Applicant: Slovak University of Technology in Bratislava

Project: Knowledge-based Faculty for Economic Practice

ITMS code of project: 26110230113

Activity: 3.2

Responsible for activity: PhDr. Kvetoslava Rešetová, PhD.

INSTITUTE OF SAFETY, ENVIRONMENT AND QUALITY - PROFILE PRESENTATION

Name of activity	**Activity 3.2** Building the tools for knowledge transfer into education
Specific objective	**3. Building the tools for knowledge transfer into education**
Aim of activity	The activity of building the tools for knowledge transfer into education concludes the information flow attained from the analysis of environment impact, and sets up specific tools for the knowledge transfer into education. It is aimed at building a set of tools for transferring the knowledge collected in the previous activities into education at the Faculty, thus enhancing the knowledge base of the target group, while focusing on the functionality of the knowledge transfer to the target group.
Date of activity implementation	10/2013 – 09/2015

Project part: activity 3.2 : 1. Tool for knowledge transfer – profile research presentations

The Faculty research is oriented particularly on the following fields:

- research in materials with focus on the research, development and technological processing of the main types of engineering materials,
- research and development of new technologies in industrial production oriented mainly on technological processing of modern technical materials and environment-friendly production,
- research in identification, automation and control of processes as well as information security of the technology, production and organizational systems,
- research and verification of principles of managerial control and its organizational structures,
- research in quality and certification of processes and products,
- research in safety and reliability of technological devices and systems with emphasis on the methods of systems analysis and synthesis.

The defined research characteristics reflect the Faculty research fields, and are subject to the Faculty evaluation processes. **The current profile presentations comprise the research profile, its identification and recording in a new way**. The Faculty experts in the research fields make the audience familiar with the research characteristics, research and development orientation, so that to provide a comprehensive research profile of the Faculty institutes (there are six institutes at the Faculty) in both Slovak and English languages. The elaboration of text in an adequate number of quires, text translation and copyright rules – all this is subject to the method of the profile presentation implementation. The elaborated profile presentations might be an important material source for:

- training at the Faculty in its key subjects
- domestic and international presentation of the Institute
- enhancement of the advertising space for promotion purposes of the project
- innovative elaboration of the Faculty research contents.

Defined project outcomes:

The project outcomes will be determined by successful implementation of the project activities, particularly activity 1.1 - stakeholding, activity 2.1 - portal of companies, activity 3.1 -implementation from acquired e-sources. Such interaction along with the information flow can influence the success of knowledge transfer into education. The outcomes of previous activities will be utilized in this final activity which should provide space particularly for knowledge transfer and improvement of knowledge base, and simultaneously provide a space for meeting the main project aim. Specific outcomes of the activity will be as follows:

- **six profile presentations mapping the research character of six Faculty institutes, applicable in training and with strong potential for the Faculty promotion**
- production of minimum 30 virtual records of technological procedures outsourced from economic practice and applicable in education, i.e. enhancement of information on applicability for the Faculty doctoral students
- production of minimum 30 virtual records of the Faculty technological procedures and processes, for application in the Faculty education, and for the purposes of comparison of the technological processes and theoretical knowledge acquired in the Faculty training to the knowledge acquired in practice
- four expert lectures for doctoral students (and also for interested Faculty researchers), forming the knowledge base of the target group in four principle science fields.

Implementation of activity:

1. In compliance with the project aims, the activity was introduced to the Heads of the STU MTF Institutes: **Appendix 1**: Information for institutes of 12 Dec 2013 , **Appendix 2** : Letter to the Heads of the STU MTF Institutes of 21 Jan 2014
2. Heads of the STU MTF Institutes delegated in writing an Institute representative who will be in charge of the profile presentation elaboration – letters to Heads of the Institutes are in the project archive of the principle investigator
3. Individual meetings of the principle investigator with related employees with focus on structure and contents of profile presentations
4. Collection of data, text modifications, graphical design of presentations
5. Text translation
6. Final arrangement of presentations into e-proceedings of scientific papers
7. Publicizing the profile presentations

Guarantors of profile presentations:

Institute of Materials – Mgr. Marián Palcut, PhD.

Institute of Production Technologies – Assoc. Prof. Ing. Erika Hodúlová, PhD.

