTIC SYSTEMS FOR DRAMA AND MUSIC THEATRES AND OTHER FACILITIES

EVALUATION

Development of project documentation for electroacoustic systems at the concept, construction or detailed design level, with respect to facilities including:

- **auditoria,**
- **drama and music theatres, concert and opera halls, assembly halls,**
- **acoustic measurement laboratories, schools of music,**
- **recording studios.**

DESIGN WITH THE USE OF NUMERICAL METHODS

TECHNOLOGY

Numerical methods are commonly used in industry in order to design, optimise and analyse selected process and product parameters. Numerical design is a time and cost saving solution allowing improvement of product reliability. The designing process usually starts in CAD programs, to be followed by modelling and simulation in order to analyse selected physical parameters, e.g. distribution of stress and temperature, electric and/or magnetic field, trajectory of charged particles, etc. The next stage involves a single- and multi-objective optimisation process, whose aim is to select proper parameters, analyse sensitivity and choose tolerance. This process is usually conducted using parametric models of products and processes.

APPLICATION

Designing using numerical methods is used in the following fields of engineering: mechanics, electronics, mechatronics, etc. Despite wide access to numerical design programs, their price as well as required experience and knowledge, especially the use of optimisation methods which require a large number of iterations, can be a problem.

VACUUM DEPOSITION OF THIN LAYERS

TECHNOLOGY

Works in the area of vacuum deposition of thin layers (conductive, resistive, magnetic, dielectric and composite) on metal, ceramic and plastic surfaces and elements. Layers can be obtained using the following techniques:

- **magnetron sputtering (DC, impulse), evaporative deposition, thermal deposition,**
- **electron beam vapour deposition.**

APPLICATION

Vacuum-deposited thin films (layers or multilayers) are used, among other things, as: food package barrier layers; decorative, antireflexive, hydrophobic layers, photocatalytic glass coating; hard coating of cutting tools, magnetic layers of mass storage media; transparent electrodes of photovoltaic cells, etc.

PORTABLE MICROFLUIDIC INSTRUMENTS FOR COMPREHENSIVE DNA ANALYSIS

TECHNOLOGY

DNA analysis with the use of standard laboratory equipment is time-consuming and limited to a stationary laboratory. Employing the possibilities of lab-on-a-chip technology, mechatronics and microengineering allows us to miniaturise equipment and develop a new class of devices that can shorten the analysis time, decrease reagent consumption and increase analysis sensitivity. Portable microfluidic instruments presented here are the first devices for conducting a full cycle of quick DNA analysis in Poland using lab-on-a-chip technology. Three independent instruments allow us to, respectively: isolate DNA using the membrane method, replicate and analyse DNA with the use of the PCR method, and detect DNA mutations using MSSCP electrophoresis. The instruments can be used intuitively using touch screens and graphical user interface software. After insertion of the sample and reagents, the analysis is conducted automatically, and the results are presented on the display of the instruments, and stored in a database.

APPLICATION

Microfluidic instruments are a key element in the newly designed mobile analytical laboratory for detecting biological hazards and bioterror attacks. They have been validated in field conditions, allowing quick detection of numerous pathogens (i.a. Bacillus anthracis, Yersinia pestis, Vibrio cholerae, avian influenza virus). Analysis is conducted using standard reagents. Thanks to the micro-scale effect, it is possible to reduce the complete analysis time (isolation, PCR, MSSCP) to about 1 hour. The instruments constitute a comprehensive system for DNA analysis, but they can also be used individually as support for existing nucleic acid analysis systems.

FACE RECOGNITION IN INDUSTRIAL SURVEILLANCE CAMERAS FEATURING ANDROID SYSTEM-BASED DEVICE CONTROL

RESEARCH

Face recognition with the use of a discriminant analysis method (kernel discriminant analysis, neuron networks) on the basis of the Android operating system.

APPLICATION

Automation of industrial processes.

OPTICAL SPECTROSCOPY

RESEARCH

Determination of the quality of radiation emitted by light sources, optical filters, spectral transmission of objects.

APPLICATION

Spectroscopy is based on analysis of radiation emitted or absorbed by objects or substances as a function of the frequency of the radiation. The analysis allows us to determine the composition of the substance or different properties of objects (e.g. parameters of optical filters, quality of radiation emitted by light sources). A measuring tool used to measure a spectrum is a spectrometer.

CONTROL OF ELECTRICAL ENERGY QUALITY

RESEARCH

Intelligent algorithms for control of electrical energy quality in non-linear objects; theory and technique.

APPLICATION

Automation of industrial processes.

TUNING AUDIO SYSTEMS

TECHNOLOGY

Regulation of electroacoustic systems with respect to sound levels, frequency characteristics, latency, choosing optimal audio crossover frequency and settings of dynamics processors.

APPLICATION

Determining optimal settings of sound systems, allowing obtainment of required parameters, such as: speech intelligibility (STIPA); sound level; signal-to-noise ratio, balanced or appropriately shaped frequency response.

MICROREACTION TECHNIQUE

TECHNOLOGY

The chemical industry's increasing interest in microreaction technology results from a significant reduction in the costs of chemical plant construction, start-up and maintenance. Implementation of a new chemical reaction on an industrial scale - i.e. the „macro" scale - first requires development of a small test chemical plant and then making a large financial commitment to the construction of a large plant - a chemical production facility. On the „micro" scale, it is possible to skip the test system, while the cost of transferring the chemical process from the laboratory phase to production, to put it in simple terms, does not exceed the cost of a few / several identical microreactors.

APPLICATION

Conducting chemical reactions on the micro scale is steadily gaining in importance. Testimony to that can be the developing market of microfluidic chips, including chemical microreactors. Also companies offering chemical installation solutions applying microreactors are experiencing growth.

TERAHERTZ TECHNOLOGY

RESEARCH

Terahertz technology is used to create and detect waves within a range of 0.3 - 10THz. These waves have unique properties which imply their applications. They can penetrate through dielectrics (clothing and packaging), which makes them competition to X-ray technology, as they are non-destructive in terms of their biological effect. They can be used as scanners at airports, parcel scanners, or to inspect electronic elements. Other uses of THz waves are related to spectroscopy in this band. Hence detection and identification of biological objects (mould, drugs) as well as characteristics of molecular objects, e.g. pharmacological, their qualification and, consequently, a reduction in the cost of research on living organisms and shortening of the production process.

- **spectral analysis of pharmaceuticals, food and biochemical products,**
- **detection and identification of hazardous materials, screening of dielectric materials and visualisations of lesions,**
- **research on molecular crystals and other components, including graphene, fullerene and other nanoparticles, as possible drug carriers in the human body.**

APPLICATION

Biomedicine, food and pharmaceutical industry, public and military safety.

CERAMIC MICROFLUIDIC MODULE TECHNOLOGY

TECHNOLOGY

Design, development and research of the properties of LTCC microfluidic modules. The design of a module is developed on the basis of the results of numerical simulations of phenomena related to flow and transport of mass and energy in a micro-scale. LTCC technology allows us to manufacture multi-layered ceramic surfaces with buried and surface micro-channels, chambers and recesses with characteristic dimensions from 100μm to single centimetres. Integration of electronic components (e.g. conductive traces, passive components, integrated circuits, etc.), optoelectronic components (e.g. light sources and sensors, optical fibres, etc.), heating elements, micromechanic and microfluidic structures in a single multi-layered ceramic module. The available technology allows us to manufacture integrated microfluidic systems designed for quick, quantitative detection of liquid substances in extremely small amounts.

APPLICATION

The technology which has been developed allows us to manufacture integrated microfluidic systems designed for quick, quantitative detection of liquid substances in extremely small amounts. These devices can be used, among others, for flow analysis of chemical pollution of waters (heavy metals, phosphates, nitrates) or quick preliminary medical diagnostics in the home-care setting.

MEMS-BASED CESIUM OPTICAL MICROCELL TECHNOLOGY

TECHNOLOGY

The technology utilises a set of procedures of silicon and glass microengineering with the use of deep micromechanic processing (applying KOH wet etching or DRIE techniques) of silicon plates and joining this material with two plates of a given type of glass by anode bonding in a buffering gas atmosphere. Thus, microcontainers (~1 mm) are created, where laser-activated sources of atomic cesium, the so-called dispensers, are located. After the activation, the glass and silicon plate sandwich is cut into separate microcell chips, which are independently fitted in a speciality casing, together with a VSCEL microlaser, microoptical circuits and a p-i-n microdetector. Inside the casing, microheaters and temperature sensors are placed as well so that it is possible to maintain a constant temperature, about 70°C, of the cesium cell.

APPLICATION

Market-wise, the application is very wide, as the demand is practically unlimited. It is a core component of the MEMS atomic micro clock.

MINIATURE VACUUM DEVICE TECHNOLOGY

TECHNOLOGY

Technology of MEMS (micro-electro-mechanical systems) vacuum units uses silicon and glass microengineering processes. It allows us to manufacture components consistent in terms of material and technology used, such as: a mobile electron gun, a high vacuum ion-sorption micropump, or an ionisation pressure sensor. These components are characterised by their small dimensions (from a few millimetres to a few centimetres) and can be integrated with other MEMS devices. The micropump can remove the internal volume of the MEMS (around 1 cm3) and achieve a pressure of around 10–5 Pa. The mobile electron gun allows to generate a concentrated beam of electrons of energy up to 1500 eV, and the ionisation pressure sensor operates in a broad range between 20 Pa and 10–5 Pa, which is unachievable for other MEMS sensors.

APPLICATION

The technology of miniature MEMS vacuum units is used in manufacturing of components of high-quality miniature radiation detectors, mass spectrometers, sources of X-ray radiation, micro atomic clocks and vacuum equipment for use in space. The MEMS micropump, which generates high vacuum both inside integrated MEMS devices and inside a sealed enclosure, is particularly useful.

MULTI-LAYER CERAMIC MODULE TECHNOLOGY

TECHNOLOGY

Designing, manufacturing and analysing electric properties of ceramic MCM modules. Coating of a surface made of alumina ceramics or a layer of LTCC ceramics with conductive traces and passive components, using the silkscreen or photosensitive paste techniques. Passive components (resistors, capacitors, transmission lines, coils, varistors) can perform as planar elements on the surface of alumina or LTCC ceramics, or as 2D & 3D elements buried within the LTCC structure. The minimal width of traces performed using the silkscreen technique is 100 µm, and using photosensitive paste – 50 µm. Performing vias, which provide electrical connection between layers or are used to carry heat away. Performing electrical connections of contact pads of chips and MCM structures with the use of SMT (Surface Mounting Technology) and flip chip.

APPLICATION

An MCM module consists of many insulation layers, conductive traces and vias that provide electrical connections between layers or are used to carry heat away. LTCC modules are widely used in high-reliability devices, used to work in difficult climate conditions. Apart from typical uses in VLSI circuits, LTCC ceramics can be used to manufacture passive components and sensors. Passive components (resistors, capacitors, transmission lines, coils, varistors) can perform as planar elements on the surface of alumina or LTCC ceramics, or as 2D & 3D elements buried within the LTCC structure.

THERMOVISION

TECHNOLOGY

Cooperation in the area of development and implementation of technologies applying thermovision.

APPLICATION

Thermovision cameras/modules allow recording a thermovision image within the range of 8-14 µm. They are applied in monitoring of industrial processes as well as surveillance security systems.

INDUSTRIAL AUTOMATICS AND CONTROL SYSTEMS

RESEARCH

Digital signal processing in electric power automation. Measurement and decision algorithms for control and protection in electric power systems. Identification and modelling of dynamic industrial facilities.

APPLICATION

Automation of industrial processes.

ULTRASONIC IMAGING OF VARIOUS MEDIA'S INTERNAL STRUCTURES

RESEARCH

Ultrasonic imaging of interior structure is based on using various acoustic parameters related to transmission of ultrasonic waves, such as: wave propagation speed, damping, derivative of the attenuation coefficient in relation to centre frequency, and parameters related to reflection of ultrasonic waves from inhomogeneities of the medium.

APPLICATION

Research with use of ultrasonic tomography methods and echographic methods of various internal structures of medium for the needs of industry and medical diagnostics.

LASER VIBROMETRY

RESEARCH

Contactless, multipoint measurement of vibrations with a laser vibrometer Vibrations amplitude: 0.1 um – 3 mm, frequency: 0.1 Hz -10 kHz. Measurements of dislocation, velocity, acceleration, spectral characteristics diagrams. Acquisition of data to a file. The measurement application can be tailored to the user's individual needs.

APPLICATION

Contactless measurements of vibrations.

PRODUCTION AND CHARACTERISATION OF THIN-LAYER COATINGS

TECHNOLOGY

Design, manufacturing and characterisation of properties of metal-based and metal-oxide-based (doped with various elements) thin layers. Coating is manufactured on the basis of materials with a Nano Crystal structure, offering unique electrical and optical properties for the needs of so-called transparent electronics. These include, in particular, thin layers of transparent semiconductive or conductive oxides. Coating is manufactured using a modified method of magnetron sputtering (developed and patented by our employees) or electron beam vapour deposition. Characterisation includes the analysis of structural, optical, electrical photocatalytic or antistatic properties of single- and multi-layer functional coatings.

APPLICATION

Metal- and metal-oxide-based thin layers can be used as functional coating in microelectronics, transparent electronics, photovoltaic industry or ophthalmic industry.

CALIBRATION OF ELECTROMAGNETIC FIELD SENSORS, PROBES AND MEASURING INSTRUMENTS

RESEARCH

Calibration of magnetic, electric and electromagnetic field meters in the frequency range of DC-90GHz. Accreditation of the calibration laboratory - PCA AP-078.

APPLICATION

The calibration works performed by the accredited calibration laboratory (accreditation no. PCA AP-078) - determination of metrological characteristics of meters for laboratories applying measurement equipment for analyses of electromagnetic fields.

APPLICATIONS OF PROGRAMMABLE DIGITAL SYSTEMS

TECHNOLOGY

Design, implementation and tests of digital devices applying CPLD and FPGA programmable logical systems.

APPLICATION

- **organisation of single-circuit System on Chip systems, implementation of processor architectures (CISC, RISC, SIMD),**
- **hardware based support for interfaces including SPI, I2C, PS/2, RS-232, implementation of built-in USB controllers, application of non-volatile Flash memory systems with serial or parallel interfaces,**
- **support for standard Flash memory cards (SD, MMC, CF…).**

ANALYSES OF WATERS AND SEWAGE COMPOSITION

RESEARCH

Physicco-chemical analyses of waters and sewage with the use of the unit's apparatuses.

APPLICATION

Municipal services, industry, public administration units.

ENERGY PERFORMANCE AUDITS, EVALUATIONS AND SUPPORT IN DECISION-MAKING ON THERMAL MODERNISATION OF CIVIL STRUCTURES

EVALUATION

Energy performance audits, recommendations and analyses related to thermal modernisation of existing buildings involving thermal sheathing, heat sources and heating/cooling systems. Support in the area of selection of the most beneficial thermal modernisation solutions. Evaluation and improvement of residential and industrial buildings' existing thermal management, based on calculations, periodic financial settlements for energy use, as well as direct measurement. Implementation of an energy management system.

PHYSICAL STUDIES AND CHEMICAL ANALYSES OF WATER, SEWAGE, WASTE, SOILS, AIR AND BIOLOGICAL MATERIAL

RESEARCH

Physico-chemical analysis with the use of classic and instrument-based methods: electrochemistry, potentiometry, VIS molecular spectroscopy, absorption and emission atomic spectroscopy, ion liquid chromatography, and gas chromatography.

APPLICATION

Determination of physico-chemical parameters in environment components. Determination of the content of metals in packaging, in compliance with art. 5 sec. 1 item 4 of the Act (Journal of Laws 2001, no. 63, item 638). Analysis of the extent of air pollution based on determination of the concentration of volatile organic compounds.

STUDIES OF AIR, ROAD, TRAMWAY AND RAILWAY TRAFFIC NOISE

RESEARCH

Studies of environmental noise conducted in accordance with the reference methodology that is in compliance with the Regulation of the Minister of Environment concerning the requirements for measurements of substances or energy levels in the environment conducted by the road, railway line, tram line, or port manager. They entail the measurement of noise as well as accompanying measurements of traffic volume and meteorological conditions.

Studies of environmental noise - caused by road, railway and tramway traffic - are carried out with the use of direct and indirect measurement methods as well as computation method, with professional CadnaA software applied for acoustics-related computation tasks. Periodic measurements of environmental noise caused by air traffic are carried out with the use of the indirect measurement method. The studies involve the use of Class 1 digital noise level meters with the possibility of saving the sound level over time in the device's memory.

The results of noise level measurement - i.e. values of noise indices for day (LAeqD) and night (LAeqN) - are presented along with the expanded uncertainty at a level of confidence of approximately 95%. The studies of traffic noise are accredited by the Polish Centre for Accreditation (accreditation no. AB 796).

APPLICATION

- **periodic measurements of traffic noise conducted in connection with use of public roads, railway lines, tram lines, and airports,**
- **control and as-built measurements of traffic noise conducted in order to determine whether environmental quality standards are met,**
- **forecasting of traffic noise levels for planned situations,**
- **reliable determination of noise levels as a basis for establishment of a required acoustic insulation of barrier walls in buildings.**

MODEL STUDIES OF WATER SUPPLY AND SEWAGE FACILITIES IN LABORATORY, HALF-TECHNICAL AND TECHNICAL SCALES WITH THE USE OF EXPERIMENTAL AND NUMERICAL TECHNIQUES

RESEARCH

Comprehensive model studies in laboratory, semi-technical and technical scale, using experimental techniques and numerical facilities in the field of engineering environment (e.g. water tanks, separators, overflows, flow regulators, separators of petroleum substances). Combination of experimental and numerical techniques helps to reduce the time and cost of implementation. For the performance of tasks, the following is used among others: hydraulic system (closed cycle with a maximum flow capacity of 25 L/s), modern measuring devices, calculation server, profes-

sional scientific and technical software. Also offered are services for optimising the design of facilities and devices, using techniques of numerical modelling of (CFD) flows using programs such as ANSYS Fluent and OpenFOAM. Portable devices to perform measurements and field studies in technical scale on actual facilities are used in the studies.

APPLICATION

Implementation of new devices for production - from concept to implementation in industrial scale. Hydraulic modernisation, optimisation and development of the existing designs of devices. Testing of solutions in boundary and extreme conditions. Reduction of time and cost for the implementation of new and improved solutions and designs of facilities used in environmental engineering.

STUDIES OF WASTE GAS AND BIOGAS PURIFICATION PROCESSES

RESEARCH

Laboratory and technological tests of methods and installations for the disposal of gaseous and dust pollution from industrial gases and combustion gases. Studies on new technologies of biogas treatment.

APPLICATION

The objective of the studies is the optimisation and intensification of existing industrial installations for the treatment of gas and testing new technologies. The offer is open to the broadly understood industry, power engineering, and municipal management (biogas plants at landfills and wastewater treatment plants, agricultural biogas plants).

STUDIES OF HEAT SUPPLY SYSTEMS AND INSTALLATIONS

RESEARCH

The studies concern selected elements, installations or the whole systems providing heat to civil structures, buildings or other complexes in which heat is used for providing suitable temperature conditions. They can relate to conditions of manufacture, transmission and the reception of heating medium, quantity of heat and conditions of thermal comfort, obtained as a result of the operation of the system supplying heat.

APPLICATION

Diagnosis and analyses of the functionality and energy efficiency of existing or designed systems supplying heat.

