# INNOVATION AND CREATIVITY IN THE COOPERATION BETWEEN UNIVERSITIES AND INDUSTRY

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***Abstract:*** In the last years, Romania has made a significant progress in economy, which finally leads at the access to the European Union. Our SCOPES project was developed during 2005-2008 between a Swiss and a Romanian partner.
The aim of the project was to establish a common research and education in the future by implementing new collaboration technologies and adapting them to the individual needs of the industrial business processes. The specific goals were the following:
moving towards quality culture and encouraging performance in teaching and research; meeting European standards in teaching and research, and adapting the educational offer to labor market demands; creating an academic environment based on responsible partnership with the students; strengthening the entrepreneurial dimension of the university; promoting university's distinctive competencies into the regional, national and international community; modernizing and developing university's assets.
***Key words:*** net-based collaborative education, mechanical engineering, virtual reality, implementing industrial contacts.

## 1. INTRODUCTION

Development of industry and the response of the higher technical education to the demands of the industry play an important role in defying the right scenarios for implementing new collaborations in education, research and industry. An important aspect in this context is the fact that solutions to certain problems are not realized by one single person anymore, but within a networked team, spread over the whole globe. This is valuable both for industry and universities as well. This net-based collaboration is not only a domain of the so-called "global players", but with an increasing amount of small and medium enterprises, which could be part of a supplier network for instance.
Taken into account all the above-mentioned necessities, many business processes do not take benefit from this new collaboration technology, although other technologies like fax, e-mail, or telephone are well established. Unaware of its potential, collaboration technologies are often treated as a "visual telephone", ignoring that there are much more perception channels, which can be addressed. Thus, all technologies remain unused, which support a collaboration in a team, resulting in large efforts and costs for team meeting with physical presence. Introducing an IT-support for business processes in the field of mechanical engineering also results in a modification of those processes. Unaware of the benefits and being insecure about the application fields of the new technology, the users often have acceptance problems. Exactly here the universities and other research institutes are needed to interfere in order to improve the man-machine interfaces and to use and teach these new technologies within collaboration with other research institutes and industry. By spreading the required knowledge they help to increase the overall acceptance and knowledge transfer into industry.
Our SCOPES project was developed during 2005-2008 between two partners: Swiss Federal Institute of Technology in Zürich (ETH) and Technical University of Cluj-Napoca, (TUCN), Romania. The SCOPES (Scientific Cooperation between Eastern Europe and Switzerland) Project was founded by the Swiss National Science Foundation.
There are five major steps defining the proposed project:
-Introduction of the technology and definition of an application;
-Implementing collaboration technology at the Romanian partner;
-Preparation of a students' exercise;
-Preparation of a use case for industry;
-Final report on the achieved results and outlook.
The project team has developed a logical structure, each step being defined by an implementing step that is analyzed at a round table. The round-table conclusions are re-introduced in the implementing process in the following step, the main step here being the feedback process.
The project has a tree structure, which permits to develop a working model at a micro scale and in the following step to take the model to a macro scale. Within the proposed project, a new collaboration

technology was implemented in university and small / middle enterprises (SMEs) in order to spread the knowledge about these systems. The project focuses on applications and business processes, since there is a large demand for that both by the Swiss and the Romanian partner.
Within other projects the Swiss partner develops the base technology, but in parallel the proposed project focuses on the non-technological facts, i.e. the possible user and the business processes, in which it is involved. Simultaneously, new demands on technology and processes can be achieved from this implementation step.
The German Department (DSG) from the Technical University of Cluj-Napoca, Romania is oriented towards the changes of the Romanian industry and also towards the educational changes required by the Bologna process (***Bologna Declaration, 1999).
The continuous changes and the higher demands of the industrial and research fields lead to an improved perspective for further development of the interaction between the German Department and these two sectors by providing a good understanding of the latest manufacturing techniques (laser beam manufacturing, virtual reality, cold forming, etc) and by opening a multinational cooperation with other universities.
The goal is to provide to the students the latest education techniques by offering them the possibility to get in touch with research facilities and working conditions of other countries.

