

Expanding Knowledge of Students of Engineering Using E-Learning Support in Education

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Abstract

The increasing demand of employers on the quality of knowledge, the expertise and competence of graduates has led scientific-pedagogical personnel with professional erudition of the Faculty of Engineering, Department of Mechanical Technology and the Department of Machining and Assembly to create two training modules - "Management and Economics" and "Industrial Engineering", in which 12 subjects were innovated. They were converted into digital form using elements of e-learning and implemented into the existing curriculum at the Faculty of Mechanical Engineering. From the pedagogical point of view the innovation of the process of using e-learning consists of application of multimedia technologies, internet and electronic media as well (the possibility of self study through the website and CD anytime and anywhere, for the handicapped, unemployed, or workers in companies as well). Innovation connects teaching the newly created technically oriented objects with practice, i.e. involvement of specialists from practice through lectures, presentations, excursions in companies, etc. The authors of innovative subjects insist on increasing education and awareness of skilled and competent technical graduates so that they are able to quickly and fully integrate into the work process and the structure of the existing teams and herewith meet the quality requirements of the industry.

Keywords

Education, e-learning, competence of graduates, professional skills, innovation

1. Introduction

The prosperity of any business in any subject depends primary on human potential. Nowadays, the employers require of the graduates the basic skills and also key competencies that include considerable entrepreneurial skills, the knowledge economy, the ability to give things in perspective, self-reliance in action and decision making. The project monitors the global goal just by focusing on the expansion and interconnection of students' knowledge in the multidisciplinary field called industrial engineering that has evolved from the modern industrial management with process engineering, so that we could send the qualified and competent graduates with the knowledge of technical engineering disciplines with the knowledge of the modern enterprise management. They will be able to rationalize, optimize and streamline the production and non-manufacturing processes as well with all this knowledge. In 2009, scientific-pedagogical staff from the Department of Mechanical Technology and the Department of Machining and Assembly submitted a project at the invitation of the Ministry of Education, Youth and Sports of the Czech Republic (MŠMT ČR) under the Operational Program of Education for Competitiveness, where the main goal was the innovation of student education at the Faculty of Mechanical Engineering, Faculty of Electrical Engineering and Computer Science and the Faculty of Metallurgy and Materials Engineering focused on professional development and empowerment of students. These employees responded to the challenge by the Minister of Education, Youth and Sports of the Czech Republic Ondřej Liska, who said, *"The share of information and communication technologies in education lags behind the OECD average in our country. Equipment of schools is still unsatisfactory. That needs to be changed. During years 2009 - 2013 we want to focus more on ICT. (MSMT 2013)"* Currently, the ICT represent an important and indispensable part of the state, business and the private sector according to the different views of different experts from the technical and economical field. Therefore, control of these technologies is one of the core competencies of graduates which we supported in this project. In June 2010,

MŠMT ČR released decision approving this grant to cover expenses related to the project implementation for modular innovation of study programs that will increase skills of the students mainly from technical fields as students are gradually losing interest in technical fields.

1.1 E-learning

E-learning is the learning process through which students can learn usage of information and communication technologies (ICT - Information and Communication Technologies) i.e. to use not only the hardware components but also software (see section 3.1 and 3.2). The multimedia element application of E-learning is the main component in which we see (as the teaching staff at the University) most innovative potential in educating a wide range of potential students, i.e. full-time students and students of distance study as well, which may include for example disabled students or the workload professional who can complete most of the teaching at the computer. It eliminates not only company financial costs but also time. Implementation of multimedia elements lies generally in the use of any available and effective didactic practices and supporting technical means by which the curriculum can be presented to students and also enables to communicate with them and to check their academic progress and to evaluate the study results. (Kopečný, J. and A. Kapias 2007).

We aim to eliminate "pure" form of study in this project, (i.e. as pure full-time, electronic or distance study) and try to push the concept of **blended learning** which combines elements of e-learning and full-time study. The integration of blended learning is the most promising method especially for universities as it was found based on the consultations and discussions with colleagues from other universities and also drawing on our own experience of teaching university students. The future of e-learning is constantly evolving and it is open because there is a sustained improvement of internet and other educational technologies. That is the reason why is the quality of skilled implementers of e-learning very important especially among university teachers. (E-learning portal 2013) Logical summary of the importance of e-learning is in facilitating access to education for full-time students and lifelong learners, educators and people of advanced age alike.