STUDIES OF MICROBIOLOGICAL BIODIVERSITY OF ENVIRONMENTAL SAMPLES

RESEARCH

Identification of microorganisms based on conventional methods and methods of molecular biology, appearing in different environment elements: water, wastewater, sewage sludge, soil, external and internal air.

APPLICATION

Identification of microorganisms can be helpful, among other things, for:

- **assessment of the operation of equipment in environmental engineering (water treatment, waste treatment, water industrial installations),**
- **assessment of the sanitary condition of water, soil and sewage sludge; related to bioremediation/phytoremediation of water, soil and sewage sludge,**
- **studies on biodegradation of environmental pollution and the development of biopreparations to trigger the process of their biological decomposition, identification and the test of biological activity of the metabolites of biodegradation transformations,**
- **studies on the spread of bioaerosols around the emitters of microbiological contamination (mainly solid waste dump sites and wastewater treatment plants) and determining the extent of their impact on the environment.**

STUDIES OF AIR SUPPLY COMPONENTS

RESEARCH

The tests are carried out in the climatic chamber (internal dimensions 4 m x 4 m x 3.5 m, with a capacity of 56 m3), with a forced circulation of air (air flow in the range of 500÷3000 m3/h). Temperature of the air supplied to the chamber can change in the range 10÷400°C. A mesh of sensors of air velocity, degree of turbulence and temperature was installed inside the chamber. The air ventilating the chamber is supplied and exhausted by a system of parallel ducts (4 air supply ducts and 4 exhaust air ducts). On each of the ducts a temperature transducer is installed (resistance sensor), as well as a relative humidity sensor (capacity sensor), control damper and measuring orifice plate. It is possible then to control air parameters (temperature, humidity, flow) for each supply air and exhaust air duct supporting the chamber. A steam humidifier is installed on the main duct supplying the air to the chamber. The air supplied to the chamber can be heated, cooled, or humidified. The chamber also allows simulation and observation of the propagation of gaseous pollutants inside the room (after installing suitable sensors, e.g. CO_2).

APPLICATION

Tests are carried out to determine the thermal output of exchangers for heat recovery. Determination of the characteristics of flow for air supply elements of different types (supply grilles with louvre slats, air valves, perforated boards). Testing of ventilation systems (organisation of air exchange) in systems: up-up and up-down and simulation of the surface source of heat and cold.

STUDIES OF INDUSTRIAL NOISE

RESEARCH

Studies of industrial noise in the environment are carried out in accordance with the applicable reference methodology specified in the current directive of the Minister of the Environment on the requirements in the area of measuring the extent of emission as well as measuring the amount of water consumption. The studies in question are conducted with the use of measurement and computation based methods, with professional CadnaA software applied for acoustics-related computation tasks.

Also used are grade 1 digital analysers/meters of sound level, enabling measurement of the frequency characteristics of sound in 1/3 and 1 octave ranges as well as storage of measurement data in computer memory. The results of noise level measurement - i.e. values of noise indices for day (LAeqD) and night (LAeqN) - are presented along with the value of expanded uncertainty ranges (with estimated confidence level of 95%).

The studies of noise generated by installations and devices, including impulse noise, are accredited by the Polish Centre for Accreditation (accreditation no. AB 796).

APPLICATION

Periodic measurements of environmental noise generated by installations and devices. Test check-ups and as-built measurements of environmental noise generated by installations and devices in order to determine whether environmental quality standards are met. Forecasting levels of environmental noise generated by installations and devices for the purpose of environmental impact evaluations, action plans and integrated permits.

STUDIES OF INDOOR AIR QUALITY WITH RESPECT TO VOLATILE ORGANIC COMPOUNDS

RESEARCH

- **development of measuring apparatus in which gas sensors are used,**
- **development of methods for the assessment of air quality found in different types of rooms.**

The subject of designation is first of all volatile organic compounds. The methods and techniques used allow us to measure the sum of volatile organic compounds quickly and at a relatively low cost. Measurements are done in continuous mode, in real time, in-situ or in the on-line mode.

APPLICATION

Identification of the sources of emission of air pollutants - including those associated with corona discharges and failures; detection of volatile organic compounds in the surrounding air and determination of the concentrations of these substances in field conditions, in real time.

STUDIES OF EXCHANGERS

RESEARCH

Tests are carried out at the laboratory station, which is equipped with a source of heat and cold, with adjustable power and temperature. The air is pumped through the exchanger undergoing tests. Based on heat balance and air flow, the efficiency and performance of the exchanger is determined.

APPLICATION

Tests are carried out to determine the thermal output of exchangers for heat recovery.

ENERGY EFFICIENCY AND CHARACTERISTICS OF BUILDINGS AND HEATING SYSTEMS

EVALUATION

Evaluation of energy efficiency of buildings and heating systems. Evaluation of theoretical and actual efficiency of structures. Development of energy certificates, evaluations of buildings' heat protection and supply solutions allowing for unconventional and renewable energy sources.

EVALUATIONS OF THE COMPONENTS OF HEAT SUPPLY SYSTEMS AND HEATING INSTALLATIONS

EVALUATION

Expertise can concern devices, fragments and whole installations or systems supplying heat to civil structures, buildings or other complexes in which heat is used to provide suitable thermal conditions. It can concern the stage of design developments, implementation or operation. The subject of analyses can also be the conditions of settlement for the consumption of heat or the distribution of the cost of heating in multi-duplex residential buildings.

IDENTIFICATION OF AEROSOL AND ODORANTS ALLOWING FOR METHODS OF THEIR ELIMINATION FROM THE ENVIRONMENT

RESEARCH

Identification of aerosol and odorant emission sources including evaluation of health hazards and development of solutions in the area of limitation of their emission to the atmosphere. The unit's facilities and apparatus are available for research use.

APPLICATION

The studies make it possible to identify the sources and determine the emission of particulates and odorants to the atmosphere, as well as evaluate their distribution in particular areas and develop concepts of their reduction and deodorisation.

IDENTIFICATION OF POLLUTANTS EMITTED TO THE ATMOSPHERE THROUGH FUEL COMBUSTION, INCLUDING BIOMASS, ALLOWING FOR METHODS OF THEIR ELIMINATION

RESEARCH

Identification of pollutant emission including development of solutions in the area of limitation of their emission to the atmosphere. The unit's facilities and apparatus are available for research use.

APPLICATION

The studies make it possible to determine emission of pollutants to the atmosphere as well as develop recommendations for an optimal relevant method/solution.

IDENTIFICATION OF SOURCES OF AIR POLLUTION, EVALUATION OF THE ATMOSPHERIC AIR IN PARTICULAR AREAS ALONG WITH RISK ANALYSIS

EVALUATION

Suggested expertise and assessments in the fields of: methodology of consumption and measurements of air pollution (including odours), statistical and mathematical tools for the assessment of the quality of free air, methods of the identification of the dynamics of changes in the air on a global scale, methods of the assessment of carbon traces in the environment, assessments of environmental risk, assessments of the impact of investments on the environment, assessments of the application of low emission solutions, techniques of limitation/elimination of pollution and assessments of health effects caused by atmospheric pollution.

AGEING SIMULATION CHAMBER (UV, WATER)

RESEARCH

Studies using ATLAS - SunTest XLS chamber.

APPLICATION

The chamber enables studies to be conducted on the impact of UV and humidity (accelerated ageing) on the top layer of materials, located in the chamber. It is possible to adjust the intensity of the radiation beam, depending on your needs from a gentle to oppressive impact on the material. The materials can be:

- **cosmetics,**
- **pharmaceuticals - tests of photostability, plastic,**
- **paints and varnishes, textiles,**
- **printing inks.**

CONCEPT DESIGNS OF PRECIPITATION WATER RETENTION SOLUTIONS

TECHNOLOGY

Design ideas for the detention of polluted stormwater allow us to solve problems associated with the disposal and detention of excess stormwater, flowing from developed land (housebuilding industry, industrial building services, roads and car parks) or areas for development in the future.

Calculations for the retention of stormwater using detention basins will be made on the basis of professional software. When evacuating stormwater to the recipient (river, ditch, a watercourse), the administrator of the recipient usually limits the stream of wastewater supply which can be reduced through the use of properly designed detention basins.

APPLICATION

Detention of stormwater can be used to reduce the maximum stream of stormwater discharge to the recipient, which has a limited capacity, lesser than the stream of influent wastewater. It is possible to include new stormwater catchment areas to an existing stormwater drainage network without substantial reconstruction, using properly designed detention basins on the designed or existing stormwater drainage or combined sewer system.

MICROBIOLOGICAL CONTROL OF TREATMENT AND DISTRIBUTION OF WATER INTENDED FOR HUMAN CONSUMPTION

RESEARCH

- **microbiological control of water treatment processes together with a sanitary analysis,**
- **detection of the presence of substances with mutagenic and toxic effects in tap water on the basis of bacterial short-term bacterial tests,**
- **biodiversity of microorganisms forming biological growths in water supply networks, on the basis of conventional methods and methods of molecular biology,**
- **detection of the formation of micro-biological growths in water supply networks using impedance spectroscopy and biochemical tests,**
- **degree of adhesion of micro-organisms and kinetics of the formation of biofilm on construction materials of water pipes,**
- **presence of micro-organisms resistant to antibiotics and disinfectants in tap water.**

APPLICATION

Negative phenomena associated with the water supply include the formation of biological growths on the internal surfaces of water pipes, which are the cause of secondary microbiological contamination of water and the presence of micro-pollution in it forming as a result of treatments related to water conditioning and disinfection.

MODELLING OF SEWAGE SYSTEMS PERFORMANCE

RESEARCH

Verification of the hydraulic capacity of existing and proposed sewage networks and specification of the number of the operation of storm water overflows and the estimation of the frequency of overflows from the sanitary drainage network. Modelling will be performed using hydrodynamic software based on the calculation motor SWMM (Storm Water Management Model).

APPLICATION

Modelling is used for the verification of existing and proposed solutions of systems for the evacuation of wastewater from the point of their compatibility with decrees (e.g. number of the operation of overflows), standards (e.g. frequency of overflows from the drainage system) or hydraulic projects (e.g. quantity of polluted stormwater evacuated).

MODELLING OF WATER SUPPLY SYSTEMS PERFORMANCE

RESEARCH

Comprehensive construction (including: extension, update or upgrade), calibration and validation of hydrodynamic models of the water supply network. Hydraulic calculations and changes in the parameters of water quality in distribution networks for fixed and non-fixed conditions are also made (hydraulic impact). Simulations can be carried out for average conditions, in any time-frame and almost in real-time. Construction of simulation models based on calculation-commercial programs (e.g. Bentley, DH) and non-commercial ones (e.g. EPANET). Analysis of the distribution of water to optimise the operation of water supply facilities (pumping stations, network tanks, pressure reducing valves). Management of pump systems and analyses of the optimisation solutions in terms of electricity consumption. Studies on water quality changes in the distribution system (including tracking the pollution or determination of the age of water). Solving the issues of the integration of hydrodynamic models with GIS system and telemetry systems. Construction of the virtual control room and training the staff to perform the analyses.

APPLICATION

Simulations of the functioning of the systems of water distribution make it possible to reconstruct and preserve real or designed networks. Operation on the numerical model of networks makes it possible to analyse the scenarios which in the actual scale would be technically impracticable and expensive or difficult for metering and billing. Simulations make it possible to predict the response of the system without disturbing the operation of the actual system.

EVALUATION OF THE HYDRAULIC AND ENERGY EFFICIENCY OF WATER AND SEWAGE PUMPING STATIONS

RESEARCH

Assessment of hydraulic-energy efficiency is developed for individual copies of pumps on the basis of studies carried out in accordance with Polish Standard PN-78/M-44005. The result of these studies is to obtain the basic parameters of pumps in the whole range of their operations in the pump system analysed, i.e. capacity, height of lifting and total efficiency. The studies carried out can be performed in the operating pumping stations of water or sewage without dismantling the pumps tested if they are temporarily switched off the current operation. On the basis of the results obtained, the assessment of individual pumps is made from the point of technical wear and actual hydraulic operating parameters in relation to catalogue value provided by the manufacturers of these devices. The results obtained allow us to identify actual parameters of the cooperation of pumps, with parallel or serial operation.

APPLICATION

The assessment of hydraulic-energy effectiveness of the pumping station is necessary in water supply and drainage system plants for the efficiency of water and wastewater management, due to current repairs planned and main pumps, and replacing them for newer machines, with higher total efficiency. The effect of the optimisation of pump operation in the pumping stations is a reduction in the consumption of electricity in the system of transport and distribution of water or wastewater.

EVALUATION OF MICROCLIMATE IN ROOMS

EVALUATION

Assessment of the parameters of internal air to determine the parameters of the microclimate of rooms. Comparing the results of studies with guidelines for heat or technological comfort for rooms with different functions and intended use. Specifying the level of PMV and PPD for rooms and buildings. Expertise can include: assessment of thermal, humidity conditions and the speed of air and the system of pressure between rooms and free air, and the assessment of the level of the sound of noise in rooms in octave frequency bands and the average value expressed in dB(A).

EVALUATION OF THE PERFORMANCE OF VARIOUS HEAT EXCHANGERS, INCLUDING HEAT RECOVERY EXCHANGERS

EVALUATION

Assessment of different designs of heat exchangers, to specify their actual operating parameters. The subject of assessment can be heat exchangers of the type air-air, air-liquid, air-exhaust gases and liquid-liquid, etc.

EVALUATION OF INSTALLATION-RELATED SOLUTIONS IN THE AREA OF AIR CONDITIONING AND VENTILATION TO ASSURE CONFORMITY WITH THE PERMISSIBLE NOISE LEVELS IN CIVIL STRUCTURES

EVALUATION

Assessment of installation solutions of ventilation and air conditioning, related to the fulfilment of requirements on permissible levels of noise emitted by devices to rooms and the external environment. The subject of assessment can be installations supporting all kinds of rooms and facilities, i.e. industrial, public utility and residential.

ASSESSMENT OF DESIGN SOLUTIONS AND EVALUATIONS OF HEATING AND THERMAL SYSTEMS

EVALUATION

Technical, economic and operation assessment of design solutions of heating and thermal systems, basic and structural solutions from the point of technological solutions, providing quality of energy supply, reliability and operation. Concepts and projects of unusual solutions and for specific facilities, using extensive know-how in the field of heating.

EVALUATION OF VENTILATION AND AIR CONDITIONING SYSTEMS FOR PUBLIC UTILITY AND INDUSTRIAL FACILITIES

EVALUATION

Evaluation of the solutions of ventilation and air-conditioning systems at the stage of design, execution and in the facilities already existing from the point of the possibilities to execute processes of air treatment, keep up the parameters of internal air and energy efficiency. The subject of assessment can be installations supporting all kinds of rooms and facilities, i.e. industrial, public utility and residential. In the area of expertise there can be air installations, heating and cooling medium.

EVALUATION OF THE EXTENT OF CONTAMINATION OF PARTICULAR ENVIRONMENT AREAS WITH THE USE OF BIOINDICATION TESTS

RESEARCH

Bioindication is a method of global assessment of the quality of water, soil and air, carried out in a battery of biotests, based on the use of single-celled or small multi-celled organisms, belonging to different trophic levels, which as a result of contact with the sample tested provide specific information. On the basis of bioindication tests, total toxicity or genotoxicity of all chemical substances in a specific sample can be assessed.

As part of the offer, the unit can carry out tests in the fields of: detection of the presence of substances with genotoxic effects in samples of water, wastewater, sewage sludge, soil and dust pollution of air, based on bacterial short-term tests (Salmonella test- Amesa test, SOS-Chromotest, UMU-test), for the detection of the presence of substances with toxic effects in samples of water, wastewater, sewage sludge, soil and plant extracts, based on fast miniaturised tests, which are standards for acute and chronic toxicity tests (Microtox, Daphtoxkit, Algaltoxkit, Phytotoxkit).

APPLICATION

The tests offered can be helpful when, among other things: estimating potential health risks resulting from contamination of the natural environment; specifying the extent of contamination and selecting places which must be subjected to further chemical tests or reclamation; monitoring the effectiveness of remediation processes; testing the degree of wastewater and sewage sludge toxicity and monitoring waters in order to protect the water sources for drinking and living organisms.

PURIFICATION OF BOILER COMBUSTION GASES OF GASEOUS CONTAMINANTS (SO_2, HF, HCL) USING THE WET LIME METHOD

TECHNOLOGY

Studies concerning the effectiveness of SO_2 removal from furnace gases using limestone sorbents.

Studies are carried out in a vertical spray scrubber in macro-laboratory scale. It is possible to specify the impact of variable parameters (temperature, combustion gas flow rate, SO_2 concentration at the inlet to the device, type of sorbent) on the effectiveness of the removal of gaseous pollutants.

APPLICATION

The technology can be used in gas treatment from different types of boilers, in particular from boilers equipped with wet installation desulphurisation. This method can help in choosing the right type of sorbent for the technology designed.

RENEWABLE ENERGY SOURCES – HEAT AND COOL

RESEARCH

Concepts and technologies for the use of renewable energy sources (RES) and non-conventional energy sources (NES) for heating and cooling buildings, preparation of tap hot water and other. Variant analyses of the possibilities and cost-effectiveness of RES and NES application, based on energy and economic simulations. Assessment of the quality of operation, capacity and efficiency of systems. Tests and studies of energy systems RES and NES in laboratory and actual conditions.

APPLICATION

Support when taking decisions on the selection or modernisation of the source of heat or cold in single-family houses, collective residence, public utility and other existing, newly designed and upgraded buildings. Development, studies and assessment of new solutions RES and NES.

OPINIONS FOR COURTS OF LAW ON ENVIRONMENTAL ACOUSTICS

EVALUATION

- **tests of communication and industrial noise in the environment, carried out in accordance with reference methodologies in force by accredited Research Laboratory of Acoustics (accreditation no. AB 796),**
- **evaluation of the level of communication and industrial noise found in the environment in light of applicable legal regulations,**
- **assessment of noise nuisance in light of the latest research and recommendations presented by the World Health Organization (WHO).**

GREEN INFRASTRUCTURE REPORTS, EVALUATION OF ENVIRONMENTAL IMPACTS AND INTEGRATED PERMITS

EVALUATION

Development of studies, expertise and building scenarios of solutions in the field of green infrastructure, execution of reports on the Assessments of Environmental Impact and applications for Integrated Permits for Industrial Plants, building scenarios to manage environmental risk for economic entities.

DESIGN AND MODERNISATION OF TECHNOLOGICAL SYSTEMS FOR WATER AND SEWAGE TREATMENT

RESEARCH

Performing laboratory works assessing the suitability of various physico-chemical and biological technological processes for water treatment and wastewater using the available apparatus facilities.

APPLICATION

Municipal services, industry.

ALLOCATION OF COSTS AND DEVELOPMENT OF REGULATIONS OF HEAT COST ACCOUNTING

EVALUATION

Breaking down the costs of heating rooms in multi-family buildings is an important and difficult technical and formal issue. Well-prepared rules concerning the breakdown of the costs of heating gives residents a sense of stability and fairness and, as a result, eliminates serious conflicts. The assistance offered concerns the preparation of regulations of the breakdown of costs individually, tailored to the specifics of a particular facility or complex of buildings. An additional effect is most often the identification and elimination of places or areas in which heat loss occurs.

TRT TEST

RESEARCH

TRT test is carried out in field conditions. Power supply of 400 V, 15 kW is required for carrying out the test. The circulating medium - water or glycolic solution. The pipes of vertical penetrometers should be flooded with a medium on which the test will be carried out for at least 7 days. The duration of the test is approximately 80 hours.

