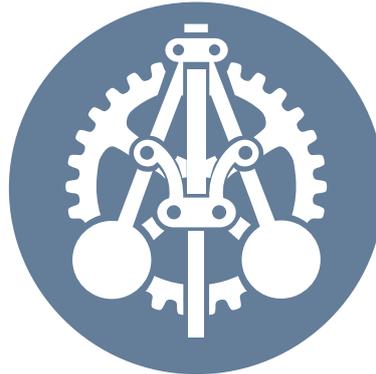




# **Budapest University of Technology and Economics (BME)**



## **Faculty of Mechanical Engineering**

### **Education and Research 2011**

Department of Materials Science and Engineering • Department of Fluid Mechanics • Department of Energy Engineering • Department of Building Service and Process Engineering • Department of Machine and Product Design • Department of Manufacturing Science and Engineering • Department of Hydrodynamic Systems • Department of Mechatronics, Optics and Mechanical Engineering Informatics • Department of Applied Mechanics • Department of Polymer Engineering

## Education

The department provides high-level education from BSc to PhD. In the first semester of the BSc programme the students of Mechatronics, Energy Engineering, Industrial Product Design, and the Faculty of Electrical Engineering are trained. Materials Engineering and Materials Science, as core subjects, are delivered to students, both concentrating on demonstrating connections between materials structure and properties, while within the subject, Materials Engineering, basic technologies are described.

In the second semester, Mechanical Technology in Materials Structure and Testing are delivered to students of Mechanical Technology in Materials Structure and Testing. The focus is on advanced demonstration of the relationship between materials structure and their properties, as well as their deeper testing. The same semester, students of Engineering Management are trained in Materials Engineering subject. This responsibility is shared with the Department of Polymer Engineering.

During the third semester students follow lectures about material production, major technologies and material selection strategies, fundamental for engineers within the subject of Metals Technology.

In the Materials Technology module of BSc, first of all, theoretical foundation of the major technologies is provided together with the Department of Polymer Engineering.

In several specializations of the MSc course, Materials Science, as a compulsory subject, is lectured to students. Within the specialization of Materials Technology, industry-motivated high-level knowledge in major technologies and materials testing is provided in the renewed laboratories.

This department also takes part in full-time and part-time PhD training of Hungarian and foreign students. Furthermore, it plays an important role in university training conducted in foreign languages (English, German, Russian and French).

The post-graduate Welding Engineer training, launched 50 years ago, has had its accreditation since 1993, thus, the graduates of this program are eligible to obtain the internationally acknowledged diploma of EWE: European Welding Engineer.

## Research

The main research fields include industrial materials design and testing, intentional modification of grain boundary structure of metals, fabrication of metallic foams and metal-matrix composites, development of welding technologies, production and testing of stents, failure analysis of materials exposed to stress and elaboration of life extension technologies, as well as the development of related material testing methods (microscopic, electron-microscopic, magnetic, and other destructive and non-destructive).

Research is done in reasonably located and well-equipped laboratories that are also used in training. Some of the demonstrating equipment: scanning electron-microscope with EDS and EBSD, optical microscopes, accelerometers and universal mechanical testing machines, laser processing units, composite laboratory, welding robots and forming machines.

The Research Group for Metals Technology of the Hungarian Academy of Sciences works at this department, the major research field of which ("Research of special materials for medicine, energy, vehicle and tools in industries, testing their microstructural and functional properties for their technology-intensive application") excellently fits into the research activity of this department.

The research project, supported by the Hungarian Scientific Research Fund, OTKA, "Intentional modification of grain boundary structure of metals", finished last year. "Magnetic testing of degradation processes of power plant materials" is still running, as well as one of our fresh postdoc's OTKA-project entitled "Infiltration of microballoons". A new project entitled "Exploration of theoretical and experimental foundation of new facilities for manufacturing ultra-fine grained constructional steels" is also under submission. Additional means for development comes from vocational training contribution, innovation and industrial agreements, as well as from Research University projects.

The results are published in periodicals having impact factors, and in Hungarian journals, as well as at international and Hungarian conferences. Several staff members have been involved in organising the Materials Science and Mechanical Engineering Conferences in Hungary for some years.