2. Objectives of the project

Sub-objectives of the project, includes the following activities.

1. The creation of two training modules:

- **Management and Economics** - focus on knowledge-based economy. The module includes objects (regions): Strategic Management, Principles of Economics, Economics and Management, Principles of Marketing, Legal Norms in Business, Business Plan, Organization and Production Management. **The module "Management and Economics" is focused on enhancing knowledge engineering students in the field of economic and business. Currently no graduate can do without them in practice.**
 - **Technological Engineering** - includes objects (regions): Computer Aided Manufacturing, Experimental Methods in Machining, Metrology and Quality Control, Principles of Assembly, Technological Principles of Design. **Module "Technological Engineering" consists of video clips that introduce the real working processes to students. The created schemas use the multimedia whiteboard that allows students to actively participate in learning and to better understand the curriculum.**
2. Creating texts (supports) used for interdisciplinary studies and their transfer into digital form so that they can be used for the preparation of studies in the form of e-learning.
 3. Training of students in bachelor's and master's degree program.
 4. Deepening cooperation with industry - in the course of the project, students also organized excursions to industrial enterprises in cooperation with project partners – Národní strojírenský klastr, o.s. which provided practitioners who have made a series of lectures in the classroom.

3. Procedure of key objectives implementation

3.1 Acquisition of modern IT tools and software

The whole process of teaching has been upgraded as part of the project primarily using e-learning in terms of the use of modern IT tools in teaching that can be bought thanks to the funding from the European Social Fund and in part of the state budget of the Czech Republic.

These items were purchased:

- modern interactive whiteboards and data projectors, video cameras and software for video processing in real working operation and presentations (Adobe Premiere Production).

Purchase of software was implemented, including apparatus:

- modern software with the latest updates such as:
 - o the QForm (QForm - Quick Metal Forming Simulation is a new generation of software to simulate forming),
 - o CAD / CAM system Mastercam for 5-axis machining,
 - o the Visio Std 2010 Sngl MVL (Visio is a program that can visually document, design and create charts, diagrams, mind maps, structures, etc. It can be used to easily visualize processes, systems and information, to analyze complex information to quick understanding and also effectively transfer information for better decision-making.),
 - o the MS Project 2010 Sngl MVL (MS Project is used to plan, monitor and manage complex projects and processes and to communicate with a given project team. It is particularly suitable for teaching courses in managerial training pillars of Management and Economics Module).

All of these devices and software enable existing target group of students to work with modern tools commonly used in practice.

3.2 E-learning system of VŠB-TUO, Creation of textbooks

E-learning system of VŠB – Technical University of Ostrava - LMS Moodle

E-learning system in the VSB - Technical University of Ostrava is available software in a virtual Learning environment **LMS Moodle** (LMS - Learning Management System, Moodle - Modular Object-Oriented Dynamic Learning Environment, see Figure 1, Figure 2, Figure 3) for both students and teachers. There are self-guided courses where educational institutions (in this case it means VSB-TUO) provide educational materials to students but do not leave them alone but guide their next learning steps. LMS Moodle has worked as a tool to support the socio-constructivist approach to teaching students.



Figure 1: Learning Management System (LMS) Moodle
(Wizards CZ s.r.o. 2009)

Benefits of LMS Moodle:

- is one of the best LMS in our market,
- is continuously developed, people from all over the world cooperate on its development,
- is used by major institutions involved in e-learning (eg Open University Worldwide),
- can be installed on each computer where you can run PHP (Hypertext Preprocessor, originally Personal Home Page), SQL (Structured Query Language),
- can be used in cooperation with the operating systems Windows, Mac and Linux. (Wizards CZ Ltd. 2009)