APPLICATION

TRT test is carried out in order to specify the thermal output of the vertical penetrometer, which is a bottom source for heat pumps. The result of the test, in addition to the thermal output, is also thermal conductivity of the ground and thermal resistance of the ground. Carrying out the test allows us to specify the size of the bottom source of heat (number of penetrometers, depth of boreholes).

APPLICATION OF REGRESSION METHODS AND ARTIFICIAL INTELLIGENCE FOR EVALUATION OF WATER SUPPLY AND SEWAGE SYSTEMS' FAILURE FREQUENCY

RESEARCH

Comparative analysis (on the basis of modelling results and operating data) and selection of the best methodology for predicting reliability indexes, for the water supply system and wastewater disposal under consideration. Modelling is carried out using Statistica software.

APPLICATION

Testing of the failure frequency of water supply and wastewater evacuation systems on the basis of prediction methods available (regression and artificial intelligence), are used to rapidly assess the level of reliability of the networks being analysed. Furthermore, thanks to the use of mathematical modelling, it is possible to evaluate which cables must be replaced or renovated first.

APPLICATION OF MEMBRANE SEPARATION TECHNIQUES FOR WATER AND SEWAGE TREATMENT

RESEARCH

Evaluation of a possibility of application of micro- and nanofiltration and electrodialysis for water and sewage treatment as well as recovery of valuable ingredients from waste water.

APPLICATION

Municipal services, industry.

EXTRUSION

RESEARCH

The set for extruding (Thermo Scientific PolyLab QC) - extrusion of rods, pipes, foil, extrusion with blow, foaming, manufacture of composites and mixtures.

APPLICATION

- **characteristics of viscosity of melted materials and reaction of degradation under thermal and mechanical loads (shear stresses), plasticisation and gelation of dry mixtures (PVC),**
- **flow and relaxation of thermosetting materials and elastomers,**
- **impact of fillers or reinforcing structures, manufacture of the mixtures of polymers or composites for further research.**

INJECTION

TECHNOLOGY

Manufacture of elements from polymer plastic using the injection method and injection moulding machine BOY 35E. Euromap: 350-15/350-52/350-92.

APPLICATION

Manufacture of elements from plastic materials and their composites, depending on the form delivered. The injection moulding machine has the form equipped with the system PRIAMUS, used for the direct measurement (in the mould cavity) of temperature and viscosity of material injected. The data obtained allow qualitative control of the process and assessment of viscoelastic properties in conditions appropriate to processing.

APPLICATION OF SPATIAL ANALYSES, ADVANCED STATISTICAL ANALYSES AND MODELLING FOR EVALUATION OF ENVIRONMENTAL IMPACTS

RESEARCH

Available apparatus facilities and model tools allow the identification of the sources of emission and diagnosis of atmosphere quality with the development of reports on the assessment of the impact on the environment and programs of atmosphere protection.

APPLICATION

Available and applied methods of spatial, statistical analyses and modelling are used for qualitative and quantitative identification and inventory of the sources of pollution emission, including atmospheric air and the assessment of the status of air quality in selected areas together with an indication of the impact of pollution on health.

APPLICATION OF RENEWABLE SOURCES OF HEAT AND COOL

EVALUATION

Variant analyses of the possibilities and cost-effectiveness of RES and NES to power supply with heat and cool, based on energy and economic simulations. Assessment of the quality of operation, capacity and efficiency of RES and NES systems on the basis of calculations, field measurements and settlements for the energy consumed. Estimation of profits from solutions implemented.

STUDIES AND DEVELOPMENT OF TECHNOLOGIES IN THE AREA OF PRESERVATION AND IMPROVEMENT OF AIR QUALITY

RESEARCH

- **development of existing and new technologies for the removal of heavy metals (including mercury and arsenic) from waste gases produced from the combustion of different fuels, e.g. coal, biomass, biofuels and waste,**
- **development of new technologies and improvement of existing technologies: removal of NOx from waste gases produced from the combustion of different fuels, e.g. coal, biomass, biofuels and waste,**
- **simultaneous removal of multiple pollutants in one reactor,**
- **studies of microclimate (also from the point of chemical pollution) in full-size climatic chamber, testing the potential risks related to the presence of organic contamination in the environment.**

APPLICATION

Removal of contamination from exhaust gases to the extent necessary to meet the most stringent legal standards. Development of existing and new technologies for the purification of waste gases. Recipients: power plants, combined heat and power stations, thermal waste disposal plants, industrial boilers using solid fuel.

FINANCIAL ENGINEERING

EVALUATION

Expertise and research related to risk management in companies - both from the point of view of the trade department (market/credit risk management) and in relation to the entire business (enterprise risk management); valuation and management of financial instrument portfolios (including derivative instruments and exchange traded products), as well as construction of protective strategies (so-called hedging). The aim of the expertise is to increase the level of risk awareness in the company, develop principles of a well-operating risk management system tailored to the company's needs, streamline trade portfolio management, and assist in selection of instruments/contracts securing the current exposure to risk.

MATERIALS SCIENCE ANALYSES OF COMPONENTS OF RENEWABLE ENERGY SOURCE INSTALLATIONS

EVALUATION

Renewable energy installations are made of metal-based materials and plastics, or amorphous materials. The materials science-oriented analyses performed at the unit will make it possible to determine the causes of damage to RES installations' components and establish a method of removal of these causes (e.g. by applying other materials compliant with the requirements).

EXPERIMENTAL AND SIMULATION STUDIES IN PROCESS EQUIPMENT AND INDUSTRIAL VEHICLE ENGINEERING

RESEARCH

- **measurements of kinematic and dynamic properties of vehicles and machinery,**
- **studies of the pull/thrust force of industrial vehicles and the distribution of the wheels and steering elements' loads,**
- **standard based studies of loaders: tearout force, overturn force, lifting capacity, etc.**
- **analyses of static and dynamic stability of vehicles, optimisation an automation of dredging and loading systems,**
- **measurements of acceleration, speed, displacement and deformation with the use of resistance and optical fibre tensometry; measurements of pressure, flows, temperature, etc.**
- **design and production of atypical force converters,**
- **design and tests of control, safety and diagnostics systems for process equipment and industrial vehicles,**
- **design and studies of wheeled and elastomer/metal caterpillar chassis or other types of chassis featuring unconventional locomotion, as well as crane bearing systems and process equipment's propulsion systems and manipulators,**
- **tensometric measurements of bearing systems' deformations, analysis and synthesis of vehicles' vibration reduction systems,**
- **strength analyses of process machines' and vehicles' dynamics with the use of the finite elements method.**

APPLICATION

- **evaluations of the technical condition of process equipment and industrial vehicles,**
- **calculations and design of process equipment's bearing systems in compliance with up-to-date standards,**
- **automation and optimisation of process equipment's and industrial vehicles' operation,**
- **measurements and verification of static and dynamic loads in machines,**
- **verification of bearing and propulsion systems designed for process equipment, MES strength analyses and simulation studies,**
- **virtual prototyping.**

STUDIES OF FRICTION AND WEAR OF CONSTRUCTION MATERIALS (POLYMER, METALLIC) AND LUBRICANTS

RESEARCH

- **friction resistance and wear of materials applied in slide elements of machines operating in different friction conditions (ambient temperature from -60 to 150° C, relative humidity from 35 to 95%),**
- **tribological characteristics of materials in biomedical applications,**
- **rheological and lubricity properties of oils and plastic lubricants,**
- **development of compositions and studies of composite slide materials based on thermoplastic polymers,**
- **friction and wear of slide friction pairs in machines and devices (e.g. bearings, seals, slideways, etc.).**

APPLICATION

- **studies of machine units' and systems' elements in terms of their friction resistance and durability,**
- **studies of lubricants and lubricant compositions,**
- **studies of friction and wear of construction materials, in particular polymeric materials,**
- **studies of friction and wear of materials applied in biomedicine.**

STUDIES OF THE TECHNICAL CONDITION OF RENEWABLE ENERGY SOURCE INSTALLATIONS

RESEARCH

Renewable energy installations consist of a number of elements and systems, whose technical condition determines the durability and reliability of the whole installation. To ensure them, it is necessary to perform comprehensive tests of the elements of renewable energy installations such as photovoltaic cells, solar collectors, heat pumps, installations using them to heat rooms and provide hot utility water, as well as combustion engines using renewable fuels.

APPLICATION

Determination of the technical condition of renewable energy installations enables assessment of its fitness for operation, i.e. whether it should be in the state of operation or undergo recycling.

REVERSE ENGINEERING

RESEARCH

Reverse engineering consists in digitalisation of real objects into 3D computer models. The outcome is digital images of objects under research (most often in the form of a cloud of dots in the three-dimensional space) - this kind of data may constitute a basis of construction works, analyses and computer simulations, or comparisons of the physical model with the digital one (inspection, quality audit). Obtaining the digital form of the object also enables its direct application in computer aided manufacture technologies. Our unique technological potential allows us to acquire and process geometrical data of a wide range of objects and their assemblies of technical or natural origin, in terms of their external shapes (optical and contact methods) and/or internal structure (computer tomography). The offer comprises digitalisation of various objects, support in the area of designing individualised products, planning the regeneration of damaged machine parts, quality audit in the manufacturing process based on a comparison of a real product with its construction or technological model.

APPLICATION

Services related to reverse engineering applications, comprising, first and foremost, the manufacturing industry, but also bioengineering, the history of art, scientific research, etc.

COMPUTER AIDED DESIGN (CAD/CAE) AND EXPERIMENTAL STUDIES OF MACHINES AND DEVICES

RESEARCH

Scientific and research operations related to the issues of computer aided design (CAD/CAE), construction of machines, devices and vehicles, comprising basics of geometrical and strength modelling in integrated CAD systems as well as development of numerical methods - including the finite elements method (FEM) applying to process machines construction. Implementation works are performed and innovative solutions are developed by the research unit in this area. Additionally, the following activities are undertaken: experimental studies of process machinery bearing systems, measurements of deformations, internal and forced vibrations frequency of machine constructions, measurements during crash tests of protective constructions of machines and vehicles, strength tests of power engineering devices in thermal and dynamic load conditions.

APPLICATION

- **strength analysis of existing objects or those being designed,**
- **dynamic, thermal and fatigue analysis, design of new machines and devices, design of mechatronic measurement systems, simulation of crash tests, and modernisation of existing constructions,**
- **ballistic and miniresistance tests, defectoscopic and non-destructive tests.**

HYDRAULIC PROPULSION AND CONTROL, NUMERICAL METHODS

RESEARCH

- **analysis and synthesis of hydraulic, microhydraulic and pneumatic systems,**
- **design of hydraulic and electrohydraulic systems,**
- **modernisation of existing hydraulic elements and systems,**
- **development of new hydraulic elements' constructions, automation of hydraulic systems' control,**
- **durability studies of hydraulic elements, simulation of dynamic phenomena in hydraulic elements and systems,**
- **optimisation of hydraulic elements and systems, construction of numerical grids, modelling of viscous and compressible liquids allowing for thermodynamic transformations,**
- **quasi three-dimensional analysis of rotational machines' blade cascades, numerical modelling of hydrodynamic reactions in ships' propulsion-steering systems, manoeuvring and resistance properties,**
- **calculations of multiphase flows: flows with cavitation (impeller pumps, globe valve) flows with free surfaces (flow around ships, differential lever),**
- **studies of one- and multi-source (hybrid) systems with a combustion engine as a primary power source along with such systems' control.**

APPLICATION

Construction, mining and agricultural machines, as well as machine tools and presses. Machine engineering, mining, aviation, automotive and military industries.

PLASTIC FORMING

RESEARCH

The research into plastic forming entails studies and analyses of plastic forming processes and manufacture with the use of powder metallurgy. As the phenomena taking place in the material being formed change the properties of the final product, the properties and quality of the products formed in this way constitute one of the main focal points of the research conducted. The research involves advanced methods of mechanical and structural testing, methods of physical modelling with the use of model materials and, which is increasingly important, mathematical modelling methods. The department's activity also involves designing systems for monitoring manufacturing processes.

APPLICATION

- **design of technological processes and tools;**
- **optimisation of technologies or manufacturing systems involving organisational and technical**

solutions eli- minating or minimising production losses caused by improperly designed processes, excessive losses of material, long tool replacement times, insufficient tool durability or excessive flaw frequency in the manufacturing process;
- **handling and supervision of measurement equipment used to measure geometrical values.**

OPTIMISATION OF THE CONSTRUCTION AND OPERATION OF MACHINE TOOLS AND MACHINING SYSTEMS

RESEARCH

High machining efficiency is an essential factor affecting manufacturing competitiveness. If it is to be attained, it is important that machine tools be precise, feature high speeds and small errors in controllable axes, as well as a high capacity of their control and software system and intelligent functions. Development of machine tools and machining systems of such characteristics is based on models, numerical simulation and optimisation, as well as highly advanced knowledge.

APPLICATION

- **CNC machine tools and machining centres,**
- **spindle and slide units as well as motor spindles, accurate machining centres for HSC,**
- **CNC grinders and grinding centres, intelligent machining tools.**

OPTIMISATION OF REMOVAL PRODUCTION TECHNOLOGIES

RESEARCH

- **studies and analysis of high-efficiency cutting processes,**
- **issues related to minimised lubrication of cutting processes,**
- **machining difficult-to-machine materials, including composite based ones,**
- **measurements and analysis of the geometrical 2D and 3D surface layer with the use of contact and optical methods,**
- **mathematical modelling of surfaces' geometrical structures,**
- **observation and analysis of microscopic machined surfaces,**
- **measurements and analysis of cutting tools' wear, measurements of machine parts' shape deviations and location,**
- **cutting non-metallic, difficult-to-machine materials with the abrasive string.**

APPLICATION

- **construction – measurements of prototypes, construction patterns, etc.**
- **technology – technical audit, studies of the impact of machining methods and parameters on the condition of the surface layer obtained,**
- **operation – studies of the impact of a product's technological features on machines' operational properties.**

CAD CAM FEM TECHNOLOGICAL PLANNING

RESEARCH

Studies of CAD CAM FEM technology planning are carried out in workrooms equipped with modern equipment and the latest versions of popular computer systems supporting technological design and manufacturing works. The unit's CAD/CAM software includes both simple, cheap systems as well as advanced, integrated tools used by large corporations. The technological processes developed may be subjected to detailed analysis on systems for machining processes simulation. The simulation includes 3D visualisation of tool movements in the working space of the machine and the material removal process. At a further stage, the NC program may be sent to a CNC machine tool in order to perform a machining process on the material. The Centre's competences enable verification works for machine parts with the use of preliminary calculations performed by means of the Finite Elements Method.

APPLICATION

- **training on spatial modelling in CAD systems,**
- **training on technology design in CAM systems,**
- **training on programming of numerically controlled machining tools,**
- **consultancy and assistance related to selection and implementation of CAD/CAM solutions,**
- **design of processes to be executed on CNC, including optional production of parts with available machine tools.**

MEASUREMENT AND ANALYSIS OF VIBRATIONS

RESEARCH

Studies involving determination of dynamic properties of machines and bridge structures. Multipoint systems are employed for measurements of vibration and excitation forces, which allows determination of dynamic characteristics with use of different methods of excitation i.e.: operation cycle, impact hammer, or different types of exciters powered by harmonic or random signals. The software at the unit's disposal allows performing advanced analyses of vibrations, as well as visualisation and archiving of results.

APPLICATION

- **determination of machine tools' and machine units' dynamic characteristics in operational and stationary conditions,**
- **studies and modelling of active and passive dampers, design and testing of inertial exciters applied for excitation of bridges.**

DESIGN, SIMULATION STUDIES AND CONSTRUCTION OF MACHINES AND MECHATRONIC SYSTEMS

RESEARCH

The works performed at the unit concern analysis and design of flat and spatial machine units, applied in practically all sectors of industry - from small precision mechanisms to mining machinery. The unit's studies focus on the application of theoretical and operation-oriented aspects of mechanics, dynamics, kinematics, the theory of machines and mechanisms, robotics, and mechatronics in solving problems related to machine design, research and operation. Another field of activity are mechatronic units capable of applying complex control algorithms ensuring reliability, full control of parameters and ample diagnostic options in the event of failures. The works focus on design of such units to cater for specific practical applications. They entail design of the mechanical part, complete development of operation algorithms, construction of control units and final validation.

APPLICATION

- **selection of a rational structure of mechanisms, design of flat and spatial mechanisms, manipulators and mobile robots,**
- **computer simulation studies of machines, mechatronic design,**
- **design of robotic workstations and image analysis systems,**
- **design of human limb rehabilitation units, as well as experimental studies of machines and devices.**

PLASTICS PROCESSING

TECHNOLOGY

Various studies related to analysis and properties of polymeric materials. Solving problems related to material processing. Production of tools for processing, such as injection moulds and extrusion heads. Mini-conferences dedicated to specific issues related to polymeric material processing; training for industry.

APPLICATION

- **construction of processing tools,**
- **studies of mechanical properties of polymer plastics**
- **production and studies of hybrid metal-polymer type materials,**
- **plastics processing modelling.**

VIRTUAL REALITY

TECHNOLOGY

Modelling, visualisation and simulation of 3D computer models' operation. 3D models and scenes presented in the virtual reality environment can support a constructor's work as well as analysis of numerical simulation results, or facilitate education and training oriented activities. Additionally, the unit offers simulation of devices', workstations' and technological lines' operation. The apparatus applied includes devices for modelling and interaction with 3D scenes projected stereoscopically on screens or in helmets.

APPLICATION

- **modelling products and processes in CAD systems, design of active 3D scenes enabling animation and user interaction,**
- **virtual presentations of product and industrial installation models in areas of manufacture, architecture, the history of art and scientific research,**
- **simulation of devices (e.g. robots - in terms of programming or collision detection), workstations and technological lines,**
- **optimisation of technological lines' efficiency.**

VISION INSPECTION AND 2D/3D OPTICAL MEASUREMENT SYSTEMS

RESEARCH

Vision systems are taking over, more and more successfully, visual control tasks ensuring high repeatability, efficiency, multi-criteria approach and documentation of the control process. The scope of their activities is related to 2D and 3D inspections and measurements, while their spectral scope is expanded beyond the visible range (UV/NIR). As far as "difficult" problems are concerned, e.g. strongly reflective, free or complex surfaces, as well as non-typical tasks, such as designing a solution for image acquisition resistant to industrial disturbances and algorithms for image analysis and feature classification, the unit offers broadly understood cooperation in the area of R&D.

APPLICATION

- **engineering and electronics industries, as well as inspection of natural products,**
- **quality audit of products through inspection or optical measurements,**
- **monitoring and control of manufacturing processes with visual feedback,**
- **safety and quality audit of food products.**

LASER MACRO- AND MICRO-PROCESSING TECHNOLOGY FOR MANUFACTURING

RESEARCH

Laser technologies for manufacturing are more and more widely used in cutting, welding, hardening, powder cladding, purifying, marking and other processes. Metals, plastics, ceramics and glass are processed in the macro- and micro-scale offering new technological possibilities. Due to materials' various properties and specific technological requirements, in order to

achieve an optimum process result we carry out research into selection of optomechatronic components and optimisation of processing parameters. It requires interdisciplinary knowledge and equipment and entails fields including optics, analysis of thermal conditions, flows, material structures and characteristics, as well as controlling devices and processes.