## 2. PARTICIPATING RESEARCH INSTITUTIONS

The Institute for Machine Tools and Manufacturing is part of the Department of Mechanical and Process Engineering (MAVT) at the Swiss Federal Institute of Technology in Zürich (ETH). The research is split up into the following four areas:
Machines:
Machine tools with parallel kinematics: IWF-Hexaglide. New machine concepts for high-speed machining, simulation, appraisal and optimization of machine tool concepts, optimal command variable generation for non-linear kinematics.
Processes:
Development of a high-performance tool for power honing and grinding tasks, methodologies for development and optimization of saw blades, chip length registration and process monitoring by acoustic emission of turning machines.
Methods:
Appraisal, optimization and simulation of highly dynamic machine tool systems, metrological survey, characterization and optimization of path accuracy, calibration of non-linear kinematics, investigation of vibration behavior and active vibration control.
Virtual Reality:
Development of interaction devices with virtual environments, development of virtual collaboration environments, implementation of VR in industrial processes, force feedback devices, visualization.
Each year, approximately 250 students in the 1st and 2nd semester and about 190 students in the 3rd and 4th semester are taught in materials and production. In addition, there are around 50 students each year being taught in the field of virtual reality.
Thus, the Swiss partner is interested to implement the results of the ongoing research at Romanian partner's institute in order to test and optimize the results, and to gain additional experience in net-based collaboration. After establishing the first installation, it is envisioned to use these new functionalities also for common research in mechanical education, and for students' education. IWF has already developed collaboration with universities in Brazil, USA, Sweden, and other countries. However, countries from Eastern Europe are so far missing. Thus, the envisioned project gives a good chance to extend the curricula in teaching and research in a long term aspect.
Technical University of Cluj-Napoca is a modern technical higher education institution, with twelve Faculties passing through a period of genuine rebirth and confirming authentic capabilities for scientific and technical creation.By the philosophy of its strategy, the Technical University of Cluj-Napoca considers education as a transnational process, which contributes to the international dimension within the European educational context and also sees reform as a means of making the academic career more flexible and turning instruction in an extra-mural activity. At present, there is a worldwide competition among universities, which fight for prestige, resources and students and this competition environment can also be found in the Technical University of Cluj-Napoca.In this respect, the technical education of Cluj assures the development of cognitive services in the European educational area, through a process that became transnational.Today, the Technical University of Cluj-Napoca has a lot of cooperation relationships with universities in Europe and other continents, through community or bilateral programs and also scientific development partnership programs with prestigious companies from around the world and this effort brings arguments by its specificity that the TUCN is heading in the right direction. This fact is also supported by the “high degree of trust” mention, granted to the Technical University of Cluj-Napoca after the assessment performed by ARACIS (The Romanian Agency for Quality Assurance in Higher Education), and also by the fact that the TUCN has been assessed in 2008 by the

EUA (European University Association).In the context of promoting globalization seen as a harmonized reunion of local diversities, education is considered both factor and effect at the same time. As foreseen, education and even more so instruction are called not only to react to the globalization, but on the contrary, to play a decisive part in the development of future desirable societies, inducing qualitative transformations, in such a way as to maintain the diverse identity of the communities and also tolerance based on communication, on the knowledge and understanding of the interest of each and every participant to the process (*** The Rector's Message, 2010).

The Faculty of Machine Building is the continuer of the early Polytechnic Institute of Cluj-Napoca. The location of the Faculty of Machine Building offers some excellent possibilities for collaborations with manufacturing industry being situated in the industrial sector of Cluj-Napoca.

The Faculty of Machine Building trains specialists whose competence enables them to solve issues related to the design, service, operation and management of machine building systems. The competences of the graduates of this faculty are in reference with the development of manufacturing and fabrication technologies, the design and operation of fabrication, transfer and handling equipment, the operation of control and automation systems and the management of production systems as well. The Department of Manufacturing Engineering from the Faculty of Machine Building is one of the leading departments at the Technical University of Cluj-Napoca being the oldest Department in the Technical University (50 years of activity).

The German Department (DSG) is part of Department of Manufacturing Engineering from the Faculty of Machine Building, (TUCN). The German Department was bourn from the collaboration between Technical University of Cluj-Napoca (TUCN), University Stuttgart and DAAD (Popa, 2004).

The main areas of the DSG are:

Machines:

Machine tools for non-conventional technologies: a flexible manufacturing cell EMCO; an impulse solid state laser installation.

Processes:

Development of the manufacturing processes of non-conventional technologies. Development of new simulations methods for manufacturing process in the field of non-conventional technologies.

Methods:

Optimization of thermal behavior of grinding machine-tools.

The German Department has a number of approximate 180 students which are taking part to the courses offered by DSG, 30 students are taking the master course and approximately 15 students / semester are involved in research projects. In the DSG activities were involved 10 PhD students.

## 3. THE PROJECT'S MAIN OBJECTIVES

### 3.1 Teaching, Education

- Analysis of the curricula in order to propose extensions or improvements, e.g. in the field of Virtual Reality, machine measurement technology, machine tools, processes, etc.
- Information exchange on how the basic / advanced student's education is performed at both partners' sites.
- Definition of correlated students' work (project work, bachelor-, master thesis, internships, etc.).
- Exchange of courses, seminars, etc.