Institute of Industrial Engineering and Management – Assoc. Prof. Ing. Helena Makýšová, PhD.

Institute of Safety, Environment and Quality – Prof. Ing. Maroš Soldán, PhD.

Institute of Applied Informatics, Automation and Mechatronics – Prof. Ing. Pavol Tanuška, PhD.

Advanced Technologies Research Institute – Assoc. Prof. Ing. Maximilián Strémy, PhD.

Introduction

The orientation of the STU MTF research activities fastens on the Faculty education profile and is in compliance with the long-term development of the Slovak University of Technology in Bratislava, covering the whole spectrum of the education at STU MTF. The activities of STU MTF researchers are implemented within the following projects:

- projects of base research supported by VEGA grant agency,
- projects of applied research supported by KEGA grant agency,
- projects investigated within international programmes,
- projects of international scientific and technical cooperation,
- projects of base and applied research supported by APVV grant agency,
- contractual research and development (business contracts).

1. Science and Research in STU MTF

Vision of STU MTF

The STU Faculty of Materials Science and Technology in Trnava, in compliance with the STU vision, intends to be a research oriented and internationally renowned faculty within the similar faculties framework, i.e. the faculties developing modern trends in research and industrial production with focus on progressive materials, sophisticated production technologies and industrial management, automation and IT implementation of production and technological processes such as quality, safety, as well as environmental and managerial aspects of industrial production.

Mission of STU MTF

In compliance with the defined mission of the Slovak University of Technology, the STU Faculty of Materials Science and Technology intends to actively contribute to meeting the requirements of the mission – with the priority laid on materials science and production technologies – in accredited fields of education, research and development within the stipulated competences:

- provide the university system of education in all stages in accredited study programmes
- disseminate, improve and develop knowledge by the research and development tools,
- ensure transfer of research results into educational process,
- ensure transfer of research results into entrepreneurial practice,
- protect its research results,
- integrate into the system of university life -long learning,
- participate in sustainable development of society with all its activities, mainly by the development of the student personality in the context of humanism and democracy ideals.

General and strategic goals of research

1. Publish the research and creativity results internationally, particularly in the renowned international scientific journals.
2. Increase the STU MTF status in the projects of international cooperation.
3. Build the research infrastructure (equipment) including the qualified service.
4. Intensify the cooperation with practice, ranging from private industrial companies to public institutions and authorities.

5. Focus the research results and free investigation also on the outcomes, e.g. patents.
6. Improve the orientation on other than grant sources from the state budget, particularly on the sources from abroad, project grant agencies and entrepreneurial activity.

The scientific and research activity of STU MTF is carried out in the forms of:

- projects of the base and applied research and development,
- projects solved within the international programmes,
- projects of the international scientific collaboration,
- projects of contractual research.

The research content is focused on the following areas:

- materials research with a focus on the research, development and technological processing of the basic and advanced types of technical materials,
- research, development and optimisation of the new technologies of industrial production, oriented particularly on the technological processing of advanced technical materials and ecologically clean processes and products, and the numerical simulation of technological processes,
- process identification, automation and control, as well as information support for technological, production and organisation systems,
- research and verification of the managerial control principles and their organisation structures,
- quality control and certification of processes and products,
- safety and reliability of technological equipment and systems, while emphasising the methods of system analysis and synthesis.

2. Institute of Safety, Environment and Quality - Profile Presentation

2.1 History of the Institute

Institute for Safety, Environment and Quality (UBEK) (former name: Institute of Safety and Environmental Engineering) was established on 1 January 2007 by decision of the STU MTF Academic Senate of 20 December 2006, fastening on the Department of Environmental and Safety Engineering established on 1 April 1995 under the original name of the Department industrial Ecology (KPE). The first Head of the Department was Prof. RNDr. Július Kováč, CSc. Since 1998, the Department and subsequently the newly established Institute has been led by Prof. Ing. Karol Balog, PhD. Currently, the Institute comprises the Department of Safety Engineering (nominee Head: Ing. Richard Kuracina, PhD.), Department of Environmental Engineering (Head: Prof. Ing. Maroš Soldan, PhD.) and Department of Fire Engineering (Head: Ing. Jozef Martinka, PhD.).