APPLICATION

- **dividing and connecting materials,**
- **making functional coatings and surface regeneration,**
- **modification of metallographic properties of surface coatings through selective thermal processing, surface cleaning, marking and texturing, testing laser beam parameters, power density distribution, caustics, and aberrations of beam supply and shaping system,**
- **development of monitoring and closed loop control systems of laser processing.**

LOGISTICS, LONG-DISTANCE TRANSPORT AND INDUSTRIAL TRANSPORT TECHNOLOGIES

RESEARCH

Development of principles for transport systems' designs (in particular intermodal solutions) dedicated to specific needs and designs of systems supporting machinery and device usage management , including:

- **analysis, selection and organisation of systems with minimum environmental impact,**
- **design of handling terminals of a projected capacity, selection of optimum transport technologies with intermodal transport in mind,**
- **studies and analysis of companies' logistic systems,**
- **logistics audits, benchmarking, use of packaging, automatic identification of trade entities, warehousing technologies, selection of means of internal transport,**
- **analysis and identification of technical systems and the usage process,**
- **development of a system for collecting and processing usage data, modelling, analysis and evaluation of reliability and safety,**
- **evaluation of the stability of machines, vibrations, noise and measurements with the use of thermography.**

Also included are:

- **studies and simulations of machine operation processes, knowledge bases regarding machines' reliability and safety, vibroacoustic and thermal diagnostics of machine elements, tests of distribution of static and dynamic deformations and stress in machine components,**
- **tests of internal stress in machine elements, evaluation of dynamic parameters,**
- **identification of statistical distribution parameters of external loads affecting machines.**

APPLICATION

The offer caters for the needs of industrial, shipping and trading companies and relates to means of transport and process and excavation equipment used in underground and surface mining.

CNC CUTTING TECHNOLOGIES

TECHNOLOGY

Scientific, research and service operations in the area of programming and application of numerically controlled machine tools, technological process automation, in particular for small series manufacturing, improvement in quality assessment methods related to manufacture executed directly with a machining tool, as well as cutting processing. The advanced facilities including both 3-axial and 5-axial machines enable research related to processing a wide range of materials and complicated components with complex surfaces made of almost any material. The high end measurement systems with which the machines are equipped allow real time monitoring and evaluation of elements being processed.

APPLICATION

- **technical and economic assessment of technological processes designed with use of OSN,**
- **simulation correctness tests of the machining tasks designed,**
- **design and prototyping of quality assessment systems for manufacture executed directly with a machining tool,**
- **assessment of cutting tools' cutting capabilities and quality assessment of cutting tools in terms of particular production tasks.**

WELDING, SOLDERING, GLUEING, PRESSURE WELDING, THERMAL SPRAYING AND CLADDING TECHNOLOGIES

TECHNOLOGY

Development of technologies for a particular user. Performance of welding, soldering, glueing, pressure welding, spraying and cladding tests. Testing of welded, soldered, glued and pressure welded connections and layers. Design and production of additional materials Hot spraying, surfacing by welding and soldering. Studies of the composition and properties of additional materials. Consultancy and training services in the area of technology implementation and quality audit of layers and joints.

APPLICATION

All industry sectors. Regeneration of worn out parts, refinement of new parts. This mainly concerns mining, road and rail transport, aviation industry, ship construction and power engineering.

RAPID PRODUCT DEVELOPMENT TECHNOLOGIES

RESEARCH

Research and development work consisting in comprehensive support of new product development processes - from consultancy all the way through concept analysis and CAD based design to physical execution of prototypes. Rapid development technologies are used at early stages of product development, which enables reduction of the time and costs connected with launching a new product on the market. The basis of the technology are Rapid Prototyping (RP) devices which make it possible to produce a physical model (prototype) on the basis of a 3D digital record (e.g. CAD 3D). Such a model can be applied with the use of the Rapid Tooling (RT) technology as a blueprint for rapid production of a tool (mould), which enables delivery of short prototype series. These technologies are closely related to CAD 3D systems, Reverse Engineering (RE) and virtual prototyping (VP), whose the application allows rapid and comprehensive product verification.

APPLICATION

- **concept design and construction of new products,**
- **production of concept and standard models for the purposes of ergonomics and marketing research,**
- **production of functional prototypes from polymers and metals, as well as prototype tools and batches made from polymers and non-ferrous metals,**
- **consultancy in the areas of research, development and implementation related to rapid prototyping, and individualised manufacture of products for the needs of industry and medicine.**

PRESSURE PULSATION DAMPENERS AS ACOUSTIC FILTERS FOR HYDRAULIC SYSTEMS

TECHNOLOGY

Based on the measurements of pressure pulsation in a machine or device with hydrostatic propulsion, an engineering solution for pressure pulsation dampeners can be offered that considerably reduces the amplitude of pressure pulsation resulting mainly from the fluctuation of the efficiency of displacement pumps applied. Reduction of pressure pulsation in a hydraulic unit results in a decrease in the levels of noise emitted to the environment and inside the operator's cage.

APPLICATION

Passive and active pressure pulsation dampeners designed for a specific hydrostatic unit, appropriately installed decrease the overall noise produced by the hydrostatic propulsion unit by a few up to several dB. An additional benefit from the application of pressure pulsation dampeners is an increased operating time of hydraulic components due to lower dynamic loads.

DURABILITY, RELIABILITY, ENERGY-CONSUMPTION, ENVIRONMENTAL CONSERVATION AND IT TECHNOLOGIES IN AUTOMOBILE VEHICLES AND COMBUSTION ENGINES

RESEARCH

The studies are conducted by qualified research and technical staff with the use of dynamometers, in engine test houses and a climatic test chamber. They concern areas of construction, technologies, operation, and environmental aspects of transport - in particular alternative propulsion, implementation of fuels from renewable resources, fume toxicity, and the atmosphere of vehicles' cabs (also as a work environment). The unit's activities include studies of vehicles' and engines' durability and reliability and qualitative and quantitative measurements of hydrocarbons in a chromatography laboratory. Also researched are IT systems for vehicle and engine process control.

APPLICATION

- **studies of combustion engines and automobile vehicles,**
- **downsizing calculations and simulations, CFD, CAD, tribology and vibroacoustics,**
- **studies of fuels,**
- **catalytic combustion gas purification systems, evaluations and mediation,**
- **evaluation of active and passive safety in vehicles, analysis of combustion gases with the use of GC/MS and GC/FID,**
- **studies of the quality of interior air in vehicle cabs,**
- **toxicological evaluation with the use of in vitro methods, development and tests of vehicles' steering systems.**

ANALYSIS AND SHAPING OF A COMPANY'S MISSION

EVALUATION

Analysis and shaping of a company's mission. A mission as an efficient tool used to improve employees' commitment, influence the organisational culture, as well as an element building relations with the company's environment.

ANALYSIS AND MODELLING OF AN ORGANISATION'S BUSINESS PROCESSES ALONG WITH STREAMLINING CONCEPTS

RESEARCH

Analysis of the existing state: analysis of the information system or IT systems of the organisation in terms of its business processes. Based on the analysis, a map of correlations of business processes is created along with business process models ("as-is") with the use of a selected notation (e.g. BPMN, ARIS/EPC). Development of a concept of business process optimisation: the first part of works comprises collecting information on the organisation's business process effectiveness (e.g. based on KPI indices) and its medium and long term goals; the send part consists in preparation of target (improved) business process models ("to-be") as well as verification thereof (with the use of simulation methods). Works related to implementation of new business processes and verification of their effectiveness.

APPLICATION

Development of a map of the organisation's processes enabling systematisation of knowledge of its business goals, ways of attaining them and resources applied. Such an analysis of an organisation's information system may constitute a basis for further works, in particular implementation of an integrated IT system for management, implementation of quality management system or implementation of BPM (Business Process Management) concept.

ANALYSIS AND EVALUATION OF THE SYSTEM FOR INTELLECTUAL PROPERTY PROTECTION MANAGEMENT IN SMBs AND OTHER ORGANISATIONS

EVALUATION

Selection of the most favourable variant of protection and methods of its shaping, depending on the market conditions and other strategic determinants (e.g. mergers, takeovers, strategic cooperation, etc.) The scope of the unit's expert services comprises both one-off undertakings and long-term, consistent maintenance of the company's intellectual protection management system, in the institutional and external dimensions (know-how protection, the company's sensitive information, etc.) The unit offers studies and expert reports in the following areas: procedures and regulations, draft agreements including provisions related to intellectual property protection, design of a process-based approach to protection, diagnostic reports, etc. Field studies for SMBs aiming to obtain comprehensive knowledge contexts concerning fields such as business models applying intellectual property protection, as well as the scope and preferences of solutions related to intellectual property protection and managerial staff's awareness in this respect.

APPLICATION

Development of reports in various research perspectives for the needs of companies, local administration units and scientific institutions.

ANALYSIS OF A COMPANY'S STRATEGY

EVALUATION

Analysis of the company's strategy along with recommendations for strategic directions and streamlining.

SIMULATION STUDIES IN BUSINESS

RESEARCH

Simulation studies based on historical data aiming to describe, diagnose or streamline a process or system of the client's choice. The studies involve collection and analysis of source data, construction of a real-life object's mathematical model, development and verification of software for the model, design and execution of simulation experiments and statistical analysis of simulations' results. The studies may particularly concern systems characterised by any level of complexity operating in highly uncertain conditions. They may be conducted with the use of existing objects/processes or to formulate an economic forecast.

APPLICATION

Simulation analysis may be applied to support solutions to any organisational, economic or management related problems.

DIAGNOSTICS OF EXISTING SOLUTIONS IN TERMS OF ERGONOMICS

EVALUATION

Corrections of existing products, workplaces, rooms, etc. allowing for ergonomic criteria. The evaluation's goal is to decrease employees' biomechanical and psychological strain.

DIAGNOSIS OF FACTORS IN AN ORGANISATION'S INNOVATION

EVALUATION

Analysis and evaluation of the organisation's elements shaping its innovativeness. Analysis of factors impacting the organisation's innovativeness and evaluation of relations between the organisation's innovativeness and its elements.

DIAGNOSIS OF AN ORGANISATION'S CORPORATE CULTURE

EVALUATION

Comprehensive diagnosis and evaluation of the company's organisational culture.

The diagnosis goal is to support managerial decisions in the processes of organisational changes and improve employees' knowledge.

DIAGNOSIS OF KNOWLEDGE MANAGEMENT PROCESSES

EVALUATION

Analysis and evaluation of solutions related to knowledge management, with particular emphasis on knowledge management processes. The diagnosis's goal is to ensure improved efficiency of the organisation's knowledge resource management.

DIAGNOSIS OF THE STATUS AND POSSIBILITIES OF SHAPING AN ORGANISATION'S CORPORATE SOCIAL RESPONSIBILITY

EVALUATION

Companies operating in competitive conditions are being increasingly more often looked at in terms of values related to social responsibility. The essence of these is building long-lasting and positive relations with stakeholders. There are many models and standardised formulas of undertaking a company's social responsibility strategy (CSR). Thanks to simple analytical tools, a CSR diagnosis will enable evaluation of the conditions, execution methods and potential of changes stemming from the company's expectations and capabilities.

The first stage of the diagnostic operations involves evaluation and analysis of existing solutions in seven dimensions of responsibility (according to ISO 26000). The second stage consists in researching the possibility of changing the extent to which these criteria, formulated on the basis of the deficiencies identified, are met. At the third stage, recommendations of specific solutions are formulated, in accordance with the priorities previously agreed on.

EVALUATIONS IN THE AREA OF HUMAN-COMPUTER INTERACTION

EVALUATION

Evaluation of the practical quality (usability) and functionality of online services and software. Comprehensive designs of computer interfaces, designs and corrections of computer programs' dialogue boxes, analysis, design and correction of ergonomic online services. Diagnosis of existing interfaces and design of new ones, allowing for usability rules.

FORMULATION AND IMPLEMENTATION OF AN ORGANISATION'S STRATEGY

EVALUATION

Development and implementation of the company's strategy, both at the level of the whole organisation and the domain of its operation, with the use of own-developed methods as well as those available in literature. Goal: to orient the company's development.

SCHEDULING AND MONITORING OF UNDERTAKING EXECUTION

TECHNOLOGY

Development of schedules for execution and control of undertakings with the use of IT tools.

APPLICATION

Project management.

IDENTIFICATION AND ANALYSIS OF BUSINESS PROCESSES IN A COMPANY FOR THE SOA ARCHITECTURE

RESEARCH

Determination and analysis of business processes in the company in order to identify IT services needed to perform its business functions.

APPLICATION

Execution of processes related to implementation of IT solutions in specific areas of company operation.

IDENTIFICATION OF E-SHOPPING APPLICATION OPPORTUNITIES IN AN ORGANISATION

EVALUATION

Determination of possibilities of applying e-shopping solutions in the company and possible causes of the company's failing to use them. Studies of the level of knowledge of e-shopping in employees responsible for procurement. Cooperation in the area of implementation of corrective measures. The evaluation's goal is to determine potential savings, the extent of use of e-shopping, knowledge of the issue, causes of the existing situation, as well as cooperation in actions aiming to apply or increase the extent of using e-procurement in organisations.

CONCEPT OF THE IMPLEMENTATION OF A COMPANY'S STRATEGY

EVALUATION

Development of principles for implementation of the company's development strategy with the use of various strategy implementation concepts, e.g. the Balanced Scorecard or strategic implementation programmes in specific strategic areas. Goal: to implement the company's development strategy.

CONCEPTS OF BUSINESS ANALYSIS IN AGILE SPECIFICATION OF THE DECISION-MAKER'S NEEDS

RESEARCH

Identification and analysis of business analysis elements in order to model concepts specifying the subject matter of business processes which the decision-maker wants to be supported with IT solutions. The study's result will be models (ontologies) usable in the area of agile specification (prototyping) of the needs of a decision-maker solving the company's specific decision related problem.

APPLICATION

Creation of a repository of knowledge of business processes being managed for the needs of the company's decision-makers. It may be useful in both analysis of business processes and IT-supported solving specific decision related problems.

SHAPING OF THE SYSTEM FOR STRATEGY AND INNOVATION PROCESS MANAGEMENT IN SMBs AND OTHER ORGANISATIONS

EVALUATION

Companies' pro-innovation initiatives in themselves do not assure success in terms of the number of new products, buyers or markets in a situation where there is no certainty about the actual intentions behind companies' actions in this respect - i.e. whether it is a real and conscious need or camouflage serving short-term goals and particularistic interests. At least two-level strategic coincidence is necessary - on the functional level and on the level of the company's general strategy. A lack of innovation strategy on the functional level results in various units within the organisation executing different priorities and tasks. Barriers diagnosed make up a sort of map of determinants hindering the development of the company's innovation processes.

Stage 1 – diagnosis of the type and importance of barriers and constraints, recommendations for changes enabling limitation thereof.

Stage 2 – it is possible to design a specific business solution, e.g. where there is an unclear division of responsibilities for the development of innovations, by diagnosing the situation and presenting a new approach and division of competences in this area.

SHAPING OF A SUSTAINABLE COMPANY

TRAINING

Training on the essence of the sustainable organisation. Development of a business model for the purpose of sustainable development. Support of managerial decisions in the processes of organisational changes. Improving employees' knowledge.

FORESIGHT METHODS IN STUDIES AND EVALUATION OF STRATEGIC UNDERTAKINGS' DETERMINANTS

EVALUATION

Analysis of the conditions of implementation and impacts of new products and technologies, including market, economic, technological (technology development trends) and social aspects, is a multifaceted research related issue. Equally sophisticated is building companies' strategies as well as implementation strategies and business models for planned undertakings including investment profitability analysis. In order to perform such analyses, it is advisable to apply a wide range of so-called foresight and forecast studies as well as conduct studies of potential consumers' needs and behaviours.

STATISTICAL METHODS IN QUALITY MANAGEMENT

TRAINING

Training on application of methods including SPC, MSA, AQL in quality management.

APPLICATION

Improving knowledge of data analysis; application of statistics in process optimisation.

FORECAST MODELS

RESEARCH

Analysis of the organisation's sales structure and recommendations for forecast models allowing for factors such as sales trends, seasonality or cyclical character. Identification of econometric forecast models allowing for factors significantly impacting sales. Development of econometric forecast models allowing for factors significantly impacting sales.

APPLICATION

Forecasting the volume of sales, demand and other economic factors.

WORKLOAD EVALUATION

EVALUATION

Evaluations and measurements of workload extent, health related risks and hazards caused by the physical work environment, as well as adjustment of a given work environment to requirements stemming from standards. Identification of causes of muscle-skeletal disorders. Evaluation of manual workload (energy expense, static loads, repetitive work) and intellectual workload (including monotony), as well as evaluation of how tiring the work is.

OPTIMISATION OF DECISIONS IN RELATION TO TRANSPORT ISSUES

RESEARCH

Analysis of transport issues in the organisation aiming to identify their structure. Selection of appropriate methods to optimise transport related decisions in the context of issues identified, as well as recommendation of effective transport models.

APPLICATION

Single-stage and multi-stage transport, commercial traveller, shipping by courier.

OPTIMISATION IN LOGISTIC SYSTEMS

RESEARCH

In a time of commonly used management support ERP IT systems, of particular importance are numerically effective methods and algorithms for solving new optimisation problems which come from real-life logistic systems and constitute the key element of the support system. In a considerable majority of cases, practical problems significantly generate NP-difficult issues of combinatorial optimisation, including multi-extreme ones, which due to their complexity (e.g. size, criteria, time constraints) may be modelled and solved with the use of the latest discrete optimisation methods developed (and still being developed) over recent years, including in particular bio-inspired methods, applying a probabilistic and fuzzy data representation and multi-thread, parallel and dispersed methods. The studies apply MIC grade (Intel Xeon Phi) and multi-GPU (nVidia Tesla) devices featuring over 4,000 cores used for real-time scheduling and optimisation.

APPLICATION

Building a collection of numerical procedures constituting tools applied for development support systems operating in the following areas:

- **optimisation of transport (routing vehicles), optimisation of 2D and 3D packaging,**
- **management of transport with data uncertainty allowed for.**

SHORT- AND MEDIUM-TERM FORECASTING

TECHNOLOGY

A wide range of econometric/statistical tools for short (up to a few days) and medium-term (up to several months) forecasting of prices, demand, etc. available in the context of point forecasts (i.e. the most probable or expected value) as well as the more and more popular probabilistic forecasts (i.e. a range of values obtained with a certain probability). The unit also offers studies and expert reports concerning selection of forecast methods adjusted to the specificity of the client company's operation (e.g. allowing for trends and seasonability).

APPLICATION

Improvement of the quality of forecasts applied so far, and - as a result - streamlining company management - on both the operational and strategic levels.

DESIGN OF CORPORATE PROCESSES

EVALUATION

Analysis and evaluation of a company's processes. Design of company process streamlining. Training on process management. Support of managerial decisions in the processes of organisational changes. Improving employees' knowledge.

ERGONOMIC DESIGNS

EVALUATION

Comprehensive ergonomic designs of workstations, tools and production rooms, design of new solutions in accordance with the rules of ergonomics.

DEVELOPMENT OF A COMPANY'S ABILITY TO LEARN

EVALUATION

Comprehensive diagnosis and evaluation of a company's ability to learn. Support of managerial decisions in the processes of organisational changes.

COMPANY DEVELOPMENT STRATEGY

EVALUATION

Comprehensive analysis of internal and external determinants, development of the company's business concept and formulation of the principles of the strategic plan as well as its subsequent implementation.

SYSTEMS SUPPORTING DECISION-MAKING PROCESSES

EVALUATION

Analysis of data sets concerning various areas of management (e.g. loan scoring, analysis of the sales basket, forecasting) aiming to determine dependencies occurring in them. Expert systems supporting decision-making processes.