Block courses are envisioned during a short term visit from teaching staff.

- Preparation of common students' exercises on typical problems in mechanical engineering.
- Preparing a net-based collaboration scenario for the students' exercise to teach and train the possibilities in global net-based collaboration.

### 3.2 Research

- Introduction of the base technology for communication and collaboration. This point is of particular interest, because future research will base on it. The focus will be to do further common development in this field, but also to use the existing technology for other research topics and for education.
- Installation of the basis infrastructure for net-based collaboration.
- Preparing the research field of a continuous simulation-based machine tool development with a later verification on real machines. This point takes advantage of the common research interests and capabilities of both partners.
- Preparing the research field of tele-service, i.e. the coupling of a real machine with a virtual one for a remote control and for easier error detection over a network.
- Ph.D. student's exchange, working on the above topics.

### 3.3 Industry

- Workshops for industry were planned in order to get into closer contact. The goal is to introduce the ongoing research to industry, but also the new achieved educational skills of students.
- Based on the push/pull-principle, the research results are applied to industry, developing scenarios on how to work together with the university. In a

next step, requirements on research and education will be gathered in order to adapt research and/or curricula.

### 3.4 Long-term goals

- Continuing with the common research started within this project by the preparation of a common EU-proposal
- Enlargement of the curricula of the German Department, with a Joint Master Course
- Deeper integration of the Romanian industry within these projects.

## 4. ACTIVITIES

The following large activities divided into tasks were running their course in the project:

**4.1 Start-up phase, establishing deeper contact between both institutes:** A common basis of understanding and a clear scenario and task list for the next years

- Evaluation of curricula
- Information exchange on students' education
- Planning teaching exchange as block courses
- Defining Ph.D. tasks and responsible persons

**4.2 Set-up of the collaboration:** Establishing the optimal scenario of implementation the new technology, basic assessment on the net-based collaboration

- Establishing the specific needs of the Romanian partner
- Implementing the technology
- Feed-back - work-shops
- Validation of the implementation process

**4.3 Knowledge exchange - Preparation of student's exercises:** Enhancing the students' knowledge on IT supported net-based collaboration

- Defining a typical problem in the field of mechanical engineering
- Developing the net-based collaboration model
- Net-based collaboration constrains
- Model validation
- Lectures on the model implemented

**4.4 Teaching exchange:** Identifying the best overall scenario for the teaching process

- Mobility criteria
- Scenarios for the teaching process with the new technology
- New curricula/teaching topics - new teaching methods
- Analysis of the educational offer

**4.5 Transfer of results into industry:** Establishing the scenario to achieve the best industry implementation of the project results.

- Suitable scenario for industry
- Industrial workshops
- "Push/Pull" principle
- Working models data-base

**4.6 Final reports on the achieved results and outlook:** Analysis of the achieved results and an outlook for future projects

- Feedback on the industry impact
- Industry case study
- Full reports/Project full overview
- Results publication
- Future steps

## 5. RESULTS

### 5.1 Knowledge exchange - Preparation of students' exercises

In order to use the full functionality of the implemented technology for teaching purposes, a students' exercise was defined and prepared. This exercise focused on a typical problem in the field of mechanical engineering, which had to be solved by a net-based teamwork. This exercise was a part of the lecture in order to demonstrate the possibilities of today's technology. However, the constraints of a net-based collaboration were emphasized. The experiences gained from this remote collaboration exercise have helped the Swiss partner to improve the man-machine interfaces. For the preparation of the exercise and its implementation into the IT-environment, bachelor or master students were involved.

### 5.2 Teaching exchange

In the first year of the project, two long-term visits were performed at ETH Zürich by two PhD students, who have accomplished the experimental research of their PhD thesis. Short-term visits were performed by the teaching staff of the DSG and by the staff of Professional Career Department. Eligibility criteria for people involved in the SCOPES-project have been settled during the meetings between the coordinators from ETH and TUCN.
The aim of this phase was to identify the best overall scenario for the teaching process, based on the Bologna process rules.

### 5.3 Transfer of results into industry

In order to distribute the achieved results to the industrial partners of the Romanian partner, a suitable scenario for the industry was developed and tested. This scenario was used within a workshop with the Romanian industry partners, aiming the introduction of the IT-based collaboration with its

benefits and possible drawbacks. The workshop has strenghthed the contact between the industry and university and it has achieved also, further requirements for net-based collaboration from the industrial partners.
A developed issue was the creation of a database with several scenarios for industry cases. Teaching scenarios for training were developed together with working scenarios. The trainings were addressed to industrial partners consenting to an IT-net-based collaboration (Popa et al., 2009).