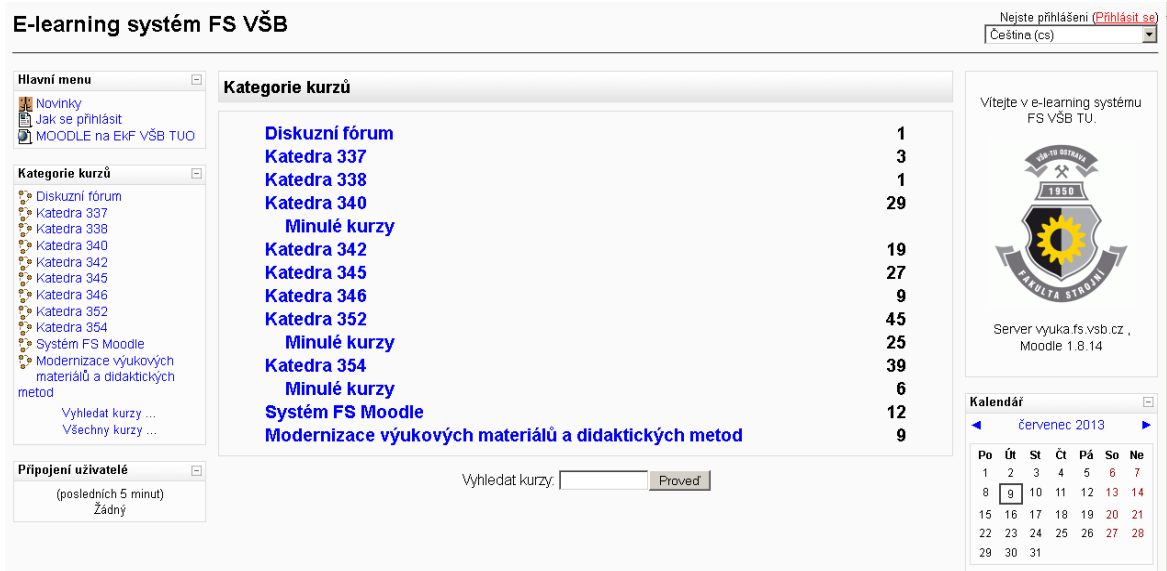


Figure 2: E-learning System FS VŠB (Faculty of Mechanical Engineerig, VŠB-Technical University of Ostrava)



Figure 3: E-learning System FS VŠB, PNP (FS - Faculty of Mechanical Engineering, VŠB - Technical University of Ostrava, PNP - Legal Norms in Business)

Creation of textbooks

Modern teaching learning materials were created in a software environment Moodle LMS in the course of the project ESF. They are available to students for self-study in the two above mentioned modules and logical sequence content of subjects in the curricula of VSB-TUO, Faculty of Mechanical Engineering was ensured, as well. At the same time, the practitioners have been involved in the educational process. Textbooks are submitted for review in the form of separate chapters (see Figure 4) in LMS Moodle. Each chapter is enhanced by activating elements. Some of them are feedback. It means they indicate if the student understood the content of the chapter. Icons with a certain meaning guide the text of each chapter (see Figure 5).



Figure 4: Example figure for demonstration of individual chapter and icons

	the role insert into the test		the open-eye icon means an item is visible to students
	preview of the course		the highlight icon allows you to highlight a section as current
	turn editing of the course		Up/down arrow icon for moving a block
	help		the delete icon will permanently delete something from the course

Figure 5: Meanings of some important icons

Modern teaching text is made up of specific content where are listed the names of the chapters. The brief introduction and a brief insight into the chapters are followed. The third part of the objective describes what the student will be able to do after a successful completion of the active teaching support, total time needed to study and guide through the study.

Introduction of each chapter consists of:

- quick preview of the problem,
- goals or what will you know,
- the time needed to study
- keywords related to the topic,
- important concepts to remember.

End of each chapter consists of:

- task to complement,
- basic summary of chapter,
- control questions,
- test questions + key to the solution,
- literature + additional resources.

The entire instructional text converted to digital form in LMS Moodle is further enhanced by Power Point lecture presentations, animations, download attachments such as model contracts, schemas, etc. For some items such as "Experimental methods in machining" movie from real operation are set out in specific chapters, etc.

4. Results and outcomes of implementation of e-learning

Created textbooks have been professionally and pedagogically evaluated by experts in the field and not only by experts from local universities but also from universities abroad and practitioners, as well. In the summer semester 2011/12, the textbooks were pilot tested in the first phase and most of the remaining were tested in the second phase, during the winter semester 2012/2013. A subsequent evaluation confirmed the possibility of introducing a newly created learning support in students teaching and the set curriculum at the Technical University of Ostrava. Newly obtained modern IT tools (interactive whiteboards, data projectors, PCs and laptops) and software (e.g. QForm, CAD / CAM, MS Project and Visio) which were introduced into classrooms of both departments have helped to successfully increase the share of ICT in education. It resulted mainly in bigger satisfaction of students who completed the prepared questionnaire in the evaluation part. The results were processed into clear graphs both

for each extra educational support and for each module. 554 students participated in pilot tests in total and 408 students out of them have expressed their opinion about the 12 processed study supports within the two modules by filling the specified questionnaire. The summary of all responses is shown for each module in the table (see Table 1) and pictures (see Figure 6, Figure 7). Verbal comments were forwarded to the authors who will further modify and improve the educational support based on them. Graphs prepared on the basis of evaluation of students are available at the project website <http://projekty.fs.vsb.cz/459/>.