TRAINING ON STRATEGIC MANAGEMENT

TRAINING

Strategic session in the form of managerial training aiming to deliver the most up-to-date knowledge in the area of strategic management as well as practical skills indispensable in the process of formulating and implementing strategies.

APPLICATION

Improvement of employees' knowledge.

TRAINING ON ERGONOMICS

TRAINING

Creating ergonomic conditions, ergonomic rules and standards in designing workstations, ergonomic requirements in designing and operating machines, basics of design of machines, devices and workstation fittings and accessories, design of work organisation, methods of researching and decreasing workload.

APPLICATION

Improvement of employees' knowledge.

TRAINING ON HUMAN-COMPUTER INTERACTION

TRAINING

Development of optimal - in terms of communicating information - online services, requirements for usable websites, recommendations for designing software of high functional quality, methodology of assessment of software's and websites' quality in terms of ergonomics, user-centred design (UCD), development of IT systems, international standards and norms related to ergonomic communication of information.

APPLICATION

Improvement of employees' knowledge.

DOWNSIZING A COMPANY'S ORGANISATIONAL STRUCTURE

EVALUATION

Analysis and evaluation of the organisational structure's simplicity. Development of a method of downsizing the organisational structure. The goal of the analysis is to support managerial decisions in the processes of organisational changes.

IMPLEMENTATION OF A QUALITY MANAGEMENT SYSTEM IN COMPLIANCE WITH THE ISO9001 STANDARD

EVALUATION

Preparation of the company for the implementation of a quality management system and a successful certification audit. Proving the management system's compliance with the international standard.

IMPLEMENTATION OF A QUALITY MANAGEMENT SYSTEM IN COMPLIANCE WITH THE ISO/TS 16949 STANDARD

EVALUATION

Preparation of the company for the implementation of a quality management system and a successful certification audit. Proving the management system's compliance with the international standard.

STUDIES OF THERMAL, DIELECTRIC AND SPONTANEOUS POLARISATION-RELATED PROPERTIES OF VARIOUS MATERIALS

RESEARCH

- **measurements of complex permittivity in a wide temperature range (120 K to 800 K) and frequency (from 0.1 Hz 10 MHz),**
- **measurements of temperature-dependent specific heat capacity of solids and liquids using DSC (construction of phase diagrams, temperatures of phase transitions and thermodynamic parameters of these transitions – heat and entropy of phase transitions),**
- **measurements of dependence of spontaneous polarisation and the pyroelectric coefficient of single crystals, ceramics and films in the range from 15 K up to 800 K,**
- **dilatometric tests of solids in the range from 90 K up to 450 K.**

APPLICATION

Characteristics of dielectric materials, single crystals, ceramics and films, studies of mineral resources in terms of their new applications, characteristics of liquids, including the liquid fuel parameters, e.g. biofuels. Production process optimisation.

MATERIALS-ORIENTED AND MECHANICAL STUDIES IN TECHNOLOGICAL PROCESSES

TECHNOLOGY

Implementation of projects in the field of materials science and mechanical properties assessment regarding the identification of important factors affecting the manufacturing process. Modern, chiefly laser, tools of production of functional surfaces, spatial microstructures and macrostructures require continuous improvement and determination of the impact of the process on the processed material. The laboratory focuses on designing and developing manufacturing technologies for materials with functional properties, especially designed for use in harsh thermal, mechanical and corrosive conditions. The studies are focused on the use of selective laser melting (SLM) and laser cladding (LC) technologies to obtain unique material properties.

APPLICATION

- **macro- and microstructure-oriented studies (microscopic methods),**
- **determination of mechanical properties of metals, composites and plastics,**
- **analysis of crack propagation with a high speed camera,**
- **microanalysis of the chemical composition of EDS ,**
- **geometry and materials-oriented analysis of powder materials,**
- **2D and 3D surface topography measurements,**
- **defectoscopy with the use of destructive and non-destructive methods (CT),**
- **analyses and studies of materials, technologies as well as inspection and measurements.**

STUDIES OF POLYMERIC MATERIALS

RESEARCH

- **comprehensive studies of polymers' and polymeric materials' properties, quantitative and qualitative analyses of materials, tests for determination of the type of polymer applied in a certain product,**
- **comparative analyses of different batches of plastics in order to prove their identicalness or indicate differences,**
- **characterisation of polymers' processing and utility properties.**

APPLICATION

Plastics processing.

LASER TECHNOLOGY FOR PRODUCTION OF THIN AND ULTRATHIN LAYERS OF POLYMER AND MOLECULAR MATERIALS ON SOLID BASES

TECHNOLOGY

This technology allows production of very thin layers of materials from a solution (ranging from single to several hundred nanometres). The obtained layers are characterised by high thickness homogeneity, and, in the case of molecular materials, high crystallinity and orderliness. The material can be coated on any solid base - the condition being the absorption of laser radiation by the base as well as an appropriate adhesion of the material being coated.

APPLICATION

This method can be used to modify the surface of materials by applying a thin layer of material with the desired characteristics (e.g. hydrophobisation of the surface). It is possible to manufacture radiation-absorbing layers which are electrically conductive. It can be used as a way of modifying the existing methods of applying layers, aiming to reduce the layer thickness and the amount of material being applied.

OBTAINING OF LAYERS BY MAGNETRON SPUTTERING

RESEARCH

Studies of the impact of sputtering parameters (target dissipation, pressure of operating gases, base surface temperature, target-base distance, group frequency, frequency of operating gas dosage) on the chemical and physical properties of obtained layers.

APPLICATION

Protective, safety, dielectric and decorative layers. Photovoltaic and varistor elements.

SYNTHESIS OF INORGANIC NANOMATERIALS

TECHNOLOGY

Synthesis of inorganic nanomaterials (e.g. CdS, CdSe, PbS, PbSe, ZnS, ZnSe, CuS, $NaGdF_4$, ...) with controlled size (approx. 1-10 nm), controlled shape and architecture. The control of these parameters enables obtaining nanomaterials with designed physico-chemical properties. It mainly concerns control of the wavelength of light emitted/absorbed by these nanomaterials in the range of 300 to 1,700 nm, their capability of charge separation, or control of their surface properties (hydrophilicity).

APPLICATION

Nanomaterials can be applied as light emitters, e. g. LED, optical markers used in biology and medicine, active elements for applications in photovoltaics as well as photocatalysis processes. Combined with other materials, they can also be applied in many other areas.

PRODUCTION OF FUNCTIONAL MATERIALS WITH THE USE OF THE ZOL-GEL METHOD AND STUDIES OF PREPARATIONS' MORPHOLOGY AND CRYSTALLINE STRUCTURE

TECHNOLOGY

The offer's focus is production of nanomaterials (powders/coatings) with the use of the zol-gel method, which guarantees low price and mild production conditions. The particles produced may be characterised by biological, magnetic and optical activity. In order to prevent nanoparticles aggregation, they may be placed on SiO_2/TiO_2 carriers or added to oxide layers. The carrier powder with active nanoparticles may be easily used as a filler which provides a product with required properties, e.g. of a biological or magnetic nature. Such powders may be added both to fabrics or packaging and to paint coatings, improving their usability and providing them with antiseptic and self-purification properties.

The offer also includes morphological and structural profiling of substances used in industry. Applying X-ray diffraction enables fast description and control of the materials' quality as well as determination of technological processes' efficiency. Scanning microscopy is used for testing the surface morphology, which enables monitoring of the processes' correctness.

APPLICATION

Due to the possibility to controlling the zol-gel process and thus obtaining various forms of products (powders, layers), nanomaterials produced this way may be widely used. They may be used in the powder form as fillers, providing the product with required characteristics. They may be applied directly to surfaces, even featuring a complex shape, in the form of thin layers. Thin layers prepared with the use of this method, depending on their chemical composition, provide surfaces with anticorrosive, catalytic or biological properties.

MODELLING OF EXPERIMENTAL DATA WITH THE USE OF ARFIMA METHODS

EVALUATION

Modelling of data regarding risks to natural environment and space, obtained using sensors and space probes. The main methodology is based on the latest advances in the theory of time series ARFIMA. It allows us to describe signal processes and anomalous transport - in particular, air quality modelling, energy consumption, electromagnetic radiation in the vicinity of broadcasting stations of mobile networks UMTS, solar activity, and space and laboratory plasma.

MODELLING OF MOLECULAR BIOLOGY DATA DYNAMICS

EVALUATION

Modelling the dynamics of data in molecular biology (dynamics of telomeres, proteins, receptors, mRNA molecules, etc.), received from experiments of single particle tracking type (SPT) using fluorescent microscopy methods. The statistical methods applied allow us to identify the theoretical model, its validation and prediction of anomalous diffusion in time.

STUDIES OF CONSTRUCTION MATERIALS AND CONSTRUCTIONS

RESEARCH

Determination of basic mechanical properties of construction materials such as metals, plastics, composites, ceramics, rubber and wood at the ambient temperature as well as at higher and lower temperatures. Strength tests of entire structures or their elements subjected to static and periodically variable loadings. Identification of the strength of construction elements' connections (welded, glued and screw connections). Measurements of deformations with the use of the electric resistance tensometry method, including determination of internal stress with the use of the hole-drilling method. Determination of materials' parameters in terms of their resistance to cracking. Numeric modelling of constructions.

APPLICATION

Various areas of industry.

RESEARCH METHODS OF EXPERIMENTAL MECHANICS, CONSTRUCTION OF BODY MODELS AND MATHEMATICAL MODELLING OF MATERIAL DAMAGE PROCESSES

RESEARCH

The subjects offered are research methods of experimental mechanics, mathematical modelling of the processes of damage to material and evolution of biological systems, theory of model similarity and planning the experiment. The offer includes a description of the process of fatigue and cracking of materials and the construction of models of bodies in a complex state of tension, in conditions of variable loads. The proposal also applies to the identification and application of selected cross magnetomechanical, magnetocaloric and thermomechanical effects in the process of static and cyclic loads. Works can apply to various polymer composites with programmed structures and properties. Studies are being conducted to master the methods of manufacturing, testing and identifying the properties of nanomaterials obtained using zol-gel technologies (polymer sensors). The subject of research is also a broad palette of magnetic materials from the SMART group (magnetorheological liquids, materials with a gigantic magnetron, materials with shape-memory) and metallic glasses.

APPLICATION

A wide spectrum of tests of the mechanical properties of materials, in conditions of static and cyclical loads in uniaxial and complex load conditions. Manufacturing, testing and applications of: polymer composites to extremely strenuous structures; magnetic smart materials and composites with their participation; nanomaterials obtained using zol-gel technologies; metallic glass and metals with nanocrystalline structure. Construction of measuring apparatus for non-destructive testing.

RESEARCH METHODS IN THE AREAS OF MATERIALS SCIENCE, MATERIALS' STRENGTH, AS WELL AS LASER CUTTING AND TEMPERATURE MEASUREMENT TECHNOLOGIES

RESEARCH

The offer involves methods of metallographic, strength and mechanical tests of alloy and non-alloy steels, copper and aluminium alloys, polymer and metal matrix composites, as well as biomaterials for biomedical applications:

- **experimental studies and numerical analyses of implants,**
- **numerical modelling of the eyeball,**
- **strength tests of entire structures or their elements subjected to static or periodically variable loadings.**

Characteristics of research capabilities:

- **structural and crystallographic analysis of metallic materials and plastics with the use of transmission, scanning and optical electron microscopy,**
- **determination of the causes of damage and failures of machines and devices, recreating technologies for the manufacture of elements without process sheets,**
- **determination of causes of corrosion damage and developing preventive methods,**
- **determination of the quality and correctness of weld execution,**
- **chemical analysis, determining and recreating materials' grade and structure,**

- **determination of basic mechanical properties of metallic and polymer materials as well as biomaterials in tension, squeezing, shearing, torsion and bending tests.**

APPLICATION

Machine, automotive, mining, chemicals and power industries, production of implants and surgical tools, jaw, face and skull surgery.

MICROWAVE MEASUREMENTS AND HEATING IN FOUNDRY ENGINEERING

RESEARCH

Application of microwaves by measuring the standing wave coefficient in order to define parameters including humidity of moulding masses, identifying the quantity of the active binder, evaluating the effectiveness of microwave absorption by used up moulding and core masses which are subject to the microwave utilisation process. Microwave heating, thanks to its specificity, constitutes an alternative to the traditional, conventional methods, which deserves particular attention. From the environmental protection and economy standpoint, it is more and more frequently used in drying, process heating, technological processes activation, or utilisation of dangerous waste in machine and construction industries.

APPLICATION

Foundries, machine, food, construction and environment protection industries, waste neutralisation, intensification of production processes.

HIGH PRESSURE TESTS, COMPOSITE MATERIALS PROCESSING

RESEARCH

Studies of composite high-pressure vessels for CNG and hydrogen - cyclic tests with pressures changing from the atmospheric up to 1,400 bar (also at low and high temperatures from -60°C up to +250°C) and burst tests with maximum pressure of 2,400 bar. Also worth mentioning is design, manufacture and studies of composite materials and constructions. The unit has the following technologies at its disposal: filament winding, pultrusion, and infusion methods such as LRTM, VARTM, RTM, LCM, among others.

APPLICATION

Automotive, aerospace and military industries, as well as other areas where light and high-strength fibre-reinforced (glass, carbon, aramide, basalt fibres) composite constructions with an epoxy matrix are required.

DETERMINATION OF MECHANICAL PROPERTIES OF TISSUES (BONES, MUSCLES, BLOOD VESSELS, THE SPINAL CORD, ETC.) AND BIOMATERIALS, AS WELL AS STUDIES OF BIOMECHANICAL SYSTEMS

RESEARCH

Determination of basic mechanical properties of bone tissue and biomaterials in tensile, compression, shearing, turning and bending tests; for soft tissue (tendons, ligaments, skin, muscles, nerves and blood vessels) – in the tensile test, in the case of blood vessels (arteries) – the internal pressure test. Mechanical properties can be determined for static or periodically variable loadings as well as in accordance with the individual needs of the ordering party.

Own-developed models or models supplied by the ordering party are applied for the purpose of numerical calculations. Analysis and tests can be carried out under static or periodically variable loadings.

Modelling of dynamic processes taking place in the eyeball.

APPLICATION

Implantology: practice, diagnostics, as well as production of implants and surgical tools. Jaw, face and skull surgery, as well as dental implantology.

ECONOMIC AND FINANCIAL ANALYSES OF COMPANIES' INVESTMENT UNDERTAKINGS WITH RISK AND PROFITABILITY ANALYSIS

RESEARCH

- **genetic algorithms,**
- **analyses of costs and benefits, profitability, statistical, systemic, technical and economic, feasibility, risk, index-type, etc.**
- **operational studies, methods: DCF, real options, simulation (Monte Carlo, conditional),**
- **optimisation, programming (integral, linear, dynamic, etc.), mixing and averaging, project management.**

Software applied:

- **integrated geological-mining systems for conditional simulation (CAE Mining Studio, NPV Schedu- ler, Datamine Planner 5.0),**
- **3D visualisation software and VR environment (Geovisionary by Virtalis),**
- **software for Monte Carlo simulation (Model- Risk, @Risk and Crystal Ball),**
- **software for data analysis (Decision Tools Suite 7.0: Precision Tree, TopRank, NeuralTools, StatTools, Evolver, RiskOptimiser)**
- **statistical and econometric packages (Statgraphics, Statistica, R environment and MatLab EViews),**
- **software for project management (Microsoft Project and Earthworks Production Scheduler).**

APPLICATION

Mining and power engineering.

STUDIES AND DIAGNOSTICS OF CONVEYOR BELTS AND THEIR CONNECTIONS

RESEARCH

Research and measurements of physical and mechanical properties of conveyor belts, conveyor connections, rubber, fabrics, rubber mixtures and plastics; evaluation of connection quality. Certification studies and opinions on the product in order to permit its application in underground mining facilities; combustibility and anti-electrostatics research.

New, pro-ecological and energy-efficient construction and material-related solutions for conveyors and connections, ecological technology for connecting conveyor belts with wire ropes, a method of evaluating cover rubber and conveyor belt construction with respect to the movement resistance generated by the conveyor belt and the demand for conveyor belt propulsion power Non-invasive diagnostics of conveyor belts, conducted directly during their operation. DIAGBELT system for evaluation of the condition of conveyor belt cores with wire rope. Two- and three-dimensional analyses, evaluation of the quality of connections, analysis of damage to the top belt cover with the use of a vision system and non-invasive measurement of the belt's thickness along with evaluation of its lateral section.

Consultancy in the area of conveyor belts and connections at the stage of designing conveyor transport systems, as well as at the stage of their operation.

APPLICATION

Conveyor transport system users (mining, power engineering, chemical industry, harbours, handling sites) and conveyor belt manufacturers.

STUDIES OF CONVEYOR BELT ROLLERS

EVALUATION

Studies of rollers applied in belt conveyors operating in underground and open pit mines. The unit performs evaluation of rollers' conformity with PN-M-46606:2010 standard, equivalent to PN-ISO 1537, as well as DIN – 22112-2. The scope of studies carried out by the unit comprises determination of basic measures of a roller's functional properties which are a source of information about its technical condition - i.e. measurements of rotation resistance, testing radial run-out, measurements of bearing units' temperature, and tests of unbalance. Additionally, the offer includes studies of rotation resistance in carrying rollers under loads, in terms of real-life forces which rollers are subjected to in mines as well as laboratory evaluation of durability, based on own-developed method consisting in determining approximate effective distribution of rollers' operation time.

STUDIES OF MINERALOGICAL PROCESSES' BASICS AND DEVELOPMENT OF RAW MATERIALS' ENRICHMENT TECHNOLOGIES

RESEARCH

Basics of the technology of enrichment and application of minerals, including: non-ferrous metals' ores, mono- and polymetallic ores, carriers of rare earth elements, heavy minerals, free gold and platinum metals, coal, waste rock, waste produced by ore processing, and secondary raw materials. The unit's apparatuses allows us to perform studies of mineral materials, carry out various mineralogical processes (including magnetic, electric and gravitational separation, floatation, coagulation, agglomeration, comminution, sieving, dehydration, drying, analyses of size composition, as well as determination of organic carbon and metallic elements), determine wettability and other physico-chemical properties.

APPLICATION

Technologies of enriching minerals and application of waste.

STUDIES OF RAW MINERAL AND EXTRATERRESTRIAL MATERIALS

RESEARCH

In our studies of chemical and isotope composition of solid (rocks, meteorites, soils, etc.), liquid (water, underground, mineral, therapeutic, thermal waters and brine in particular) and gaseous (mainly geogenic gases - CO_2, CH_4, H_2S, N_2, O_2, He, Ar, Rn, etc.) natural substances, we apply the following techniques: atomic absorption, gas chromatography, alpha and beta radiation spectrometry, as well as other specialist methods dedicated to particular elements or isotopes.

APPLICATION

Environmental studies of underground waters, geogenic gases, rocks and minerals (chemical composition, physical properties, deposit aspects, stream of geogenic gases); studies of hydrogeological properties of rocks. Project and documentation works related to resources and deposits of underground waters, including brine, thermal and therapeutic waters. Studies of extraterrestrial matter - meteorites (mineralogical , cosmochemical and isotope studies). Studies of natural radioactivity (waters, rocks, air and underground objects).

CONSTRUCTION AND IMPLEMENTATION OF SPATIAL INFORMATION SYSTEMS. ANALYSIS OF SPATIAL DATA IN GIS

RESEARCH

- **development of spatial information systems for public administration units, industrial plants (such as mining), including freeware based systems,**
- **management of GIS implementation projects and consultancy in the area of GIS systems implementation systems in accordance with the requirements of the INSPIRE directive,**
- **spatial analyses of environmental and other data and development of digital theme-based maps,**
- **construction of spatial geological models and spatial (3D) visualisations of engineering structures, training in the field of commercial and open application of GIS software.**

APPLICATION

The research is widely applied in mining, geology and geodesy.