The Institute trains experts in the Bachelor study programme of Occupational Safety and Health Protection and in the Master and Doctoral study programmes of Integrated Safety.

After incorporating the Department of Production Quality Engineering (nominee Head: Ing. Katarína Lestyánszky Škůrková, PhD.) in 2013, the Institute was renamed as the Institute of Safety, Environment and Quality (UBEK). The Institute thus provides education of professionals also in the Bachelor study programme of Production Quality, and in the Master and Doctoral study programmes of Production Quality Engineering.

2.2 Characteristics of the Institute workplaces

2.2.1 Department of Safety Engineering

Department of Safety Engineering is part of the Institute of Safety, Environment and Quality. The Department staff is involved in the research and education activities in the fields of occupational health and safety, dangerous substances, and analysis and management of risk and major industrial accidents.

Education activities of the Department of Safety Engineering are aimed at teaching profile subjects such as Engineering of Working Environment, Hazardous Substances, Safety of Technical Systems, Methods of Analysis and Management of Risk and Technological and Natural Disaster. The knowledge in the field is essential for graduates of the Bachelor and Master studies, as required for the State Examination in both degrees.

Study on the Bachelor and Master degrees takes the form of lectures; the acquired knowledge is then presented by students in the seminars or laboratory exercises.

The education activities of the Department involve the supervision of the Master and Bachelor theses focused on the issues dealt with by the Department staff.

Staff of the Department of Safety Engineering can provide services in the above-mentioned fields of occupational health and safety, and analysis and management of risk and industrial accidents. They have also participated in the major engineering projects, cooperating with the companies such as VUJE, JAVYS and the Expertise Institute of Fire and Technology.

Department of Safety Engineering focuses on various areas within the occupational health and safety, risk analysis and management, working conditions and evaluation of working environment. It disposes the facilities for the working environment evaluation, the devices designed for monitoring and measuring the noise levels of the working environment and their exact evaluation. On the basis of the measurements and accurate determination of noise load of the working environment, the experts can make an accurate assessment of how the monitored working environment meets the requirements of the law in terms of noise exposure. Subsequently, they elaborate the recommendations regarding the necessity of using collective means of protection or personal protective equipment to protect hearing of employees form noise. The Department of Safety Engineering also possesses the equipment for monitoring lighting conditions at work. The Department staff can use Luxmeter to measure whether working environment meets the minimum requirements in terms of lighting. They can also assess whether the arrangement and

selection of light sources is optimal for the specific needs of the working environment and in compliance with the requirements defined in the regulations and laws on workplace lighting.

The equipment operated by the Department contains the device for measuring the speed of air flow. The device helps to determine working conditions in terms of air flow (e.g. draft). When identifying substandard conditions, the workers can propose effective measures to improve the working environment.

The Department of Safety Engineering has several devices to monitor dust in the working environment. There is a sieving device working with a wide set of accessories to measure the ratio of dust, based on the size of dust particles. This device is also frequently used to prepare samples for further research in the field of dust (both settled and turbid).

There is also a device for determining the characteristics of settled dust. It enables monitoring the ignition of settled dust and, based on the collected data, classifying the working environment into safety classes. It is also possible to assess safety of the working environment with such dust. The staff can then propose measures to avoid dangerous situations in the work process.

The devices for measuring and monitoring turbid dust measure the size of dust particles and their amount in turbid state. The device works on the laser principle, recording the reflected laser light; it is the possible to calculate concentration of particles and their size in turbid state.

Another instrument for measuring the properties of turbid dust is a detonation chamber. The device was modified by the Department staff to initiate the stirring up of the dust. The Department members devised a nitrocellulose initiator that can be re-used after dosing nitrocellulose. The initiator works on the principle of a resistive wire which causes the burning of nitrocellulose. Similarly, the Department devised a system for dust stirring. Compressed air is blown from the pressure vessel with the working pressure of 8 bars into the chamber with a vortex bowl. Quick opening of the solenoid valve lets the air flow from the pressure vessel in to the chamber, where the air is blown at high speed into the dust sample which is immediately stirred in the chamber. After the dust in the chamber has been stirred, the initiator is activated at 60 ms. Hot particles of the burning nitrocellulose ignite the dust in the chamber. The pressure transducer mounted in the chamber monitors the changes of pressure in the detonation chamber. The recorded pressure values are collected in a datalogger. Research and development in this field continues focusing on the modifications of the stirring or initiation systems.