## Education

The educational assignments of the department can be sorted into three major complementary groups: theoretical and empirical considerations; computer simulation methods - supported by our computer cluster; and measurement techniques - promoted by the readiness of our laboratory facilities.

The department is responsible for the following subjects and subject groups, most of them also being taught in English: Aerodynamics, Fluid Mechanics, Fluid Mechanical Measurement Techniques, Fluid Machinery, Building Aerodynamics, Gas Dynamics, Industrial Air-Conditioning, Vehicle Aerodynamics, special subjects pertaining to environmental protection and environmental technology, Air Quality Control, Engineering Meteorology, Technical Acoustics and Measurement Techniques, Large-Eddy Simulation, Computational Fluid Dynamics, Technological Processes and Modelling of Mechanical Engineering Systems, Theory and Modelling of Turbulence, Multiphase and Reactive Flow Modelling, Water Treatment, Noise Protection.

The department is responsible for holding BSc courses in Mechanical Engineering and in Mechatronics, as well as MSc courses in Energy Engineering, Mechanical Engineering, and Mechanical Engineering Modelling.

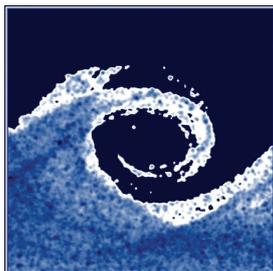
The department is highly involved in educating the PhD students of the Pattantyús-Ábrahám Géza Doctoral School in Mechanical Engineering, with special regard to the subprogram, Mechanical and Energy Engineering Systems and Processes.

An important element applied by the department in educating engineers involves feeding back industrial expertise and applied R+D results into the practical training of engineers through industrial case studies and field-work, laboratory and project assignments, and by hosting a club for students interested in learning more about fluid mechanics related subjects. Active cooperative relationships exist with Italian and British universities regarding student mobility.

## Research

The department traditionally has always been actively engaged in projects requiring expertise for consultation and applied R+D for Hungarian and foreign industrial companies and institutions. This activity encompasses the main process industries - such as steel production, energy, food, gas purification, pharmaceutical, as well as chemical and water treatment.

The department also takes part in research projects related to the automotive industry, thermal engineering and HVAC - within this, flow control - and atmospheric flow. Computational fluid dynamics and, within this, the newer developments in large-eddy simulations open up important opportunities for the department.



Computational aero-acoustics is a new research field of the department which is developing dynamically. Acoustic simulations are well-supported by the Békésy György Acoustic Laboratory's background in measurement technology. Laboratory investigations play a key role in research, especially, in accordance with international trends, the use of laser optical flow

diagnostics.

Since 1999 the most important foreign research and development partner has been the world-famous Von Karman Institute for Fluid Dynamics in Belgium, which is supported by NATO.

Computational and laboratory modelling of flows for engineering purposes is an intensively developing area. As an international forum of the research results, the Conference on Modelling Fluid Flow (CMFF) is organised by the department every third year in Budapest with the participation of fluid technology researchers from more than 30 countries. Due to the high-quality of this event, the prestigious International Journal of Heat and Fluid Flow publishes a special issue on CMFF, which presents the most outstanding contributions.

In the past few years, the average age of staff members has been approximately 35 years, which is reflected in the momentum of and ambitious work of this department team.

## Education

The department offers the undergraduate programmes (BSc) of Mechanical Engineering, Energy Engineering, Mechatronics and Product Design, and the postgraduate programmes (MSc) of Mechanical Engineering, Energy Engineering and Mechanical Engineering Modelling. It also offers research programmes (PhD) and specialized education in energy production.

The department pioneered the establishment of energy engineering education in Hungary, and it has been coordinating the education programmes ever since. It played a key role in introducing the two-cycle education system, as well as in establishing the BSc and MSc courses in energy engineering. Decisive core subjects offered by the department include Engineering Thermodynamics I-II, Heat Engines, Energy Engineering I-II, and Energy Supply. Besides providing solid theoretical background in core subjects, the department pays special attention to laboratory practice and measurements.

All students of mechanical engineering and energy engineering can work in a high-quality laboratory, where measurements can be carried out on modern and traditional power machines, and on equipment like micro-turbine, gas engine, condensing boiler, fluidization heating unit, heat pump, internal combustion engine and steam turbine. A renewable energy laboratory and a modern training local substation have been added to the facility this year.