INNOVATIVE SOLUTIONS IN CONVEYOR BELT TRANSPORT

RESEARCH

Design and modernisation of industrial conveyor transport systems with the use of the own-developed QNK-TT IT system supporting multi-variant advanced engineering calculations. The ONK-TT system offered was developed based on long-term research and has been verified with numerous utilisation measurements.

APPLICATION

Decreasing conveyor transport systems' energy consumption. Optimal selection of conveyor components (belt, rollers, drums, tightening devices, pouring devices, indirect drives).

SPECIALIST GEODESIC MEASUREMENTS OF ROAD STRUCTURES. FORECASTING DEFORMATIONS OF ROCK MASS SURFACE IN MINING AND POST-MINING AREAS

RESEARCH

- **measurements of road structures' technical condition, measurements and evaluations of dislocations and deformations of road structures along with analysis and interpretation of results,**
- **inventory measurements of buildings and structures, measurements and forecasting of area surface deformations caused by underground and open-pit exploration,**
- **evaluation of mining operation impact on civil structures.**

APPLICATION

The studies allow us to develop results of geodesic and satellite measurements, as well as process data obtained by ground-based scanning.

THREE-DIMENSIONAL MODELLING OF DEPOSITS, DESIGN OF MINES AND RECULTIVATION, PLANNING AND OPTIMISATION OF EXTRACTION, VISUALISATION OF 3D MODELS IN THE VR ENVIRONMENT

RESEARCH

Estimation of resources, quality assurance and control systems (QA/QC) in mining, modelling of deposits, geostatical modelling, design of open-pit mines, design of underground mines, design of recultivation projects, planning and optimising extraction, averaging and control of spoil quality, pricing deposits, pricing mining designs and companies, consultancy, training, 3D model visualisation, and VR environment. Application of integrated geology-mining software as well as software for 3D visualisation in the VR environment.

APPLICATION

Support for geological-mining projects; visualisation of mining and recultivation operations development scenarios; dedicated training on the application of modern digital modelling and design methods.

CHARACTERISATION OF SEMICONDUCTOR DEVICES

RESEARCH

Research into defects in semiconductors with the use of photoelectric techniques.

APPLICATION

Testing semiconductor devices: electrical measurements of semiconductor connectors in a wide temperature range (20 to 350 K); research related to characterisation of defects in semiconductor structures with the use of DLTS and TSCAP methods; studies related to characterisation of defect kinetics with the technique of time-resolved photoconduction and photocapacitance spectroscopy; research into relaxation processes in semiconductor connectors with use of impedance spectroscopy technique.

PHOTOVOLTAICS AND PLASMONICS OF METALLIC NANOSTRUCTURES

RESEARCH

Nano-scale quantum technology for the purposes of research into a new generation of plasma-modified solar cells.

APPLICATION

Photovoltaic and photonic applications of plasmonics.

QUANTUM CRYPTOGRAPHY

RESEARCH

Contemporary systems for quantum key distribution utilising entangled and non-entangled photons.

APPLICATION

IT security, special absolute security IT connections.

OPTICAL TWEEZERS

RESEARCH

Measurements of mechanical properties of cell membranes, DNA thread and other biological microstructures with piconewton resolution. Measurements of local properties of solutions and colloids (e.g. viscosity). Two holographic optical tweezers can be used - with an optional module for trap control with the use of a pizeoelectric mirror. The optical traps in the optical tweezers are generated holographically, thanks to which more than twenty traps can be generated and independently controlled at the same time. Each trap's parameters can be defined independently. The traps can be moved in three directions. Light and dark traps can be simultaneously generated. The optical tweezers are equipped with fast cameras (up to 10,000 frames a second) as well as a sophisticated tool for measurement results analysis utilising advanced statistical methods. Additional optical ports enable extension of the system with, for instance, a fluorescence module.

APPLICATION

Trapping and manipulating living cells, large-size biological aggregates (e.g. lipid film) , DNA and other dielectric micro objects.

OBTAINING POROUS GLASS-BASED FERROIC NANOCOMPOSITES

TECHNOLOGY

Porous glasses are obtained from homogeneous sodium borosilicated glasses. Phase separation is carried out by heating at an appropriately adjusted temperature. The temperature and time of heating determine porous glasses' parameters. A further stage is etching the sodium-boron phase with hydrochloric acid. The silica gel present in the pores is leached with potassium hydroxide. The pores are filled with solution or alloy originated ferroelectric material.

APPLICATION

Composites may be applied in construction of memory components, electromechanical converters as well as photonic systems. These materials are used in basic research – i.e. research into dimensional effects in ferroic nanoparticles and its results prove to be useful for the purposes of construction of new multi-purpose materials.

OPTICAL MEASUREMENTS

RESEARCH

- **inferometric measurements with the use of the Mach-Zender system and a unique optical vortex inferometer. With use of the optical vortex interferometer, two or three parameters can be measured simultaneously with high resolution (e.g. the angle of rotation can be measured against two perpendicular axes, independently).**
- **polarimetric analysis – the polarimeter is a compact, small device with which it is possible to determine, during a single measurement, three parameters characterising doubly refracting media: the azimuth angle and the ellipticity of light after its passing through the medium being examined, as well as the phase shift between the glass and the free axis. The resolution is relatively small (amounting to 2-3 degrees) but the simplicity of analysis and the one-shot measurement make it possible to measure media of fast changing characteristics.**
- **photometric measurements – measurements of basic parameters of commercial light sources and lamp fittings. The facility enables the use of a 15m long photometric darkroom, where a fixed temperature of ~23°C is maintained.**

APPLICATION

Studies of the quality of optical elements, polarimetric measurements. Quick measurements of the azimuth angle distribution and ellipticity, as well as the phase shift between the fast axis and the slow one. Measurements of the directional characteristics of luminous intensity (minimum angle spacings: ΔC=2.5°, Δγ=2.5°), luminous flux, the source's luminous efficiency (lm/W), fitting efficiency (%), lamp efficiency (lm/W), and studies of spectral characteristics: SPD, CCT, CRI, CQS.

DESIGN, PROTOTYPING AND IMPLEMENTATION OF SOLUTIONS IN THE AREA OF OPTICS, OPTOMECHANICS AND PRECISION ENGINEERING

TECHNOLOGY

Design and production of components and devices combining precision mechanics, instrumental optics and electronics. The unit comprises three design engineering and production teams which offer the following services:

- **measurements, analysis and design of optical elements and systems,**
- **production of optical elements (lenses, prisms, wedge filters, optical parallels, etc.), design and production of mechanical systems.**

The services offered by the unit concern broadly understood instrumental optics, with unique and one-off solutions in particular. Apart from design and production, the unit performs technical analyses and expertise. The unit uses well equipped stock of tools enabling the following technological processes:

- **machining steel, non-ferrous metals and plastics (cutting, turning and milling),**
- **welding steel elements,**
- **precision laser processing: cutting and engraving (plastics and organic materials),**
- **complete technological line for processing optical glass: cutting, grinding and polishing; interferometric measurements.**

APPLICATION

Design and production of prototype devices and short batches. Modernisation and renovation of mechanical and optical devices. Design and production of mechanical elements and systems. Design of lighting optics systems, photometric and colorimetric measurements. Interferometric measurements of surface shape, measurements of light refraction ratio and its spatial distribution.

RAMAN AND AFM SPECTROSCOPY

RESEARCH

High resolution Raman spectroscopy and atomic -force microscopy.

APPLICATION

Advanced studies of materials.

SPECIALITY OPTICAL FIBRES, OPTICAL FIBRE SENSORS

RESEARCH

Design of speciality optical fibres, photonic optical fibres, waveguides and optical fibre elements with defined transmission and/or sensor related parameters with the use of advanced numerical methods. Measurements of transmission and/or sensor related parameters of speciality optical fibres, including losses, chromatic dispersion, birefringence, cutoff wavelength, crosstalk between polarisation modes, and bending losses. Recording Bragg and long-term grids in polymer optical fibres with a He-Cd laser. Recording long-term grids in silica optical fibres with a CO_2 laser.

APPLICATION

Construction of optical fibre elements and systems for sensing solutions, with the use of speciality optical fibres and elements such as Bragg grids, long-term grids and photonic optical fibres. Measurement of various physical quantities, such as temperature, elongation, hydrostatic pressure and bends, with the use of optical fibre sensors. Possible applications in the construction industry (monitoring large structures' state), technological process check-ups and mechanics.

ADVANCED SPECTROSCOPY IN 0.2 UM – 1 MM WAVELENGTH RANGE

RESEARCH

- **measurements of transmission, reflection - determination of semiconductor material and structures' absorption in the range of 0.2- 1000 um,**
- **measurements of differential absorption (modulation spectroscopy) and emission (photoluminescence, activating luminescence) spectra - also in order to determine parameters of optoelectronic devices (lasers and detectors),**
- **measurements of optical spectra in the visible and close infra-red range with an ultra-high resolution (single microeV) - also in the presence of strong magnetic fields (up to 16 T),**
- **Raman spectroscopy,**
- **time-resolution spectroscopy (with ultra-high accuracy),**
- **quantum objects spectroscopy (dots, lines and nanocrystals),**
- **modelling processes occurring in optoelectronic devices (theory and own spectroscopic studies).**

APPLICATION

Optical studies of materials. Determination of physical parameters of materials and structures. Characterisation of optoelectronic devices' structures.

FURNACE INSTALLATION FOR COMBUSTION OF LOW CALORIC GASES, LIQUID WASTE FUELS AND DIVIDED BIOMASS

TECHNOLOGY

The issue of application of low caloric waste gases of a variable composition, as well as solid and liquid waste organic substances characterised by high viscosity requires special solutions. Waste organic substances can be applied in places of origin as an additional source of thermal energy. Hence the technology of special furnace and pre-furnace chambers, allowing stable combustion, developed at the unit. Combustion of top gas in vortex chambers was undertaken in Legnica Copper Smelter, at the feed preparation department. Burners for liquid glycerol fuels were tested at Kozienice power plant, while HAST company performed tests with waste biomass burners.

APPLICATION

Application of gaseous, liquid and solid waste fuels at the place of their origin for their integration with an existing energy generation system or as a separate installation using heat for technological purposes.

POWER ENGINEERING MATERIALS SCIENCE

RESEARCH

Research work and expertise in the area of power engineering materials science - in particular, studies of degradation and ageing processes. Specialist training for engineers related to the impact of ageing of power engineering machinery and devices on their operational parameters and condition monitoring.

APPLICATION

Research and expertise in the area of degradation of ceramic and metallic materials' properties. Development of quality control systems for materials as well as technical and economic criteria of their selection. Monitoring of ageing processes of power engineering machinery and devices taking place during their operation (water and steam pipelines, welded and screwed joints, thermal insulation of fire resistant materials, sealing materials, etc.).

WASTE HEAT RECOVERY FROM THE BOILER OUTLET COMBUSTION GAS

TECHNOLOGY

The technology of recovery and use of waste heat from gases (e.g. exhaust gases from boilers using solid fuels), with condensation of steam which they contain. Analyses of application of recovered waste heat. Calculations of exchangers' thermal and design parameters. A technological design of a system for recovery and use of heat along with determination of technical and economic results of solutions proposed.

APPLICATION

Recovery and use of waste heat transmitted to the atmosphere with combustion gases results in an increase in the effectiveness of the conversion of fuels' chemical energy to electric energy (in a conventional power plant) or heat (in a heat generating plant or CHP plant) through decreasing the cost of fuel used in the process, as well as it allowing a limitation of pollution, chiefly with CO_2.

OPTIMISATION OF THE ELECTRICAL AND HEAT ENERGY POWER UNIT AND ICE WATER PRODUCTION UNIT IN TERMS OF ENERGY EFFICIENCY AND REDUCTION OF GASEOUS POLLUTION

EVALUATION

Analysis of an existing system for production of electric energy, a cogeneration system and a tri-cogeneration system in terms of improvement of efficiency and limiting emission of gaseous pollutants, also aiming to minimise energy and financial costs. A concept for system modification in terms of generation and reduction of pollutants (sulphur dioxide, nitrogen oxides and carbon dioxide) - selection of technology. 3D modelling of flow with combustion, heat exchange and precipitation of deposits in power boilers.

OPTIMISATION OF CONVERSION PROCESSES AND ENERGY USAGE IN HEAT AND ELECTRICAL POWER GENERATION

EVALUATION

Analysis of the existing technical condition of the company including indication of areas of the technological path where improvement of energy conversion is possible (e.g. conversion of fuels' chemical energy to electric energy or heat). Application of waste heat sources. Development of a concept for improvement of process effectiveness along with a multi-variant technical and economic analysis.

COMBUSTION AND EXPLOSIVENESS PROCESSES

RESEARCH

- **studies of fuel combustion processes (solid, liquid and gaseous),**
- **studies of gaseous pollutant emission and properties of combustion waste,**
- **studies of fire and explosive properties of gases and powders as well as explosion threats,**
- **diagnostic studies and monitoring of corrosion threats to boiler furnaces,**
- **studies in the area of the plasma technique in combustion and gasification processes,**
- **research related to optimisation of power boilers of different sizes.**

APPLICATION

Determination of explosive parameters of gases and powders as well as design of anti-explosion protection measures in power engineering and industrial installations. Diagnostics and continuous monitoring of corrosion threats

in pulverised-fuel boilers. Studies and optimisation of fuel combustion processes in terms of limitation of pollution from boiler furnaces. Application of the plasma technique in the start-up of power boilers and in the process of waste fuel gasification.

REDUCTION OF POLLUTION, ENERGY CONVERSION, CHARACTERISATION OF FUELS, COMBUSTION, GASIFICATION AND PYROLYSIS

RESEARCH

Studies of fuels, biomass, waste and RDF's. Determination of properties of raw and torrefacted fuels as well as fuels after pyrolysis, gasification and combustion. Additionally, the unit undertakes determination of fuels' slagging and fouling. Studies of the behaviour of different fuels in powder form, in the processes of combustion and co-combustion in a laboratory grade flow reactor (25kW thermal power) - with adjustable combustion parameters and evaluation of gaseous and powder pollution. Studies of the process of conversion of biomass to syngas (gasification, fermentation, torrefaction and pyrolysis). The unit's research infrastructure allows us to evaluate the efficiency of desulphurisation, denitriding and separation of carbon dioxide from combustion gases with the use of appropriate solid calcium sorbents or liquid sorbents. Pilot scale stands for drying, torrefaction, pyrolysis and gasification of solid fuels are applied for the tests. The unit's apparatuses and probes allow us to tests real-life objects.

APPLICATION

- **torrefaction, pyrolysis, gasification - selection of parameters, technical and elemental analysis of fuels and mineral substances,**
- **evaluation of corrosion threat to boiler furnaces; distribution of temperatures and concentrations of gaseous constituents in a boiler's combustion chamber,**
- **studies of mercury in fuels, ashes and combustion gases; emission of gaseous and solid combustion pollutants,**
- **optimisation of systems for desulphurisation, denitriding and separation of CO_2,**
- **balance measurements and evaluation of emission from power boilers.**

TECHNICAL DUE-DILIGENCE OF HEAT AND POWER GENERATION COMPANIES

EVALUATION

Analysis of the company's technical resources (including analysis of their current technical condition) needed for an investment. Analysis of financial outlay, also with respect to environmental conservation. SWOT analysis.

BOILER TECHNOLOGY, MILL INSTALLATIONS, ADVANCED MEASUREMENTS OF MILL INSTALLATIONS' BOILERS, FUEL STORAGE AND CLOSE TRANSPORT DEVICES

RESEARCH

Services including measurements of real-life objects such as boilers and mill installations in terms of possibilities of biomass and alternative fuel combustion; evaluation of fire and explosion threats.

APPLICATION

- **measurements of mill installations during milling and co-milling of biomass and other alternative fuels,**
- **evaluation of fire and explosion threats during milling and co-milling of biomass and other alternative fuels; protection of a milling installation against fire and explosion threats,**
- **fuel storage management, protection against self-ignition and fires,**
- **measurements of boiler efficiency and boiler balance during biomass combustion and co-combustion,**
- **measurements and limiting of gas and heavy metal emission.**

LOW TEMPERATURE LIGNITE DRYING TECHNOLOGY IN AN INSTALLATION WITH A BUBBLING-SPOUT FLUIDISED BED AND PRODUCTION OF BIOCOAL IN A QUASI-AUTOTHERMAL REACTOR

TECHNOLOGY

The issue of improvement of the efficiency of lignite-fuelled power units is now a major concern for the Polish and global power engineering sector. Lignite is currently the cheapest source of electric energy (around 19 USD/MWh), which accounts for 65% of the cost of Energy obtained from hard coal. Four of the five large Polish power plants (lignite-fuelled) produce energy cheaper than the least expensive power plant applying hard coal. It is indispensable to apply technologies oriented towards improvement of the efficiency of energy production in units using lignite due to its low calorific value, related mainly to the high humidity content (40-55%) it is characterised by. Hence the necessity of preliminary drying and therefore selection of technology and parameters of the humidity removal process. The main criterion applied when selecting a lignite drying technology is the extent of lignite economy stemming from the increase in the unit's and the very boiler's efficiency resulting from dried lignite combustion, which is directly reflected by limited CO_2 emission. Another important problem related to power generation is decreasing emissions of CO_2 from energy production processes. It is possible with the use of biomass. However, due to the disadvantageous properties of raw biomass as a fuel, compared to coal, its use in power generation is being limited. Improvement of its millability and calorific properties with the use of slow pyrolysis makes this kind of biomass, called biocoal, comparable to coal, thanks to which it becomes a product sought after on the market. Application of biocoal contributes to a decrease of CO_2 emissions.

APPLICATION

The demand for heat for drying purposes has a major influence on the efficiency of a power unit fitted with a drying system. Application of low temperature lignite drying installation with optional use of waste heat sources or thermal energy obtained from a concentric solar collector fitted with an accumulation system can improve the efficiency of energy production.

Application of an installation for biomass pyrolysis makes it possible to produce zero-emission fuel characterised by good millabilty and hydrophobic properties.

TECHNOLOGIES OF COMBUSTION, GASIFICATION, PYROLYSIS (INCLUDING CARBONIFICATION AND TORREFACTION) AND VALORISATION OF SOLID FOSSIL FUELS, WASTE AND BIOMASS

RESEARCH

Services including studies of basic processes of combustion, gasification and pyrolysis (including carbonification and torrefaction) and valorisation of solid fossil fuels, waste and biomass. Explanation of the mechanisms of the processes. Description of phenomena accompanying these processes (transformation of the mineral substance, NOx i SO_2 emission, heavy metal emission, corrosion and erosive wear). Determination of parameters describing the above technologies and processes (chemical kinetics, quality and quantity of products of specific processes, speed of the process), as well as characterisation of various fuels, fuel mixes, waste and biofuels according to their usefulness in different processing techniques. Mathematical modelling describing the above technologies and processes. Assistance in selection of an energy production technology and rational use of fuels, both in power engineering facilities or companies operating in industry and administrative districts.

APPLICATION

Selection and replacement of fuels and power resources with new ones; fossil fuel processing; disposal of low quality fuels; application of biofuels, sewage sludge and waste as well as selection of fuels and technologies; modernisation oriented towards improvement of operational efficiency, limitation of emission of harmful substances and decrease in costs. Specification of fuels, evaluation of power installations' quality, design of power installations, mathematical modelling of combustion, gasification and pyrolysis processes.