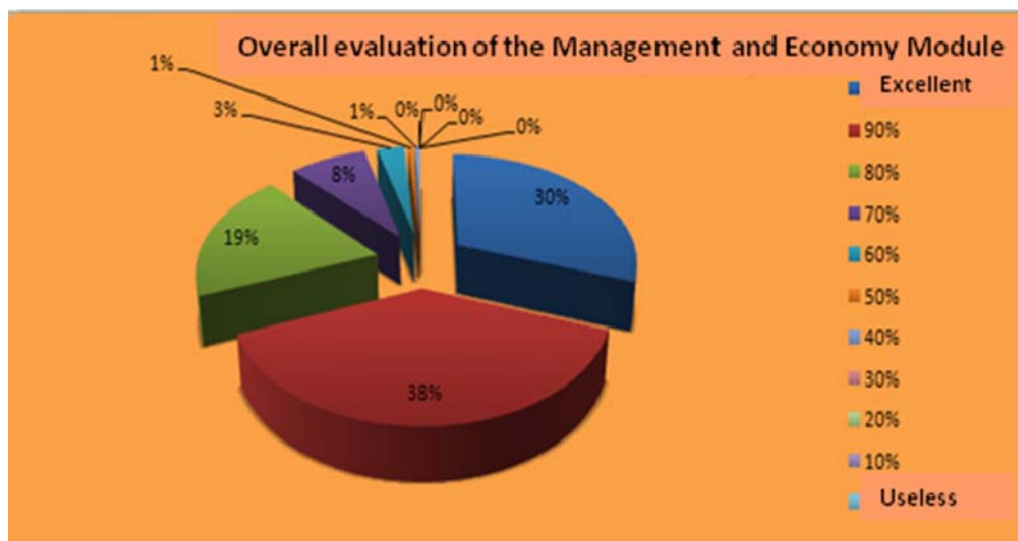


Figure 6: Management and Economy Module - overall evaluation of the 7 learning courses by students

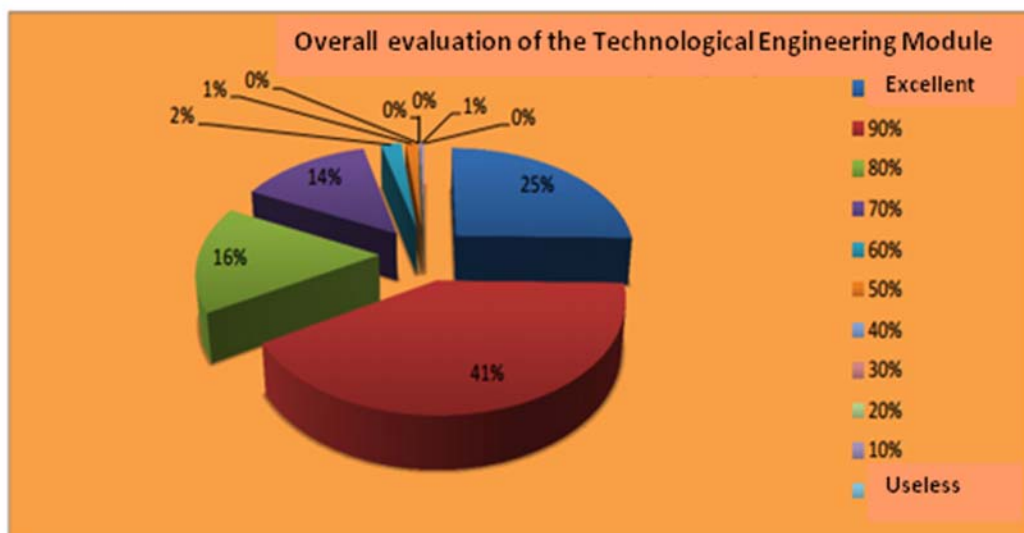


Figure 7: Technological Engineering Module - overall evaluation of the 5 learning courses by students

Table 1: Pilot validation of learning courses of the project - Percent of evaluating students