The department also prepares the students with energy engineering related knowledge in law and economics and often invites specialists from the government, companies and civil societies to deliver lectures. Students can study modern computational methods of thermodynamics, heat transfer and fluid mechanics, simulation tools of energy processes and systems, symbolic mathematical and engineering software products in a new computer laboratory with 18 workstations.

The department has been a member of a consortium of five universities for four years, as a result of a successful EU tender within the Erasmus Mundus programme ([www.mastereurope-me3.org](http://www.mastereurope-me3.org)).

## Research

At the Department of Energy Engineering, research is carried out in the field of systems and machinery connected with transformation and efficient utilization of energy, as well as economic, social and natural processes.

The department contributes to solving social dimensions of energy challenges through basic and applied research, and experimental development for harmonized and environmental-friendly utilization of energy, in order to provide their competitiveness and supply security.

The economic basis of research activities is provided by a wide range of industrial R+D projects, and by means obtained within grants published by the Hungarian Scientific Research Fund, OTKA, by the National Innovation Office, NIH and the EU. Resources are continuously invested in the development of the laboratory.

In addition to Hungarian institutions, the department co-operates with Canadian, German, French, Portuguese, Polish and South-African universities in various fields. Staff members of the department actively participate in scientific organisations; the editorial board of the periodical *Energiagazdálkodás* (Energy Management) is located at the department.

The department takes part in elaborating background studies about social and economic aspects of energy supply, makes proposals for policy and regulation, works for leading companies of the industry on technological and economic issues related to direct and CHP generation projects. It develops solutions in a new approach for power station control. As a result of research of air pollution by energy industry, a measurement system and software for determination of pollutant dispersion have been developed. Numerous pilot programmes for utilization of renewable energy sources have been completed with the participation of the department. The water regime researches contribute to the expertise of NPP Paks to reach the level of the developed countries. It carries out continuous research on the test benches in relation to the utilization of renewable fuels and to the determination of effects of fuel additives in IC engines.



## Education

The Department of Building Service and Process Engineering takes part in the education at the Faculty of Mechanical Engineering at all the three levels, BSc, MSc and PhD. In the BSc programme of mechanical engineering, this department is not only responsible for the specialization named Building Service Engineering, but also teaches most of its subjects. Lecturers of the department in the field of process engineering are responsible for several subjects of the specialization of Process Engineering. The department also makes its contribution to the specialization Building Energetics within the Energy Engineering BSc course. The independent MSc course in Building Service Engineering and Process Engineering was launched on the initiation of the industry as of the academic year of 2009/2010, that admits both BME-diploma holders (BSc), and engineers with BSc diploma obtained in another higher educational unit to one of its specializations called Comfort Building Service Engineering and Process Engineering. This department trains also environmental engineering students of the Faculty of Chemical Technology and Biotechnology, both in BSc and MSc courses. The students can complete their theoretical knowledge by practical skills not only in the laboratories of the department but also within laboratory exercises or internships at various companies (such as IMI Hungaria, LG, Grundfos, Főtáv, Geberit, Uponor, Daldrop, Richter, EGIS, MOL). In their work, lecturers are supported by demonstrators, selected from excellent students, preparing additional materials and/or carrying out measurements.

## Research

In the field of HVAC, the accent is on comfort research, heat supply and heating systems, ventilation systems, as well as gas and water supply, district heating and sewerage systems. Within this range, defining requirements and technical parameters, on the basis of probability theory and risk analysis, is the priority research field. Research topics of the above HVAC systems are connected to system elements and issues of complex systems.

Any industry related to unit operations, where material flows are transformed, such as chemical industry, pharmaceutical and oil industries, environmental protection and biotechnology, offers topics to research. Typical devices include separation columns, heat

exchangers, mixers, tanks, pressure vessels and pipeline systems. Operations and equipment of heat and mass transfer, their construction and modelling, experimental testing, control and instruments belong to the foundation topics.

## Research University projects

- efficiency improvement of air-conditioning systems;
- technology and equipment development for decreasing SO<sub>2</sub> and CO<sub>2</sub> emissions.

## Projects of the Hungarian Scientific Research Fund, OTKA / National Innovation Office, NIH

- improvement of special new batch distillation processes and configurations;
- supply of comfort spaces with high-quality air;
- optimum design of new environment-friendly batch rectification systems;
- investigation of heat and mass transfer processes during convection drying; and
- research and development of new biological sewage purification equipment and technologies.