The detonation chamber is well adapted to carrying out the experiments in the field of explosions. The chamber can be used for explosion metal plating, explosion welding and explosion forming. The maximum

quantity of explosive substance in the detonation chamber is determined as TNT equivalent of 150 g.

The Department of Safety Engineering also has a device for determining the conditions of self-ignition of substances. The device can monitor the long-term behaviour of materials when exposed to elevated temperatures on a selected carrier material. The results of these measurements can be used to determine the conditions of self-ignition of substances in the working environment and industry. Based on the results, the workers are able to propose measures to prevent accidents after self-ignition of substances.

The Department of Safety Engineering can also determine the basic physical and chemical properties of substances, e.g. sensory properties, density or viscosity. From the chemical properties, experts can determine solution heat, combustion heat in a combustion calorimeter, or chemical composition of samples of hazardous substances (e.g. by polarography).

Density of solid insoluble materials and the liquid can be measured by pycnometry. Workers can measure density of liquid substances by using the Hoeppler viscometer or rotational viscometer with a series of bodies and containers.

The Department of Safety Engineering developed an infrared emitter with a recording device to monitor the impact of heat flow on materials. Workers can monitor selected parameters (such as changes in the shape and mass) of a material during its exposure to heat flow. In the course of material degradation, it is also possible to observe visual changes or the gaseous products of the material degradation. Based on the measurements, it is possible to define the optimum working conditions, or to assess potential risks and reduce their value.

Department of Safety Engineering is also intensively engaged in the risk analysis and management. The staff can evaluate risk of the selected workplace and technology, and, based on the assessment results, propose measures and recommendations to increase the level of security in order to provide the pleasant and safe working environment.

2.2.2 Department of Environmental Engineering

Department of Environmental Engineering (KEI) is one of the departments of the Institute of Safety, Environment and Quality. The Department provides the research and education activities in the analysis of hazardous substances in the living and working environment, utilisation of advanced degradation techniques of hazardous substances and renewable energy sources, with the emphasis on the use of solar energy and biomass.

Education activities of the Department are focused on teaching the profile subjects such as Fundamentals of Environmental Science, Inorganic and Organic Chemistry, Environmental Chemistry, Environmental Engineering, Processes and Equipment of Environmental Technologies, and Waste Management Technologies. The acquired knowledge is essential for the graduates of Bachelor and Master studies.

The Department staff can provide services in the quantitative and qualitative analytical determination of hazardous substances, and in advisory in the field of renewable energy deployment.

The Department of Environmental Engineering has been active for many years in the areas of utilisation, promotion, consultancy and study of the new options of renewable energy sources and their impact on the environment. The technology and advisory laboratory built at the Department demonstrates practical laboratory models of the equipment using solar energy, biomass, hydropotencial, biogas and bioethanol. It can simultaneously elaborate a long-term evaluation and testing of the equipment functionality, regarding the economic, environmental and safety aspects, and thus contributing to higher education level and better knowledge in the field of research into renewable energy sources.

Laboratory for the use and promotion of solar energy was put into operation on 30 March 2007 as a part of the Laboratory for utilisation and promotion of renewable energy sources. It was established within the INTERREG IIIA AT-SR Community Initiative.

The role of the Laboratory for the use and promotion of solar energy is to:

- iniciate and support cooperation of the organizations involved in the projects aimed at the research, development and construction of the devices using solar energy,
- organize regular seminars and workshops in the above-mentioned fields,
- provide consultancy in elaborating the projects of the solar energy utilisation, and assist in such projects implementation,
- monitor the options of the solar energy utilisation in a long-term horizon.

The Laboratory includes a thermal system and a photovoltaic system. The photovoltaic panels (670Wp) that convert the energy of the incident solar radiation into direct current represent the heart of the photovoltaic system. The direct current is then conducted to the control and monitoring unit which evaluates the current characteristics and, based on compliance or non-compliance with the given parameters, controls the operation of the whole system. Datalogger sends information to the Internet, where it can be used to evaluate the whole plant operation. The generated DC current of the required values of relevant features is then converted to alternating current in the DC/AC converter, from which the AC current flows directly to

the electricity distribution.