The total number of students (or percent)	
Pilot validation of learning courses of the project (12 courses)	554
Evaluation of learning courses of the project	408
Percent of evaluating students	73,65 %
Pilot validation of learning courses of Management and Economy Module (7 courses)	237
Evaluation of Management and Economy Module	174
Percent of evaluating students	73,42 %
Pilot validation of learning courses of Technological Engineering Module (5 courses)	317
Evaluation of Technological Engineering Module	234
Percent of evaluating students	73,82 %

Advantages of created learning support transferred to digital software environment Moodle LMS:

- easier access to the created modern teaching texts, the opportunity to study from anywhere (internet),
- student homeworks are submitted only via PC, not on paper,
- students can verify gained knowledge generated by learning support through self-tests,
- educators can correct their work anytime and anywhere (internet),
- teachers need no more to correct paper and pencil tests as students take tests at the PC and the tests are evaluated by computer which clearly makes the work of teachers easier,
- feedback and overall communication between students and teachers is much faster,
- creation of educational materials in LMS Moodle for teachers using e-learning is easier, faster and more understandable for students because of better two-way communication,
- within the framework of the stated objectives and to ensure the compliance with the tasks, the project management conducted by the implementation team through the duration of the project and lessons learned thus obtained were implemented in face-to-face teaching.

Disadvantages of created learning support transferred to digital software environment Moodle LMS:

- a different way of processing of teaching materials puts greater demand on teachers in terms of training and identification with the new way of teaching,
- continual communication between teacher and student takes a lot of time and therefore the course should be limited to optimal number of students,
- overloading or unavailability of LMS Moodle, student syndrome, etc. (Šajdlerová I., 2013)

The general overview of the results (monitoring indicators) are shown in a table (see Table 2), both developed modern textbooks and participating authors, practitioners, reviewers, partners, and students.

Monitoring indicators operate as a feedback about whether the progress and results of the project meet the targets that were set at the beginning ie. in the application for financial support, and are crucial for the final evaluation of the project funded by the European Social Fund and the state budget of the Czech Republic. (MMR 2013)

Number of supported people - the total number of students of VSB-TUO who completed any training course within the project- subjects, excursions, expertise, professional experience, etc.

Number of successfully supported people - the total number of students of VSB-TUO who have successfully completed any of the available courses - Exercises evaluation and Examination or Graded Exercises evaluation.

Národní strojírenský klastr, o.s. (NSK, o.s.) - is a voluntary association of organizations in engineering and related fields. It was founded on 20 March 2003 as an association of legal and natural persons. Its membership consists of 66 companies and their number still increases from year to year. The importance of this partnership is especially important in terms of possible networking of many businesses in education (in this project, we were able to bring together more than 20 companies from the total membership base). Other benefits include the linking of theory and practice which is particularly important for students with practical experience and finally, in implementation of the requirements and needs of the educational modules. (NSK, o.s. 2013)

Table 2: Overview of monitoring indicators

Achieved value of monitoring indicators	
Name of monitoring indicators	Achieved value
Number of new innovated subjects	12 learning subjects
Number of successfully supported people - students VSB-TUO	470 students
Number of supported people - students VSB-TUO total	1218 students
Number of supported persons - service providers - the authors of innovated subjects, reviewers, experts out of the practice	40 people
Number of involved partners	1 (Národní strojírenský klastr, o.s.)

7. Conclusion

“Learn everything you can, anytime you can, from anyone you can - there will always come a time when you will be grateful you did.”

Sarah Caldwell

VSB - Technical University of Ostrava realize that linking of the fundamental aspects of life (economic, social and environmental) is a fundamental principle of sustainable future development. Only precaution, prevention and long-term perspective ensure quality life for us and future generations as well. Knowledge of new progressive technologies and their use in practice are integrated into the training modules which will allow to reduce negative impacts on the environment. Project team in collaboration with project partners NSK, has sought to develop the skills and personal potential of students, knowledge sharing and also skills inter alia integrating practical knowledge in teaching and a focus on entrepreneurial skills. Through the close cooperation of VSB-TUO with partner of the project the contact with potential employers of graduates was established. These contacts can largely help the graduates in their search for first employment. From this perspective, the project has a large positive impact on sustainable development (Šajdlerová I., M. Gregušová 2013).