## Typical R&D projects

- study of air-conditioning, indoor air quality and thermal comfort of office buildings and hotels;
- study of economical development of chilled water systems;
- optimization of temperature schedule and parameters of district heating systems;
- mathematical modelling of heat storage;
- building physical revision of a standard building; determination of dimensioning parameters of HVAC systems;
- investigation of radiation asymmetry and impact of floor temperature causing thermal discomfort involving human subjects;
- modelling of pressure distribution caused by wind around a building or building group;
- capacity increase of a coke oven gas purification system;
- capacity increase of recovery of methanol by distillation;
- investigation of an activated carbon adsorber used for solvent recovery;
- experimental investigation of heat transfer and hydrodynamic characteristics of heat exchangers;
- development of plastic rain water container/cistern;
- pilot plant spray drying experiments.



# Department of Building Service and Process Engineering

## Education

The department plays a significant role in training mechanical engineers in the BSc, MSc and PhD programmes of the multi-level Bologna system at BME. The BSc subjects, Fundamentals of Machine Design, Fundamentals of CAD and Machine Elements, are compulsory for all mechanical engineering students. Practicals are held in the well-equipped classrooms of the department. For computational laboratory work there are three laboratories with modern computers accessible by students. Within the subject called Machine Elements, students carry out related measurements and simple mounting tasks in the department laboratories. From the fifth semester of BSc, students can also select the Machine Design specialization, where industrial design tasks are solved, by using the latest computer-aided design programs, guided by lecturers. Students are introduced to the fundamentals of automation technology in the FESTO pneumatics laboratory. Having their BSc diploma obtained, the best students are encouraged to continue their studies in the MSc programmes of Machine Design and Agricultural Machine Design supervised by this department.

An independent programme of the Faculty of Mechanical Engineering is the BSc course entitled Industrial Product and Form Design Engineer, that was introduced in Hungary by the Department of Machine and Product Design. As an organic part of the training, the students can even build the model of their designed product or equipment in the frames of the subject called Integrated Product Design, in the model workshop of the department any semester.

Subjects of industrial design are instructed by Munkácsy Prize and Ferenczy Prize holding lecturers. The best students can go on with their studies in an MSc course. Students graduated from this department have won the Hungarian Design Award of the Hungarian Design Council several times in the recent years. Utilizing the existing international connections, some students can spend a semester at the Delft University of Technology, at the Kaiserslautern University of Technology or at the Karlsruhe Institute of Technology. Department members deliver lectures not only to students of the Faculty of Mechanical Engineering but also to those of the Faculty of Economic and Social Sciences.

## Research

Research at the Department is carried out - in harmony with education - in three major fields: machine design, agricultural machine design and product design. In all the three fields there is

- basic research (e.g. Hungarian Scientific Research Fund, OTKA: product structure-based modelling and resource-oriented optimization of design process, frictional behaviour and failure mechanisms of structural elements made of polymers, elastomers, ceramics and composites),
- applied research (e.g. design ecology - theory and practice of environment-oriented design, design and development of machine elements, assemblies and machine systems), and
- experimental development (such as the operative program, GVOP: technology and device development for decreasing climate change impacts, mechanization of technologies for production and utilization of biological raw materials and energy carriers).



Following earlier research in Hungary, the department has joined some of the relevant European programmes (such as EU6, KRISTAL "Radical and new knowledge-based surface development for tribology and better lubrication").

In research the department successfully co-operates with higher educational institutions of Hungary and institutes of the Hungarian Academy of Sciences (MTA GAB, MTA AMB, Szt. István University, University of Miskolc, University of West-Hungary, University of Óbuda, College of Kecskemét, MOME) and development centres of the industry (Knorr Bremse Hungária, Mediagnost, Ratipur, MEGOSZ and MEGFOSZ, CAD-terv Mérnöki Kft, Direct-line, DESIDEA Stúdió).