The thermal system includes four pieces of HELIOSTAR TS400V vacuum collectors with a total collector area of 8m^2. The installed collectors are directed towards the south side at an inclination of 45 ° to the ground, for the optimum collection of heat energy throughout the year. The Laboratory also disposes a sensor of the solar radiation intensity and a small weather station.

We also deal with security of solar systems, including the assessment of such systems in terms of mechanical resistance, fire safety, operational safety, reliability and recycling.

Technical and advisory Laboratory for the use and promotion of renewable energy sources is specialized in both the traditional and non-traditional use of renewable energy sources: solar energy, hydropower and hydrogen energy.

Photovoltaic off-grid system is part of the technical and advisory Laboratory for the use and promotion of renewable energy sources. Multi-crystal photovoltaic panels of SOLARTEC SG 215-6Z type with an installed capacity of 215 Wp, the total installed capacity of 645 Wp and efficiency of 16% are essential parts of the Laboratory. The system also includes a PHOCOS PL 60 controller of solar system for the battery charging 12/24 V in the solar system, which protects the batteries from overcharging of solar cells and from excessive discharge caused by the appliance. The Laboratory research focuses on electrolytic production of hydrogen and chlorine using photovoltaics as an electricity source.

Photovoltaic panels generate electricity which is stored in accumulators by means of the controller. Energy from the batteries is subsequently converted in the voltage converter into widely accessible mains electricity, i.e. to 230 V. The whole part of the generated electric power is connected to a measuring and control device for the optimized use and monitoring of the energy generated by photovoltaic panels. Prior to entering the electrolysis, the generated and stored energy is transformed into a form suitable for use in a particular type of electrolyser. After reducing the voltage to the desired value, the energy enters the electrolysers.

Upon the entry of electrical energy into the hydrogen electrolyser, the latter produces hydrogen, which is then collected and stored in a hydrogen storage tank. After sufficient accumulation, hydrogen flows from the tank into the low-temperature fuel cell, where the reaction of hydrogen and oxygen on a special membrane produces energy and water. Upon the entry of the electric energy, the chlorine electrolyser produces hydrogen, chlorine and sodium hydroxide. Feedstock for the electrolyser is saline. Chlorine is then introduced into the container of water for chlorination to disinfect the water. The whole equipment is

monitored by a chlorine analyser in order to avoid potential leakage and accidents.

Part of the technical and advisory Laboratory for the use and promotion of renewable energy sources is also a small testing station for testing the basic parameters of small (pico) water turbines, which simulates water flow conditions in the real environment. It comprises a centrifugal pump and a mechanical brake to simulate loading, a digital torque meter, a digital revolution meter, a flow meter, a supporting structure, a slop tank and a measuring and control equipment.

Thanks to the development of low-energy-saving technologies, the excessive and inefficient use of energy has lost its leading position of a major energy challenge. The current problem No. 1 in the field is generation of energy from non-renewable energy sources. Since humanity inevitably needs energy for its existence, we must look for the long-term and economically viable alternative sources. All the above-mentioned along with other facts support the intense interest in alternative energy sources, biofuels or alcohol fuels (e.g. methanol, ethanol).

The Department is involved in the research into the production of bioethanol from lignocellulose, its pre-treatment options in particular. The aim of such pre-treatment is to change the properties of materials in such a way as to be ready to ensure the maximum effect of microbial decomposition, i.e. to achieve the maximum removal of lignin and hemicellulose, and thus increase porosity of materials (inner surface) and improve their digestibility, thereby ensuring their processing and increase yields of simple sugars. Each type of pre-treatment has a different impact on cellulose, hemicellulose and lignin. Potential types of pre-treatment examined in the Department are:

(1) physical methods – cutting, breaking and grinding,
(2) physical and chemical methods – hydrothermal pre-treatment, ultrasound,
(3) chemical methods – ozonisation
(4) combinations of the methods.

We also test and monitor the effect of acid hydrolysis under various conditions (at atmospheric pressure, elevated pressure and temperature, various periods of hydrolysis) on the amount of reducing sugars. Research in the Department is oriented on the production of bioethanol from biomass – the waste of the phyto-remediation process. Glucose as a reducing sugar (formed in decomposition of complex sugars to simpler fermentable ones) is able to reduce toxic metals, which are usually toxic in their higher oxidation state. After reduction to a lower oxidation state, they either become less toxic or loose toxicity. In addition to generating bioethanol, we eliminate hazardous waste. Future research may focus on the suitability and effectiveness of enzymes and yeasts for contaminated biomass.