USAGE OF FUELS, SELECTION AND CHARACTERISATION OF FUELS AND FUEL MIXES

RESEARCH

Measurements of physico-chemical properties of raw fuels, including coal, coal waste, I and II generation biomass, as well as alternative fuels (sewage sludge, RDF, SRF and other). Optimisation of selection of various fuel mixes, studies of their physico-chemical properties. Determination of parameters characterising combustion, gasification and pyrolysis processes. Determination of parameters characterising fuels in terms of fire and explosion threats, slugging and ashing, emission of gaseous pollutants and heavy metals, corrosion and erosion. Selection of various additives limiting slugging, ashing and corrosion. Issues related to application new types of fuel in power engineering devices.

APPLICATION

Physico-chemical analyses, determination of explosiveness, determination of combustion, gasification and pyrolysis characteristics of solid fuels. Evaluation of properties of fuels' mineral substance and heavy metal content; determination of of gaseous pollutant emission levels (NOx, SO2.) Studies of fuels' milling susceptibility and transport related properties, as well as evaluation of properties of various additives improving combustion and limiting threats during solid fuel combustion.

VALORISATION OF FUELS AND LOW EMISSION COMBUSTION TECHNOLOGIES

RESEARCH

Studies related to power engineering. Thermal valorisation of fuels in pilot scale. Drying, torrefaction, gasification and pyrolysis of solid biomass fuels. Issues related to reduction of emissions of harmful substances to the atmosphere and minimisation of deposits caused by biomass co-combustion. The research conducted and developed by the unit can result in general improvement of the growth of bioenergy technology.

APPLICATION

- **production of biocoal from biomass with the torrefaction and slow pyrolysis methods,**
- **gasification of low calorie fuels, waste and biomass; integration with electric energy and heat production of combustion of high viscosity liquid fuels in dynamic and atomising burners,**
- **combustion and co-combustion of biomass with additives in order to minimise deposits,**
- **separation and removal of CO_2 from combustion gases,**
- **application of low temperature heat sources in ORC systems.**

LEAN MANUFACTURING

RESEARCH

Lean Manufacturing is a concept of process organisation which, due to elimination of wastage, enables shortening the time from placing an order to product shipment, from an idea for a product to production launch and from investment to return on it. Lean Manufacturing originates from the industrial practices of Toyota, whose excellent business results resulted in the idea's popularity. The distinctive characteristics of Lean Manufacturing are, among others, work standardisation, JIT (Just In Time) supply system, incorporating quality into the process or a single piece flow or the pull system.

The offer includes the following services:

- **product design with the use of the Lean Product Development and Lean Systems Engineering concepts,**
- **design of disassembly and remanufacturing systems with the use of the Lean Manufacturing concept,**
- **methodology of manufacturing systems scheduling in companies co-operating with each other in a supply chain,**
- **optimisation of automatic equipment service processes oriented towards improvement of the Overall Equipment Effectiveness index, training on the implementation of Lean Manufacturing methods.**

Research outcomes and the team's experience are put to use in co-operation with companies and the Lean Enterprise Institute Polska (www. lean.org.pl), which is a spin-off organisation of Wrocław University of Science and Technology, with its seat at the Wrocław Technology Park.

APPLICATION

Lean Manufacturing supports elimination of wastage and enables synchronisation of manufacture in value streams with the use of a pull system and takt time.

SIMULATION MODELLING AND OPTIMISATION OF MANUFACTURING SYSTEMS

RESEARCH

Computer modelling and simulation are currently among the most important tools for production planning in manufacturing companies. They allow such companies to flexibly adapt to the market needs and to consistently lower their production costs. The types of modelling and simulation used are as follows:

- **modelling, simulation and optimisation of production systems,**
- **business processes modelling (BPMN, IDEF0, UML, Case Method),**
- **production systems reorganisation in accordance with specific criteria,**
- **design or reorganisation of production systems in accordance with Lean Manufacturing principles (implementation and applications of tools such as VSM, 5S, TPM, Kanban and the pull system, Kaizen and others).**

APPLICATION

- **reorganisation and improvement of manufacturing systems in accordance with selected optimisation criteria, design of new production systems, improvement of production systems' efficiency, decreasing the inventory of raw materials, finished products and production in progress,**
- **optimisation of workstations' arrangement, eliminating wastage in production processes,**
- **analysis and assessment of risk in the manufacturing process,**
- **training on production management, reorganisation, modelling and optimisation.**

TECHNOLOGICAL PROCESS PLANNING

TECHNOLOGY

The subject matter of planning technological processes is related to the development of integrated IT solutions supporting complex tasks of the contemporary process technologist and planner. The research works conducted at the unit involve development of a concept of construction of a modular computer system supporting planning technological processes (Computer Aided Process Planning). The system is based on structural data of products from CAD 3D systems; it has a built-in module for identification of technological elementary objects based on artificial intelligence methods. Algorithms for sorting and grouping objects have been implemented in the system.

APPLICATION

- **co-operation in the area of development of new techniques supporting planning technological processes,**
- **IT solutions which allow processing CAD 3D system geometry so that its technological interpretation is possible,**
- **solutions in the area of development and implementation of expert systems dedicated to particular technical applications,**
- **comprehensive analyses of CAPP class IT systems used for particular product classes and their integration with CAD, CAM, PCM and ERD.**

ATMOSPHERIC PLASMA SPRAYING (APS)

RESEARCH

Identification of coatings' mechanical characteristics and optimisation of coating process parameters in order to obtain required functional characteristics (anticorrosive , tribologic, biological, etc.); selection of composition and analysis of properties.

APPLICATION

Plasma spraying technologies are applied in many industrial sectors (mining, power engineering, aerospace, machine design and medicine) in order to provide materials with high quality and unique performance characteristics, including tribologic wear resistance, anticorrosion, or thermal barriers. The unit's technological infrastructure also allows processing of powder materials, e.g. speroidisation.

QUALITY MANAGEMENT

RESEARCH

The contemporary economy requires a comprehensive approach to quality-related issues. This approach is the subject matter of the team's research and implementation works as well as training and consultancy services, where we mostly focus on a systemic approach to quality management as well as on the application of preventive methods of quality assurance and the use of analytical methods to make decisions based on facts. The research carried out involves all processes within an organisation, while particular attention is paid to the processes related to product execution.

APPLICATION

- **studies of improvement, optimisation and monitoring of manufacturing processes,**
- **assistance in developing systemic solutions in the area of quality management, in compliance with ISO 9000 standards,**
- **assistance in research into stability and capability of processes as well as systems' uncertainty and capability,**
- **training and consultancy for the development of competences in the field of quality improvement methods and technologies,**
- **training and consultancy related to methods and tools applied in the Six Sigma strategy.**

INTEGRATED IT SOLUTIONS FOR INDUSTRY

TECHNOLOGY

Works in the field of the development of own IT solutions as well as integration of existing IT solutions for industry, in particular with respect to systems supporting management of new products in the domains of construction, technology and setting up production. It mainly concerns PDM/LDM systems managing information and data in the product creation, manufacture and development processes.

APPLICATION

- **analyses and re-engineering of business processes in the area of product development, planning and manufacturing,**
- **development of dedicated IT solutions, in particular with regard to project management and work in a dispersed business environment, management of documentation and enterprises' business processes,**
- **system pre-implementation analyses and implementation assistance,**
- **training in manufacturing process organisation and management with the use of IT tools.**

DIAGNOSIS OF ORGANISATIONS' HUMAN POTENTIAL

EVALUATION

Diagnosis of the organisation from the point of its culture, professed values, satisfaction of employees, motivating and non-motivating factors. The aim of expertise is the optimal use of the organisation's potential, associated with its human resources and changes in the values and culture of the organisation, in order to raise its potential.

EVALUATION AND DEVELOPMENT OF MOTIVATIONAL SYSTEMS

EVALUATION

Diagnosis of the needs of employees and the development of a system of motivational tools for work adapted to the enterprise. Optimisation of employees' effectiveness and methods of human resources management.

TRAINING ON BUILDING EFFECTIVE TEAMS

TRAINING

Workshops in the area of knowledge and techniques of building and maintaining effective task-oriented and project teams.

APPLICATION

Improvement of competences in the area of human resources management.

TRAINING ON COMMUNICATION WITHIN THE ORGANISATION

TRAINING

Workshop training with an individualised programme, tailored to the organisation's needs, on communication within a group, task-oriented or project team.

APPLICATION

Improvement of employees' competences in the area of communication.

TRAINING ON RESOLVING DIFFICULT SITUATIONS IN THE WORKPLACE (STRESS, CONFLICTS, HARASSMENT)

TRAINING

Workshops on recognising, solving and counteracting difficult situations in the workplace, as well as coping with difficult situations.

APPLICATION

Improvement of competences in the area of solving difficult situations in the organisation as well as the ability to cope with work related strain and counter its health impacts.

TRAINING ON EFFECTIVE STAFF MOTIVATION

TRAINING

Workshops for managerial staff in the area of processes of motivation to work and their psychological determinants.

APPLICATION

Improvement of competences in the area of human resources management.

TRAINING ON TIME MANAGEMENT AND EFFECTIVE WORK ORGANISATION

TRAINING

Workshops aiming to optimise effectiveness in the area of work organisation and allocation of work time.

APPLICATION

Improvement of competences in the area of individual work effectiveness.

ANALYSES OF THE DISTRIBUTION OF ELECTROMAGNETIC FIELD INTENSITY NEAR RADIO COMMUNICATION INSTALLATIONS

EVALUATION

Determination of the range of protected zones surrounding radiocommunication installations (e.g. cellular base stations); determination of the field strength level in selected locations.

MEASUREMENT OF ANTENNAS' ELECTRICAL PARAMETERS

RESEARCH

- **measurements of radiation of antennas with mass up to 100 kg and a diameter of up to 1.5 m in the 800MHz-40GHz frequency range,**
- **measurements of the gain of antennas with mass up to 100 kg and a diameter of up to 1.5 m in the 800MHz-40GHz frequency range,**
- **measurements of input impedance in the 9kHz--67GHz frequency range,**
- **measurements of the reflection coefficient and input standing wave ratio in a 9kHz-67 GHz frequency range in a laboratory and a 9kHz-8.5GHz frequency range directly at the installation site of the antenna.**

APPLICATION

Determination of antennas' electrical parameters to evaluate compliance with Polish standards.

OTA MEASUREMENTS

RESEARCH

OTA (Over The Air) measurements of radio communication equipment, including:

- **measurements of radiation patterns, measurements of Total Radiated Power (TRP).**
- **measurements of equivalent isotropically radiated power (EIRP), measurements of spurious emission.**

APPLICATION

Evaluation of the quality of radio devices.

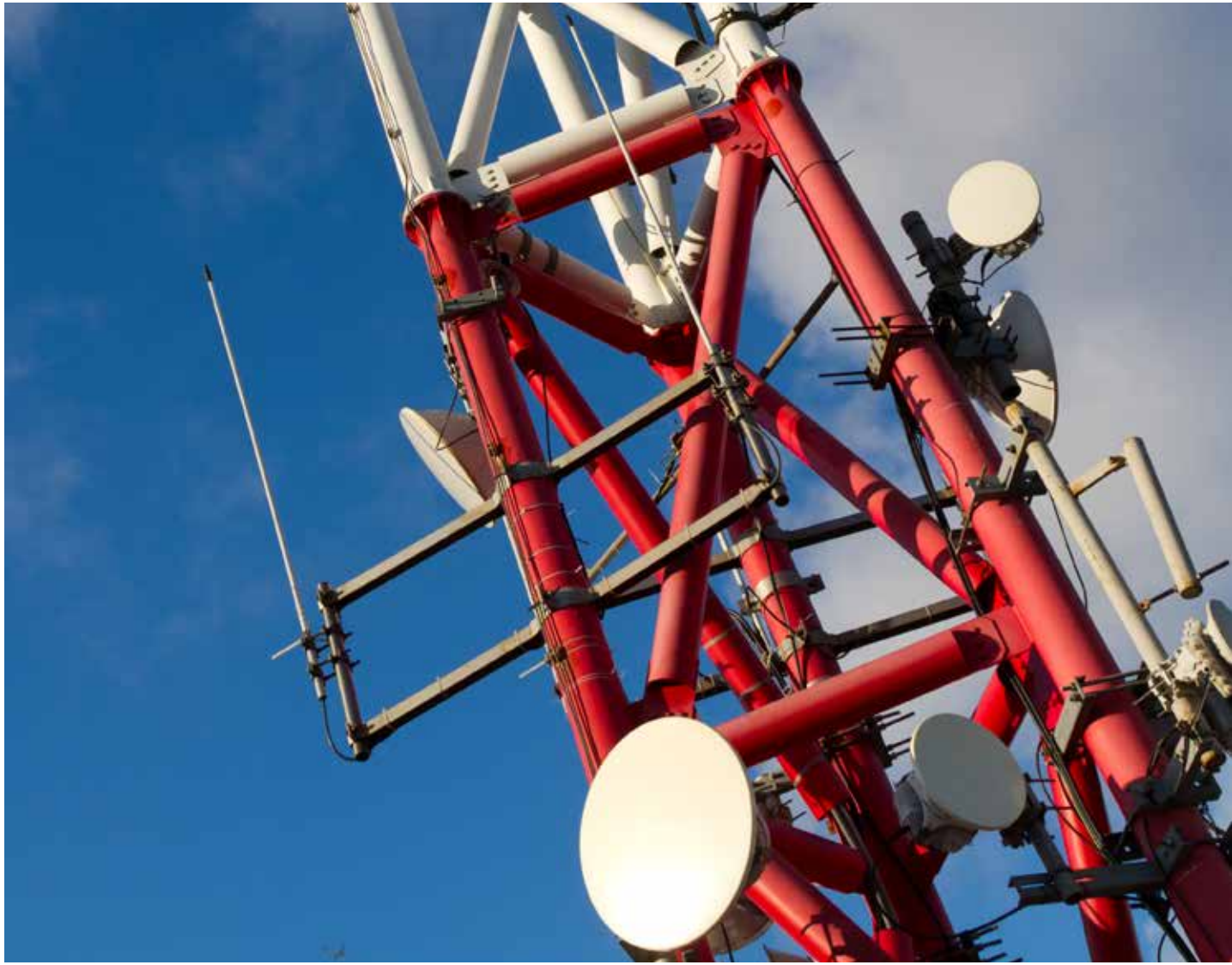
DESIGN OF ANTENNAS

TECHNOLOGY

- **designing printed (microstrip), stub and parabolic antennas for measurement, radio communication and RFID purposes,**
- **rapid prototyping of antennas, including: casing, printed circuits,**
- **CAD/CAE numerical calculations.**

APPLICATION

Development of prototypes of antennas or improving existing designs.



ACADEMIC ENTREPRENEURSHIP INCUBATOR

The Academic Entrepreneurship Incubator at Wrocław University of Science and Technology was founded with new enterprises in mind, particularly those coming from the student background. The Incubator, along with the MANUS Foundation, delivers a pre-incubation service, which makes it possible for young people to test their ideas for a business without a need to register commercial operation.

The goal of pre-incubation is to prepare the pre-incubated person to set up and run their own company. The Incubator and Foundation support participants in the initiative in all fields of their operation in areas including formal and legal accounts (agreements, bills, invoices, etc.), legal and marketing advice, practical substantive training sessions, as well as assistance in finding appropriate conditions in terms of equipment and business premises.

Thanks to us, you may assign the company's Ambassador at the University - a person selected from MSc and PhD students to represent the business and support it in recruitment and image related operations.

Additionally, twice a year (in spring and autumn) we organise the "Academic Career Expo", which is an excellent opportunity to introduce your company and specific job offers to students. We regularly publish the "Employer Catalogue" - a source of the most important information about companies and their recruitment procedures.

The beneficiaries of the assistance are MSc and PhD students, graduates of public tertiary institutes (over a period of 3 years of their graduation), as well as employees of Wrocław University of Science and Technology who intend to run a business operation or already have their own company. The Incubator ensures for the beginning entrepreneur conditions allowing them to develop and safely avoid difficulties which are usually experienced by start-ups. People who have a plan to make their operation grow but lack the experience needed to run a business may expect the Incubator's support up to a point when they are ready to operate on the market on their own. The Incubator's "care" lasts 3 years. Incubation provides the following forms of support to companies once they are registered: access to a virtual office (address necessary to register and run a business operation), equipped office infrastructure, on preferential terms; with us acting as an intermediary, one can apply for an office at the Lower Silesian Academic Incubator located at Wrocław Technology Park, conference rooms, legal, financial and account consultancy, participation in conferences, training sessions, seminars and workshops organised by the Incubator, substantive support in the area of obtaining EU funds, promotion in the media.

Contact information:
Wybrzeże Wyspiańskiego 23-25, 50-370 Wrocław (building C-13), room 1.07
71 320 43 82, inkubator@pwr.edu.pl, www.inkubator.pwr.edu.pl

CAREER SERVICES

If you are interested in recruiting staff or interns, we offer you the support of our Career Services.

We also offer comprehensive services related to building the company's image as an employer.

What can we do for you?

- **we distribute job offers, as well as information about available internships in the University's academic milieu,**
- **we allow recruitment at the University's campus (Recruitment Week, Speed Recruitment), we organise meetings where employers and students can get to know each other (e.g. presentations, training sessions, open door days, company tours, etc.).**

All services can be delivered either on a one-off basis or as long-term and comprehensive campaigns. Thanks to them, you will quickly reach sought after candidates, as well as become an employer of choice in the eyes of students and graduates.

Contact information:
Wybrzeże Wyspiańskiego 40, 50-370 Wrocław (building H-14, floor I)
71 320 46 08, biurokarier@pwr.edu.pl, www.biurokarier.pwr.edu.pl

CONGRESS CENTRE

The Congress Centre at Wrocław University of Science and Technology is a perfect venue to hold scientific conferences, symposia, company events, training sessions, discussion panels or promotional events. The Congress Centre is located at the University's main campus, in Grunwaldzki Square - Wrocław's important transport hub and a commercial and leisure centre. It is perfectly connected with the city centre, the main railway and coach stations, and popular hotels.

The centre comprises three conference rooms, which thanks to their modularity can be arranged in the following ways:

- **room with 620 seats (700 m²)**
- **room with 320 seats (335 m²)**
- **room with 300 seats (365 m²)**
- **room with 460 seats (L-shaped) two rooms with 160 seats each (2 x 167 m²)**

Also three smaller conference rooms can be used - 40 m² – 45 seats each (classroom layout) or 90 seats (cinema room layout).

Equipment:

- **system for simultaneous translation, including special booths,**
- **multimedia projectors and screens,**
- **access to a wireless Internet connection and Wi-Fi, stationary microphones and microphone stands, cordless microphones,**
- **microports, a visualiser with a camera,**
- **presenter for remote slide changing + laser pointer,**
- **laptop computers and DVD,**
- **changeable lighting system,**
- **audio recording equipment for conferences.**

Apart from the congress room, we own an exhibition complex located in very close proximity. It can be used for accompanying exhibitions, poster sessions, catering or press conferences.