The department publishes its R+D+I results in Hungarian and international journals, and presents them in exhibitions. The results of student projects, theses and diploma works, products designed by the department, and built in co-operation with industrial partners attracted numerous awards in Hungary and abroad in the past years (AGRO+MASHEXPO Innovation Prize: 2010, SX mulch seeding machine, 2011, FF2300 front loader; Hungarian Design Award: 2010, anti-theft glass billets, guide light switch family; Hungarian Innovation Award: 2010, 3E environment-friendly machine system (high recognition); LG HIMACS Design Contest: 2009, Big Bang Lamp; Formula Student 2009/2010: 3<sup>rd</sup> prize).

## Education

The main goals of the educational activity of this department are to teach students the most important manufacturing, assembly and measurement technological processes, traditional and modern manufacturing and assembling equipment, industrial mechatronics systems (metal-cutting machine tools, industrial robots, CNC and CAD/CAM applications), production tools (cutting tools and devices), most modern control systems and their programming (CNC and PLC control), traditional and computational methods of production, solutions supporting planning, implementation and operation of production systems, as well as production informatics.

A practice-oriented curriculum makes the theoretical foundation complete. In the laboratory, traditional and CNC machines, a flexible production system, measurement instruments, robotics and ultra-precision NC equipment, class-rooms equipped with computers serve educational purposes, support the work of Students' Scientific Groups, and other activities related to departmental research. In the BSc program the task of this department is to provide knowledge and skills enabling graduated engineers to recognize, understand and solve problems arising in engineering practice. In the MSc and, especially, in the postgraduate PhD programmes the department educates students, in their own scientifically founded research, on understanding, applying, and improving modern theoretical and practical results. In the main subject of the department, Manufacturing, all students of mechanical engineering, mechatronics, industrial and product design, fundamentals of manufacturing engineering are taught. This department is responsible for various BSc and MSc specializations in mechanical engineering and mechatronics. Practical placements are parts of the curriculum, and organised with the help of, and within leading Hungarian mechanical engineering companies, and small-, and medium-sized enterprises. In most cases, the students write their diploma works while placed in these companies, and, in this way, solve some of their engineering problems on the spot.

## Research

The level of the economy of industrialised states is decisively influenced by the most important production activities of the economy, like advanced technology and information technology.

To contribute to this in Hungary, the department performs research in the following fields.

- Supervision, diagnostics, optimization and adaptive control of cutting processes;
- ultra-precision and micro-machining, processing of nano-textured materials, machining of hard materials;
- environment-friendly mechanical engineering technologies;
- construction and production of non-circular gear-wheels;
- knowledge-based process planning, production planning and scheduling, assembly optimization;
- NC technology;
- construction of manufacturing devices (measurement instruments, devices, tools);
- measurement technology, process measurement, quality assurance;
- construction of machine tools, production systems;
- industrial robots and robot applications, service robotics, rehabilitation robotics;
- quick prototype production; and
- production planning and control (production networks; Computer Integrated Manufacturing; information technology in production; intelligent production processes and systems; digital plant).



The research activity is supported by four pillars.

- Basic research is supported by the Hungarian Scientific Research Fund, OTKA.
- The department does applied research in co-operation with foreign and Hungarian universities, departments, and industrial partners within EU-financed projects (FP5, FP6, FP7, AAL). The department often plays the role of the coordinator in various projects. The coordinators of the EUFP6 project REHAROB, Robotic motion therapeutic rehabilitation of disabled upper limb, were awarded the Academy Prize of the Hungarian Academy of Sciences (HAS) in 2007.
- It participates in (state-financed) large technological projects with Hungarian industrial partners.
- It contributes to company innovation doing applied research for companies active in Hungary.

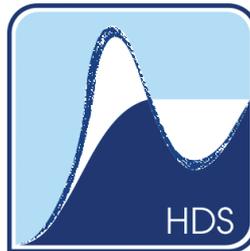
Also, students are involved in research via working in Students' Scientific Groups, and doing their diploma works.

Important industrial partners of the department: GE, Knorr Bremse Hungária Kft., ALCOA, Direct-Line, Grundfos, NCT Zrt., SIEMENS Zrt., SemiLab, Mitutoyo Hungaria Kft., Varinex Zrt., Excel Csepel, etc.

## Education

In the subjects taught by the department, the transfer of knowledge based on natural sciences (Thermodynamics, Fluid Dynamics, Mechanics and Mathematics) is decisive. Developing experimental skills is another important aspect of education. Great attention is paid to consequent and correct grading.