KEI possesses a prototype facility for the production of bioethanol, which is used for promotional and educational purposes. The prototype is available for general public and experts, and mainly for the University students who elaborate their final theses. The aim is to inform about the fermentation process of the bioethanol production and demonstrate various components of smaller scale.

In addition to the production of bioethanol, we also deal with other types of biofuels, e.g. biodiesel. Biodiesel is environmentally friendly fuel for diesel engines, based on methyl esters of unsaturated fatty acids of vegetable origin. Biodiesel can be made from pure oils of raw oil materials (oil-seed rape, sunflower, various exotic plants etc.), as well as from the used cooking oil - the waste produced by households. Biodiesel can be made by transesterification, which takes place in the presence of a catalyst (NaOH or KOH) and methanol at an elevated temperature. The amount of catalyst added to the transesterification process depends on the quality of the oil used for its manufacture. By-product is glycerine which can be used in the production in other industries.

Any material, technology of its production, use and disposal has a particular effect on humans and environment. It is therefore important to know these effects and preventively eliminate potential adverse effects, or remediate the consequences which are due to the non-compliance with work procedures or unwanted events. The Department staff performs the environmental and geochemical monitoring of the living and working environment (especially chemical analysis of the surface and ground waters, soils, bottom sediments and partly rock environment), the effects of selected activities on the environment (e.g. the impact of acid mine water on the environment, the impact of fires on the ground etc.), and the possibility of reducing these impacts in case of unwanted events (e.g. work in the field of the industrial contaminant sorption to the modified inorganic and organic materials, degradation of organic contaminants by progressive methods). In experiments, classical instrumental chemometric and instrumental methods are used (particularly UV-VIS spectrophotometry, FT-IR spectrometry, GC-MSD et al.). The devices for progressive methods of removing contaminants comprise the experimental UV photoreactor, device for sonication, ozonation etc.

Department of Environmental Engineering has a sterile culture of model organism for determining the ecotoxicity. The higher plant of Lemna minor was obtained in the year 2006 from the Ecotoxicology Centre s.r.o. in Bratislava, The plant enables observation of the toxic effects of different substances on the higher green plants in aqueous medium. Toxic effect occurs as the retardation of the plant growth for a period of 7 days, or as low production of chlorophyll, chlorosis in certain cases (total loss of the green dye) or even death - necrosis.

For several years, Department of Environmental Engineering has been examining toxicology effects on bacteria, particularly the bacteria of activated sludge, in order to measure inhibition of respiration (oxygen consumption) within 3 hrs.

The above-mentioned model organism of Lemna minor was used as a sorbent material. Its high sorption capacity was demonstrated in case of e.g. toxic hexavalent chromium, or even some organic hazardous substances, such as pentachlorophenol. When compared to so-called bioaccumulation when a plant "extracts" heavy metals from the water to grow, the advantage of using biosorbents is that the sorption works also at very high toxic concentrations, and, moreover, takes up a very short period (minutes), while bioaccumulation process lasts several days.

Various cutting media are used during machining to cool and lubricate the place of cut. The Centre of Excellence uses various emulsions and synthetic fluids, which are attacked by various consortia of microorganisms that can adversely affect the health of workers. Research in our workplace examines the possibilities of using ozone to eliminate the occurrence of such bacteria; this would also allow reducing amount of the biocides used. The biocides are not completely harmless to health.

Department of Environmental Engineering disposes six cultures of microalgae with higher lipid content. The lipids can be used to produce various kinds of fuels, starting from biodiesel up to bioethanol, methane or even hydrogen. Currently, we are trying to establish a laboratory which would focus on the research in the area. The Department has submitted two H2020 projects of cooperation with 12 and 10 leading European centres focused on the production of biofuels from algae.

In cooperation with partners from the Institute of Materials, we focus on synthesis of the magnetite nanoparticles, which can be used in collecting algae. Magnetic particles surround the algae (bonding to it by electrostatic forces), while not inhibiting the adoption of solar radiation. After some time, algae can be collected with a magnet attached to the wall of a container and decant the remaining water easily.