The exhibition complex comprises the following:

- **right foyer of the congress room - floor area: 242 m²**
- **left foyer of the congress room - floor area: 179 m²**
- **mezzanine - floor area: 217 m²**

Apart from the rental of floor area at the Congress Centre, we ensure comprehensive technical and logistic service for every conference:

- **design of conference materials (leaflets, advertising posters, roll-up's, conference programmes, badges, brochures, folders, lanyards with badges), organisation of transport for participants,**
- **organisation of optional trips (hiring a guide, organisation of information materials),**
- **organisation and running of a reception and registration point for participants,**
- **running a simultaneous translation system, assistance in communication with foreign clients, arrangement of poster sessions, exhibitions and presentations, hotel/accommodation booking, and negotiating prices.**

Contact information:
ul. Janiszewskiego 8, 50-372 Wrocław (building D-20)
71 320 45 33, konferencje@pwr.edu.pl, www.konferencje.pwr.edu.pl

CONTINUING EDUCATION CENTRE

The Continuing Education Centre at the Wrocław University Of Science And Technology, in cooperation with the faculties, conducts postgraduate studies and organises various courses and training sessions. Its educational offer includes over 37 postgraduate study course programmes in response to employers' and the labour market's demand. The Centre ensures development of employees' qualifications as well as growth of companies' adaptive potential through promotion of the idea of life-long learning and continuous delivery of the highest quality of services offered. Thus, beginning studies on the course programmes offered makes it possible to update one's knowledge in line with the newest research. Besides postgraduate studies, which have been implemented for many years, the complete offer of the Continuing Education Centre also comprises flexible services that cater to the client's expectations. It enables organisation of postgraduate studies, training sessions as well as courses in the area of the research-oriented and didactic activity of the University.

Areas of co-operation offered:

- **cooperation in the area of professional development of managerial staff and company employees through postgraduate education,**
- **cooperation in the area of organisation and delivery of specialist training sessions and courses commissioned by companies,**
- **initiating and supporting cooperation with business, support and implementation of training outsourcing enabling companies to focus their growth potential on their key business processes.**
- **dissemination of continuous academic education in the context of employees' professional development.**

Contact information:
ul. Karola Szymanowskiego 7, 51-609 Wrocław
71 340 75 17, cku@pwr.edu.pl, www.cku.pwr.edu.pl

CENTRE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Centre of Information and Communication Technologies of Wrocław University of Science and Technology was founded at the faculty of Electronics as an interdepartmental body. The Centre's mission is to foster the University's cooperation with the concern IBM in the area of development of students', graduates' and academic staff's competences, as well as establish and maintain cooperation in the field of science and research with organisational units operating under the IBM brand. The centre runs interdisciplinary operations in fields including research, education, services, training and promotion, focusing on IT and teleinformatic technologies.

The Centre's key activities include the following:

- **organisation and delivery of research and technical services, as well as delivery of scientific research and education related services,**
- **organisation of relevant lectures, training sessions and specialist courses for people working in the fields of industry and education, including employees of Lower Silesian tertiary institutes,**
- **promotion of knowledge about the achievements of Wrocław University of Science and Technology and co-creation of the University's image as a place friendly to the business sector.**

The Centre cooperates particularly actively with the Center for Advanced Studies of IBM Polska, but it is also open to cooperation with other partners. We work in research teams operating in fields such as: teleinformatic networks and their environment, micro- and nanoelectronics, cyber security, statistical methods in large scale issues: high dimension, non-linear methods of mathematical statistics applied in areas including classification and detection changes in data streams, processing of industrial images, monitoring production quality and security of computer networks, remote teaching, education, virtualisation systems for educational purposes, medical imaging, smarter water, modelling, optimisation, meta-heuristic approach, complex systems, etc.

Contact information:
ul. Z. Janiszewskiego 11/17, 50-372 Wrocław
71 320 38 52, jerzy.kotowski@pwr.edu.pl, www.eka.pwr.edu.pl

CENTRE FOR SCIENTIFIC AND TECHNICAL INFORMATION – CENTRE FOR SCIENCE AND ECONOMY COOPERATION

We deliver comprehensive services in relation to all forms of cooperation with Wrocław University of Science and Technology, with the needs of companies willing to become more competitive in mind. We have

cooperated with the business sector for years and we know what the market expects.

- **we initiate and coordinate scientists' cooperation with entrepreneurs,**
- **we provide consultancy in the area of selection of the right research team, laboratory or specialist of Wrocław University of Science and Technology. Whether specific commission, expert report, opinion or research piece, our experience will make it possible to solve problems and indicate alternative units to cooperate with,**
- **we identify and monitor scientific research projects with high commercial potential; we have created a technology transfer system and a model for cooperation between science and business. We provide information and consultancy in legal and organisational terms with respect to technology transfer feasibility and procedures, as well as financial support under EU or NCBiR projects,**
- **we have developed and use in practice clearly defined rules for cooperation with business entities in the area of scientific research and development works, as well as commercial commissions placed with Wrocław University of Science and Technology,**
- **we boast a competent team of people responsible for effective cooperation with business - we will reply to every enquiry,**
- **we provide comprehensive support, making sure - on entrepreneurs' behalf - that all formalities have been gone through. We ensure formal-legal services in the area of negotiation, drawing up, performance and settling of agreements related to commercialisation of research results, as well as agreements in relation to execution of research, consortium agreements and agreements of scientific research cooperation,**
- **we support innovative ideas in the process of attracting business partners. We cooperate with entities including chambers of commerce, as well as technology, science and industrial parks.**

Thanks to the latest IT technologies applied by the Centre, you are ensured free of charge access to:

- **the Knowledge Repository, containing source information and publications of the University's researchers,**
- **a database of inventions, research proposals and projects in which the University is involved.**

The structure of the Centre for Scientific And Technical Information – Centre For Science And Economy Cooperation also comprises:

1. The Regional Centre of Patent Information, part of the European PATLIB network, offering free of charge access to information on patents (including patent procedures, types of patent ownership rights and costs of securing protection). The centre delivers training in the following fields:

- **effective application of patent data bases' resources,**
- **protection of industrial property and copyrighted items, including protection of companies' interests when launching new products and brands.**

2. Standards Information Office, which cooperates with the Polish Committee for Standardisation, ensuring access to the collection of Polish standards, as well as their relation to European standards, and also access to American standards.

3. Scientific research laboratories equipped with unique apparatuses enabling research projects and innovative solutions. The laboratories perform tasks and commercial services commissioned by external entities.

You are welcome to visit our website www.biznes.pwr.edu.pl where we provide databases (including databases of projects, inventions, as well as our of-

fering of research and technologies ready to be put into business use), along with agreement templates facilitating quick establishment of cooperation.

Contact information:
plac Grunwaldzki 11, 50-377 Wrocław (building D-21)
71 320 47 42, 71 320 47 59, biznes@pwr.edu.pl, www.biznes.pwr.edu.pl

CENTRE FOR ADVANCED MANUFACTURING TECHNOLOGIES

The Centre for Advanced Manufacturing Technologies (CAMT) operates as part of the Department of Laser Technologies, Automation and Production Organisation. The research areas and competencies of CAMT entail the latest trends in development technologies, manufacturing and IT systems. Its wide range of research and implementation projects ensures constant technological development and increases the scientific and research potential of the centre. Close cooperation with Polish and German industries makes it possible to conduct research projects in Polish and international consortia.

CAMT executes commissioned work for industry related to design, prototyping, manufacturing series of product models, research into materials, development of laser technologies for particular applications, as well as consultations regarding implementation of products for mass production; it is also carrying out a number of Polish and European research and development projects. The Centre specialises in generative, laser, material and simulation technologies as well as inspection. It encompasses a number of specialist laboratories, whose competences enable comprehensive performance of research works and industrial implementation projects:

- **Technological Planning and CAD CAM FEM Laboratory,**
- **Accredited Laboratory of Reverse Engineering, Laboratory of Virtual Reality, Laboratory of Rapid Product Development, Laboratory of Technological Process Planning,**
- **Laboratory of Simulation Modelling and Manufacturing Systems Optimisation**
- **Laboratory of Integrated IT Solutions for Industry,**
- **Laboratory of Lean Manufacturing, Laboratory of Quality Management,**
- **Laboratory of Manufacturing Machines Design and Optimisation,**
- **Laboratory of Automatics and Robotics,**
- **Laboratory of Optomechatronics and Vision Systems, Laboratory of Laser Technology,**
- **Laboratory of Laser Cladding, Laboratory of Functional Coatings Technology,**
- **Laboratory of Materials Studies and Mechanical Engineering,**
- **Laboratory of Numerically Controlled Machine Tools.**

Apart from the aforementioned themed laboratories and workrooms, part of CAMT constitutes the Lower Silesian Innovation and Science Park, which is related, in personal and substantive terms, to the Industry Point of Contact at the Polish Technological Platform of Manufacturing Processes as well as the excellence network ProNet. Under the agreement of 2008, the research unit was included in the international Fraunhofer Project Centre (FPC) created together with Fraunhofer Geselschaft, and in substantive terms with Institut für Werkstoff - und Lasertechnologien from Dresden, in the field of laser and generative technologies. Together with its foreign partners the unit carries out research in the field of laser technology development and applications, new materials as well as hybrid technologies. By combining the Fraunhofer Institute's experience of laser applications and CAMT's experience in the fields of production processes, generative technologies, reverse engineering and optomechatronic systems, the unit does research into development of generative manufacturing technology.

Contact information:
ul. Łukasiewicza 5,Wrocław 50-371 (building B4)
71 320 20 46, edward.chlebus@pwr.edu.pl, www.camt.pl

WROCŁAW CENTRE FOR NETWORKING AND SUPERCOMPUTING

The Wrocław Centre for Networking and Supercomputing (WCSS) is an inter-university unit operating since 1995. The Centre's scope of activity involves the following areas: development and maintenance of the Wrocław Academic Computer Network (WASK), ensuring access to the Internet to Wrocław's academic environment, schools, public offices, hospitals, and public administration units, development and maintenance of computing infrastructure for research purposes, development and maintenance of service-oriented infrastructure for business entities, public administration, and scientific research units, delivery of services involving good quality and highly accessible high efficiency digital data transfer, running the IT security centre, R&D activity in the area of ICT, and delivery of training. The Centre boasts an advanced network, server and data storage infrastructure which is the basis for the services it delivers as well as for the R&D activity within the framework of internal, domestic and international projects.

The Centre welcomes co-operation in the following fields:

- **data transfer services (L2VPN, L3VPN), access to the resources of the global Internet network, large scale computation tasks,**
- **development and maintenance of data repositories and archives, including OpenData,**
- **development, optimisation and paralleling of applications, including those for computation accelerators,**
- **setting up computational clusters, grids and clouds, IT security (including security tests and penetration tests of networks, operating systems and applications, post-breach analysis, creating security policies and authentication systems),**
- **implementation of systems for monitoring of network and service infrastructure,**
- **implementation of helpdesk systems to ensure effective service for clients, users or internal processes,**
- **development and implementation of systems for scientific data management, particularly those for laboratory management (LIMS) and the laboratory notebook (ELN), maintenance and administration of network applications, data bases, websites, electronic mail, as well as virtual and dedicated servers, collocation of servers and services,**
- **training on programming, large scale computation and operation of scientific software.**

Contact information:
pl. Grunwaldzki 9, 50-377 Wrocław
71 320 39 21, kontakt@wcss.pl, www.wcss.pl

WROCŁAW CENTRE FOR TECHNOLOGY TRANSFER

Our mission is commercialisation of results of the University's scientific research, stimulation of research and technology related cooperation on domestic and international levels, as well as support of enterprises' innovativeness. We have been operating since 1995, being Poland's oldest academic technology transfer centre. Every year, we deliver services to about 1,200 enterprises and 1,500 scientists. For many years now, we have published the "High-Tech" quarterly dedicated to the cooperation between science and business. We are members of the following networks: Enterprise Europe Network, Euraxess and the Network of National Contact Points for EU Research Programmes.

We have received numerous awards, such as the Economy Award - the Lower Silesian Griphon, Spire - the Business Centre Club's award, Domestic Innovation Leaders, the Crystal Brussels Sprout, and LUMEN - Leaders in University Management.

Our offering for business comprises the following:

1. **Innovations and transfer of modern technologies:**
   - **we offer inventions and technologies developed by the researchers of Wrocław University of Science and Technology, supporting buyers in implementation,**
   - **we perform analyses of new technologies' market potential and evaluate new technological solutions,**
   - **we seek businesses which could be providers or recipients of technologies,**
   - **we perform technological audits in relation to a company's needs and capabilities in terms of technology, as well as audits in relation to visual communication and industrial design,**
   - **we provide support in negotiations,**
   - **we assist businesses in the development of their own innovative products and services with the use of the design thinking method, we help businesses protect their intellectual property (patents, trade marks, utility models, etc.).**
2. **Cooperation with foreign entities:**
   - **we develop exports strategies,**
   - **we assist in finding a foreign partner (in terms of trade or technology) via the Enterprise Europe Network,**
   - **we organise trips to foreign trade fairs, economic missions and meetings aiming to establish cooperation,**
   - **we develop market analyses for selected business sectors and countries,**
   - **we deliver consultancy services in the areas of law and patents.**
3. **Raising non-repayable finance (grants):**
   - **we provide information on which domestic or European programme is the most suitable for a given undertaking: research and development operation, innovation, investment, etc.**
   - **we provide information on these programmes' requirements as well as offer assistance in development of applications (application and/or feasibility study),**
   - **we provide consultancy services at the stage of project execution and accounting.**
4. **Raising capital:**
   - **we verify the entrepreneur's planned business model,**
   - **we provide assistance in business plan development,**
   - **we facilitate contact between the entrepreneur and a suitable seed or venture fund,**
   - **we provide assistance in the area of investor presentations for the needs of meetings with fund representatives,**
   - **we provide support in negotiations with investors.**

Contact information:
ul. Smoluchowskiego 48, 50-372 Wrocław
71 320 33 18, wctt@wctt.pl, www.wctt.pl, www.komercjalizacja.pwr.edu.pl

Laboratory of Olfactometric Research

Faculty of Environmental Conservation
research laboratory, accreditation no. AB 1461

Scope of research:
- drawing of samples, laboratories accredited for drawing of samples,
- sensory tests.

Objects of research:
environmental samples, air, water, soil, waste, sediments and sewage.

Contact information:
izabela.sowka@pwr.edu.pl
71 320 25 00

Laboratory of Electromagnetic Compatibility

Faculty of Electronics
research laboratory, accreditation no. AB 167
Scope of research:
- electromagnetic compatibility tests

Objects of research:
- electrical, telecommunications and electronic (including software) products,
- fittings and equipment,
- medical equipment,
- vehicles.

Contact information:
www.lke.wroc.pl
lke@pwr.edu.pl
71 320 29 47

Work Safety Laboratory

Faculty of Geoengineering, Mining and Geology
research laboratory, accreditation no. AB 905

Scope of research:
- chemical studies, chemical analytics,
- studies related to environmental engineering (environmental and climatic), studies of physical properties,
- drawing of samples, laboratories accredited for drawing of samples.

Objects of research:
environmental samples, air, water, soil, waste, sediments and sewage.

Contact information:
www.wggg.pwr.edu.pl
mariola.stefanicka@pwr.edu.pl
71 320 68 44

Research Laboratory of Transport Infrastructure Facilities

Faculty of Civil Engineering
research laboratory, accreditation no. AB 1211

Scope of research:
- mechanical and metallography tests,
- non-destructive studies,
- studies of physical properties.

Objects of research:
- construction products and materials, civil structures.

Contact information:
www.lboit.pwr.edu.pl
antoni.szydlo@pwr.edu.pl, jaroslaw.kuzniewski@pwr.edu.pl
71 320 23 52

Research Laboratory of Acoustics

Faculty of Electronics
research laboratory, accreditation no. AB 796
Scope of research:
- acoustic and noise tests - also tests of noise caused by vibrations,
- studies related to environmental engineering (environmental and climatic).

Objects of research:
- construction products and materials, civil structures,
- electrical, telecommunications and electronic products, fittings and equipment, environmental samples, air, water, soil, waste, sediments and sewage,
- machines, production facilities, fittings and equipment - including nuclear installations.

Contact information:
www.lba.pwr.edu.pl
lba@pwr.edu.pl
71 320 28 30

Building Constructions Laboratory

Faculty of Civil Engineering
research laboratory, accreditation no. AB 455

Scope of research:
- mechanical and metallography tests,
- studies of physical properties
- drawing of samples, laboratories accredited for drawing of samples.

Objects of research:
- construction products and materials, civil structures,
- structural products and materials including metals and composites.

Contact information:
www.wbliw.pwr.edu.pl
zbigniew.matros@pwr.edu.pl
71 320 37 61, 22 64

Construction Materials Laboratory

Faculty of Civil Engineering
research laboratory, accreditation no. AB 1569

Scope of research:
- mechanical and metallography tests,
- studies of physical properties.

Objects of research:
construction products and materials, civil structures.

Contact information:
bozena.borkowska@pwr.edu.pl
71 320 22 64

Laboratory of Electromagnetic Field Measurements

Faculty of Electrical Engineering
research laboratory, accreditation no. AB 1568

Scope of research:
- studies related to environmental engineering (environmental and climatic).

Objects of research:
environmental samples, air, water, soil, waste, sediments and sewage.

Contact information:
http://zep.ie.pwr.wroc.pl/index.php?id=pola_laboratoria
zbigniew.wroblewski@pwr.edu.pl
71 320 37 68

Laboratory of Electromagnetic Field Standards and Metrology

Faculty of Electronics
research and calibration laboratory, accreditation no. AB 361, AB 078

Scope of research:
- magnetic and electromagnetic quantities
- studies related to environmental engineering (environmental and climatic).

Objects of research:
- sources of electromagnetic field - including electrical , telecommunications, electronic and medical products, fittings, equipment and installations.

Scope of calibration activity:
- magnetic and electromagnetic quantities

Calibrated objects:
- electrical and magnetic signal strength meters,
- power density meters,
- magnetic induction meters, induced current meters

Contact information:
www.lwimp.pwr.edu.pl
lwimp@pwr.edu.pl
71 320 30 87, 24 97

Reverse Engineering Laboratory

Faculty of Mechanical Engineering
research laboratory, accreditation no. AB 969

Scope of research:
- studies of physical properties.

Objects of research:
- structural products and materials - including metals, composites, glass and ceramics,
- other products,
- plastic and rubber products, wood.

Contact information:
www.lre.pwr.wroc.pl
lre@pwr.wroc.pl
71 320 40 61, 42 08

Belt Conveying Laboratory

Faculty of Geoengineering, Mining and Geology
research laboratory, accreditation no. AB 710

Scope of research:
- fire tests,
- mechanical and metallography tests,
- studies of physical properties.

Objects of research:
- plastic and rubber products.

Contact information:
www.ltt.pwr.edu.pl
monika.hardygora@pwr.edu.pl
71 320 68 42

Laboratory of the Computer Aided Design Research Unit

Faculty of Mechanical Engineering
research laboratory, accreditation no. AB 659

Scope of research:
- mechanical and metallography tests.

Objects of research:
- machines, production facilities, fittings and equipment - including nuclear installations,
- other products,
- vehicles.

Contact information:
www.ikem.pwr.wroc.pl/cad
eugeniusz.rusinski@pwr.edu.pl
71 320 38 60

KEY WORD INDEX

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Centre for Cooperation between Science and Economy

- Consultancy in the area of selection of the right research team, laboratory or specialist for cooperation
- Comprehensive formality and legal services (we make sure - on entrepreneurs' behalf - that all formalities have been gone through)
- Professional technology transfer system, including identification of research projects with considerable potential for Entrepreneurs
- Proceeding on legal protection of intellectual rights

Connecting business & science

www.biznes.pwr.edu.pl biznes@pwr.edu.pl 71 320 47 42, 71 320 47 59

Wrocław
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of Science
and Technology

Centre for Cooperation between Science and Economy

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