Basic subjects of BSc courses constitute a group of subjects: Introduction to Mechanical Engineering, Mechanical Operations in Chemical Industry, Analysis of Technical and Economic Data, Measurement and Signal Processing, Applied Statistics. Common feature of these subjects is to get the students to understand the fundamental engineering processes, develop a unified energy-oriented approach, and introduce them into statistical methods and error estimation of measurement techniques, both theoretically and practically. The total number of theoretical and practical classes in these subjects is almost identical. Most subjects are taught both in English and German.



The special subjects of the BSc and the MSc courses constitute the other group of subjects. They include but are not limited to: Fluid Machinery and Systems, Selected Chapters of Fluid Mechanics Technology, Numerical Flow Modelling, etc.

To develop the practical skills of students, the subject called Individual Project was introduced, in which a staff member, with one or two students, spends a whole semester solving a problem requiring intensive work, independence, innovation and reading and applying literature. At the end of the semester, the students give a presentation on the results to other students and to the staff of the department.

As far as possible, students select the topic of their thesis or diploma work relying on their individual projects or results of work in the Students' Scientific Groups, and develop this topic at an industrial company or at the department.

In PhD courses with increasing importance, personal consultation and independent work have crucial significance. The PhD students join the scientific network of the world, and work on current problems interesting also for leading institutions.

## Research

The department is committed to becoming a decisive factor in the science of fluid mechanics in Hungary. It is aiming to achieve this by using theoretical, computational fluid dynamics (CFD) and experimental tools. In basic research, it is active in the following fields.

- Description of self-sustained flows and noise, generated by them;
- medical fluid dynamics, including analysis of brain aneurisms and description of arterial and venous blood flows by network computational methods;
- applying optimization e.g. in generating pump schedules with minimum energy consumption;
- stability analysis of hydraulic power transmission systems;
- cavitation research both for single bubbles and bubble clouds; and
- stationary and transient computation of pipe networks for full and partially filled pipes.

The department carries out research mostly within projects of the Hungarian Scientific Research Fund, OTKA, and international bilateral co-operations, publishing the results in international periodicals. It also actively attends international scientific conferences.

In general, the department does applied research in co-operation with its industrial partners. There are numerous waterworks among its clients, but it gets various commissions from a wide range of companies. These projects include operational problems of fluid machinery, carrying out stationary and transient pipe network simulations, multiphase 3D numerical flow simulations, optimization problems, design of pneumatic transport machinery, expertise in lawsuits, design tasks.

For research purposes, the computer facilities of the department are continuously improved, in terms of both hardware and software. Instruments and measurement devices of the 900 m<sup>2</sup> laboratory are permanently modernized. It has pump measurement stations, various pressure and volumetric flow rate transducers, and flow velocity measurement devices, as well as modern data processing systems. In a self-maintained workshop the department is able to design and build highly specialized measurement rigs.

## Education

The department plays a significant role in the multi-level Bologna system's BSc, MSc, and PhD programmes at the Faculty of Mechanical Engineering at BME.

In the Mechatronics BSc programme, attended by the department, engineers are to design and operate complex products and production systems with the integration of mechanical engineering, electronics and information technology.

In the BSc degree course, Mechatronics, six specializations are available for the students of the department: Mechanical Modelling, Integrated Engineering, Mechatronics of Production Systems, Mechatronical Instruments, Opto-Mechatronics and Bio-Mechatronics. The three latter specializations are hosted by the department. Within the MSc degree course, Mechatronics, students are trained in seven specializations: Mechatronics of Production Systems, Opto-Mechatronics, Vehicle Mechatronics, Bio-Mechatronics, Robotics, Precision Instruments, and Integrated Engineering.

The department introduces its students the state-of-the-art devices of these scientific fields.

Its well-equipped laboratories greatly contribute to these efforts: Robotics, Informatics, Optical Measurement, Modelling and Simulation, Vision Systems, Computer-Aided Design and Engineering, Digital Control, Mechatronical Components, Opto-Mechatronics, Control Systems, Pneumatics, Mechatronical Systems and Measurement.

Students prepare works in a considerable number for the conferences of the Students' Scientific Groups at the Faculty, and also at national level.