2.2.3 Department of Production Quality Engineering

Department of Quality Production Engineering is part of the Institute of Safety, Environment and Quality. The Department staff carries out the research and education activities in the field of quality management systems, integrated management system, statistical tools and quality management techniques, total quality management, and monitoring customer satisfaction and consumer protection.

Education activities of the Department of Quality Production Engineering focus on teaching profile subjects such as Statistical Methods for Quality Control, Tools and Techniques of Quality Management, Quality Audits, Total Quality Management, Standardization, Certification and Conformity Assessment. The acquired knowledge is compulsory for the graduates of Bachelor and Master studies in the State Examination.

The education activities of the Department comprise the supervision of the Master and Bachelor theses. The theses are focused on the issues from the Department research. The theses are elaborated mainly in the manufacturing organizations (e.g. Miba Steeltec, ZF Sachs, Bosch, Osram, VW, Slovnaft etc), where students can directly apply the theoretical knowledge acquired during their study.

Staff of the Department of Quality Engineering can provide services in the above-mentioned areas of quality management systems, whether in the form of cooperation in supervising the theses, or training and education of personnel of external organizations in the form of courses.

The Department of Quality Engineering is engaged in the research of quality management systems, applications and utilisation of the tools and techniques of quality management, quality audits and assessment of partnerships with customers and suppliers.

2.2.4 Department of Fire Engineering

Education activities of the Department focus on teaching the profile subjects such as Fire Engineering, Reserved Technical Equipment, Identifying the Causes of Fires and Accidents, Theory of Fires and Explosions and Fundamentals of Fire Engineering. The knowledge is mandatory for graduates of Bachelor and Master studies.

Research activities in the field of fire engineering are focused on fire risk of materials with emphasising the needs of investigating the causes of fires and the assessment of the fire and explosion risk on the production site. The Institute has a cone calorimeter of the Fire and Security Technology Testing Co., and SEDEX calorimeter operating on the principle of ARC calorimetry. These devices currently represent the top technology in the research of material behaviour under the fire conditions.

Cone calorimeter can measure the rate of heat release, the total heat released, the calorific value, the rate of the carbon monoxide formation, the cumulative release of carbon monoxide, the carbon monoxide yield, the rate of smoke production, the cumulative release rate of smoke and the smoke generation of the materials under the load of the heat radiation with the density of heat the flow from 0 to 100 $kW.m^{-2}$. Such conditions allow simulating all phases of the fire development. Rate of heat release during the combustion process is based on the finding that when burning most of the organic polymers, 13.1 ± 0.7 kJ of heat can be released per one gram of consumed oxygen. Specific feature of the cone calorimeter is a modification allowing the investigation of liquid samples. According to the currently available information, the Institute of Safety, Environment and Quality is the second workplace in the world, where such modification was implemented and tested. The research of flammable liquids is mainly focused on the prediction of the of fluids behaviour during fire in the large capacity tanks from the data obtained by measuring a sample in a container with a diameter of several centimetres. Options of the above-mentioned prediction were tested on samples of gasoline and ETBE. The results were published in scientific journals, namely the Journal of Thermal Analysis and Calorimetry and Procedia Engineering. Further research will be focused on the possibility of using the results obtained by the cone calorimeter to predict the dynamics of fire development in the flashover stage. The flashover stage is the most important phase of the fire development as it represents a transition from local fire to the fully developed one.

SEDEX safety calorimeter enables the research of materials propensity to self-ignition. Self-ignition is a process in which the heat required to burn the substance is formed by the chemical or physical changes in the substance itself, or as a result of interaction of the substance with environmental factors. Safety calorimeter is used primarily in the research of propensity to self-ignition of the liquids containing double or triple bonds and deposited on a porous support. A standard SEDEX safety calorimeter enables measurement

of exothermic reactions taking place in the substance under variable temperature conditions. The equipment was modified for the purposes of the Institute to allow the investigation in various temperature conditions, as well as in variable conditions of air supply to the process of self-ignition. In addition to the teaching and research, SEDEX safety calorimeter is currently being used for elaborating expertise and expert reports in the field of identifying fire causes.