Updating of study programs and courses, support of their teaching by using modern study aids - devices and software, e-learning, etc. are also included in the Strategic Plan of educational, scientific, research and other creative activities of VSB-TU Ostrava. Possibility of education via the internet extends the possibility of obtaining knowledge and information in these areas as well as other important groups interested in studying this issue (in these groups can be included handicapped people, socially disadvantaged, etc.). Modern textbooks created by the project are used in the teaching of subjects according to current curriculum at the Faculty of Engineering, and the Faculty of Electrical Engineering and Computer Science and Faculty of Metallurgy and Materials Engineering. The acquired knowledge and experience in the implementation of the project will be used to upgrade other disciplines and study programs.

“A goal properly set is halfway reached.”

Reference

- E-LEARNING PORTÁL, Základy e-learningu, Začínáme s e-learningem, Available: <http://vsportal.osu.cz/showCategory8ece.html?kod=85>, June 15, 2013.
- Konečný, J., Kapias, A., *E-learningový kurz E-learningu – průvodce studiem*, VŠB-Technická univerzita Ostrava, Regionální centrum celoživotního vzdělávání, 1st Edition, Ostrava, (41 pages), 2007. ISBN 978-80-248-1542-8.
- Ministerstvo pro místní rozvoj (MMR), Strukturální fondy – slovník pojmů – monitorovací ukazatele (indikátory), Available: <http://www.strukturalni-fondy.cz/cs/Informace-a-dokumenty/Glosar/M/Monitorovaci-indikatory-%28monitorovaci-ukazatele%29>, June 3, 2013.
- Ministerstvo školství, mládeže a tělovýchovy (MŠMT), ICT ve vzdělání, Available: <http://www.msmt.cz/ict>, February 22, 2013.
- Národní strojírenský klastr, o.s. (NSK, o.s.), Vítejte na stránkách Národního strojírenského klastru, Available: <http://www.nskova.cz/index.php?article=uvod>, May 6, 2013.
- Šajdlerová, I., Gregušová, M., *Souhrnná informace o realizaci projektu Operačního programu Vzdělávání pro konkurenceschopnost*, April 23, 2013.
- Šajdlerová, I. E-learningové prvky pro podporu výuky odborných a technických předmětů – Základy managementu. In *SBORNÍK SEMINÁŘE ŘÍZENÍ STROJÍRENSKÝCH PODNIKŮ*, 21. – 22. listopad 2007, Beskydy, Visalaje. Ostrava: VŠB – TU Ostrava, (21 pages), 2007. ISBN 978-80-248-1657-9.
- VŠB-Technical university of Ostrava (VŠB-TUO), E-learning systém FS VŠB-TUO, Available: <http://vyuka.fs.vsb.cz/>, January 15, 2013.
- Wizards CZ s.r.o. 2009, Wizards Group s.r.o., Moderní vzdělávání je e-learning!, Co je LMS Moodle?, Available: <http://www.wizards.cz/e-learning/>, March 8, 2013.

Biography

Markéta Gregušová is an Academic Staff Member in the Faculty of Mechanical Engineering in the Department of Mechanical Technology - Institutes of the Planning, Organization and Economics of Engineering Production at the VŠB – Technical University of Ostrava, Ostrava-Poruba, Czech Republic. She holds a Master in Management of Technology in the Department of Mechanical Technology - Institutes of the Planning, Organization and Economics of Engineering Production Systems and PhD in Mechanical Technology in the Department of Machining and Assembly in the Faculty of Mechanical Engineering at the VŠB – Technical University of Ostrava. She has published conference papers and workshop papers. Markéta Gregušová has done research projects co-financed by European Social Fund and state budget of the Czech Republic. Her research interests include manufacturing, optimization, reliability, scheduling, lean, marketing.

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Jana Petrů is a Head of Department of Machining and Assembly and expert in the field of conventional and unconventional machining and assembly. She is a tutor of the course Assembly works and automatization of assembly works and Technology. She is a coordinator of several education and research projects for evaluation of the quality of the surface after machining, selection of the appropriate cutting conditions for machining of special materials, assembly working. The author or co-author of more than 40 verified technologies, 5 functional samples, 2 prototypes according to the present methodology of the government council for the R&D, which have been successfully introduced in practice and confirmed by a company. Principal investigator or co-investigator of more than 5 commercial agreements within cooperation with a number of companies from the Czech Republic that solve reducing cost of technologies.

Current list of R&D results at: <http://innet.vsb.cz/profil/cs/nov92/vedeckovyzkumnevystupy>.

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