The department hosts the Mechatronics subprogram of the Doctoral School (PhD) of the Faculty. Within this subprogram Mechatronics, Control Engineering, Optics and Information Engineering courses offer research topics to the most talented students graduated from MSc courses. PhD graduates can work in industrial R+D centres and research institutes, and the best ones are invited to the department as lecturers.

## Research

The department has four main research areas.

- Mechatronics: Robotics; System and Control Engineering; Sensors and Actuators; Cognitive Telemat Manipulation; Human-Robot Interaction; Slide Mode Control and Time Delayed System Control
- Optics (Applied and Engineering Optics): Colour Science, Colour Vision, Colour Measurement; Computation and Measurement of Optical Transfer Function, Moiré Measurement Technology; Photometry, Radiometry and Spectroradiometry
- Measurement, Instrumentation Technology and Precision Engineering
  - Informatics: Image Processing; Computer Simulation, FEM in Mechatronics; Presentation Techniques; 3D Simulation

The department participates in three projects in the Research University Program at BME. In the field of material sciences the department does research in the application of silicon elastomers in sensors. Within the energy engineering area the development

and measurement techniques of new light sources are dealt with, and within the e-technologies program 3D virtual telemanipulation is being worked on.

In addition to disciplinary research activities, the department contributes to the solution of industrial R+D+I tasks. A large number of patents in this area have been created in this course of work. The department has also developed glasses with colour filters for the correction of colour deficiency. Further to it, diagnostic instruments to analyze the state of individual colour vision have been designed and created.

The department continuously participates in the activities of the technical committees of CIE, ICVS, IEEE Industrial Electronics Society, and IFAC. The most important international background to these activities is provided by the iSpace Laboratory Network coordinating research groups, engaged in the research of intelligent spaces by the joint Japanese-Hungarian, and the joint Norwegian-Hungarian laboratories, as well as space projects of NASA and ESA.



## Education

The Department of Applied Mechanics takes part in training mechanical engineers at all the three levels of the Bologna system (BSc, MSc, PhD). In the BSc programmes, the department teaches Statics, Strength of Materials, Dynamics, Vibrations and Fundamentals of Finite Element Method for students specialized in Mechanical Engineering and Mechatronics, while it contributes to the education of the Energy Engineering, and the Industrial and Product Design programmes with one subject each. The department is responsible for two BSc specializations (Mechanical Engineering Development and Mechanical Engineering Modelling) and for one MSc specialization (Applied Mechanics). The department initiated, formed, and has been responsible for the MSc programme of Mechanical Engineering Modelling in English, the popularity of which has been rapidly increasing not only among foreign but also Hungarian students in the last years. Twelve subjects in BSc courses, and twenty-nine subjects in MSc courses (such as Continuum Mechanics, Plasticity, Thermomechanics, Experimental Methods of Mechanics, Robot Dynamics, Nonlinear Vibrations, Machine Tool Vibrations) are taught by the department. In the frames of PhD training, in addition to consultation with students, staff members deliver lectures to the students of the Géza Pattantyús-Ábrahám Doctoral School in Mechanics. All basic subjects and some special ones are taught both in English and German to Hungarian and foreign students. Training is supported by a computer laboratory and a vibration measurement laboratory where students can implement their theoretical knowledge in practice.

The department has succeeded and participated in numerous educational exchange programs both in Europe and America (Erasmus, Atlantis), thus, there are foreign students in the courses conducted in English every year. In return, Hungarian students have the opportunity to study one or two semesters abroad. Contribution to the education of young scientists is also granted at the department. At the Students' Scientific Conference, the Section of Applied Mechanics is launched each year, and the most talented students, supervised by the lecturers of the department, can present their research results there. In addition to experienced lecturers, a couple of PhD students join the department each year to take part in research and education.

## Research

The staff of the Department of Applied Mechanics carries out cutting-edge research in the field of solid-body mechanics. The major research topics include transient chaotic motions, stability and nonlinear vibrations of delayed dynamic systems, suspensions, wheel dynamics, parametrically excited vibrations, digitally controlled systems, robotics, robot controls, mechanisms, finite elastic-plastic deformations, theoretical and numerical analysis of constitutive equations containing geometrical and material nonlinearity, finite element methods, fatigue analysis, micro-continuum deformations, strength analysis of micro-electromechanical systems, fracture mechanics and dynamical analysis of composites.

During the past ten years, researchers of the department have been involved in several international research projects including bilateral projects with Slovenian, Spanish, French, German and English partners. In various EU projects, the department acts as the coordinator or as the principal investigator. Lecturers of the department coordinate 6 research projects financed by the Hungarian Scientific Research Fund, OTKA, and further 5 international research programmes.

Research results are published in peer reviewed periodicals of high impact factor, and at high-ranking international conferences. The annual cumulated impact factor of the papers written by the staff of the department is about 20. The internationally recognized level of our research is confirmed by the fact that our departmental studies receive more than 200 independent citations registered by SCI every year.

Staff members regularly provide consultancy to industrial partners. Prominent partners of the department include: Knorr-Bremse Break Systems, Furukawa Electric Institute of Technology (FETI), Nuclear Power Station in Paks, Vértés Power Station, Bosch-Rexroth, Visteon, Olajterv/oil industry, ALCOA-KÖFÉM, Vegyterv/chemical industry, Hungarocopter, Thyssen Krupp Production Systems, WOCO Gummitech.



## Education

The Department of Polymer Engineering participates in the education at all levels - BSc, MSc, PhD - of the Bologna system at the Faculty of Mechanical Engineering, and also provides further educational training to industrial partners in numerous fields.

This department delivers lectures not only in Hungarian but also in English and German in polymer-related foundation subjects, as compulsory basic subjects, in the BSc courses of the Faculty's responsibility. Together with the Department of Materials Science and Engineering this department is responsible for the Material Technology specialization of the BSc programme of the Faculty of Mechanical Engineering. The students of this specialization can select from many subjects like Technology of Polymer Composites, Application Technologies of Polymers, Polymer Processing or Injection Moulding. On annual average, 30 students prepare their BSc theses, and do their final exams at this department.

The independent Polymer Engineering specialization of the MSc course at the Faculty of Mechanical Engineering is one of the specializations attracting the largest number of students. MSc students can study special subjects, meeting even higher industrial requirements including but not limited to Polymer Parts Design, Prototype Manufacturing in Plastic Industry, Polymer Processing and Machinery, Polymers and Composites in Transport Engineering or Injection Moulding Simulation.

Both BSc and MSc students can learn testing and processing technologies of raw materials in the well-equipped laboratory of the department corresponding to European standards. As a result, the number of students working in Students' Scientific Groups, based on various industrial projects, is extraordinarily high, and also the implementation of their results in industry is above the average.

This department actively participates in PhD training, on annual average 12-14 PhD students work at this department, most of them are state scholars. Annually, 3-4 persons out of them obtain their PhD degree, typically, in industry-connected research fields.

## Research

Research at the Department of Polymer Engineering is connected to polymer processing comprising material property definition, optimization of processing parameters, simulation and modelling of technological processes, development of new materials and design of new products. The major current topics include recycling of polymer materials, development of processing technologies of biodegradable polymer variants, application of polymer materials in medicine, development of hybrid, nano and self-reinforced composites for special applications.

The laboratory facilities of this department are excellent, even in international comparison, due to continuous investments into instruments and equipment. Available material testing devices include computer-controlled state-of-the-art universal tensile testing machines, instrumented impact tester, falling weight impact tester with heat chamber, scanning electron microscope with the most modern EDS fixture, optical microscope with com-

puter-aided evaluation system, acoustic emission measuring instrument, DMA and DSC devices, electron beam generator, heat chambers and climate chambers, MFI equipment, thermal camera, and other testing equipment. The laboratory houses the following polymer processing machines: injection moulding machine, extruders, vacuum forming machines and presses, blown film extrusion and blow moulding machines, two pieces of modern equipment for rapid prototyping, reactive injection moulding machine, etc.

The department is involved in a great variety of Hungarian and international research projects (within the Hungarian Scientific Research Fund, OTKA, Széchenyi Plan, Jedlik Ányos Programme, GVOP Operative Program, EU7, etc.), fulfills numerous industrial orders, and has connections to many foreign (German, French, Chinese, Indian, Mexican, South-African, Malaysian, Argentinian, etc.) universities with-in bilateral co-operations, leading to many development results and papers in journals with impact factor. International acknowledgement of the scientific work of this department is also mirrored by the fact that the impact factor of the Express Polymer Letters journal published by this department is 1.452

(<http://www.expresspolymlett.com>).