### 5.4 Final report on the achieved results and outlook

The project was closed with the final written report on the achieved results, containing the reports of the students' exercises and an outlook on future research activities. Five papers were published in national and international technical revues. A national patent was registered based on a mathematical model for electrical discharge machining (EDM). Two books were published: a course of practical laboratory applications (Popa, 2005) and a bilingual (German-Romanian) textbook containing the new lectures in the curricula (Popa et al., 2009).
The importance of the work performed during this project was reflected at the end of the project by new powerful links with the industrial sector.

## 6. CONCLUSIONS

In order to have a good assessment on the project the following criteria were taken into account: attainment of milestones; industry response; students feed-back; new curricula; papers published; further projects based on the knowledge accumulated in this project; linking the project with other programs (Erasmus program).

### 6.1 Dissemination/exploitation of the results, follow-up

The project was disseminated by the above-mentioned publications. It had also a strong feed-back from the industry. The follow-up of the project consists in industrial projects based on the achievements from this project. Another follow-up is the continuation of the present researches in other programs with European Union financing. In the next years the net-based collaboration will be developed at a large scale in order to reduce the dead-time in case of machine-tool mal-function. The need for well trained personal has increased the possibility for further development of the project's results together with the development of a training network for teleservice in order to overcome the distance between the manufacturer and the end-user, in case of small machine-tool mal-function (Fig. 1).

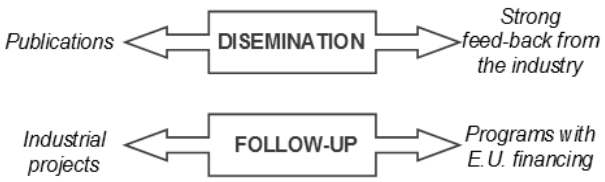


Fig. 1. Dissemination/exploitation of the results

### 6.2 Impact on strengthening of institutions

By having access to new technologies, the quality of graduates has increased. This fact has led to a better position of the Technical University of Cluj-Napoca in the research and academic field. The planned activities of the project have led to a higher degree of cooperation with the industrial sector. The collaboration with the industrial sector has led to a real emphasis for DSG (Fig. 2).

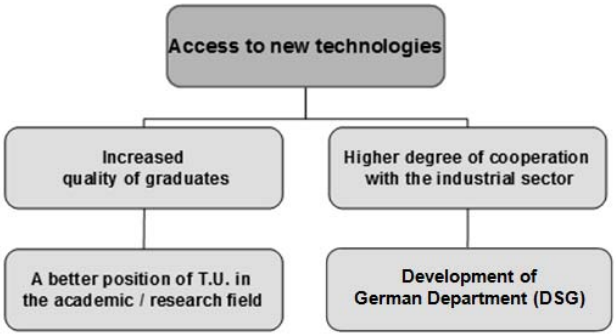


Fig.2. Impact on strengthening of institutions

### 6.3 Impact on national and international networking

In order to be up to date with the latest technologies and to have access to research facilities, a wide network offers the right response to the industry's and students'demands. The importance of networking consists in the fact that it can offer a better chance to be present in different parts of Europe and by this to increase the capability of DSG staff / graduates to be at the same level with the research institute's staff / graduates. The adaptation to an open market regarding the academic activity (Bologna process) brings the networking to a high level of consideration (Fig. 3).

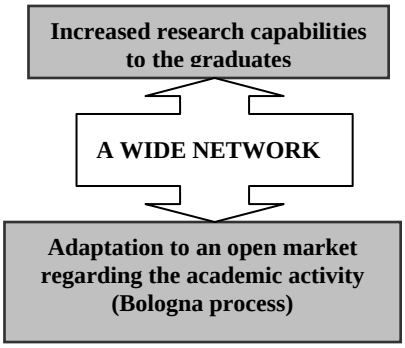


Fig.3. Impact on national / international networking

### 6.4 Impact on economy and/or society of partner countries

The deep transformations of the industrial sector and the use of German language as common language have significantly increased the possibility of collaboration. The best scenario to implement a new technology is based on re-arranging the industrial sector and the capability of having qualified people for this. The open market has forced the industry to be more competitive and innovative. The social benefits, which come along with the re-vitalization of the industry, have open a search for people with high qualification and the knowledge of a foreign language at a technical level. It is important to develop contacts among students, young researchers, and professors. In this way, they will be able to compare and enhance their environment to the benefit of the entire community (Fig.4).

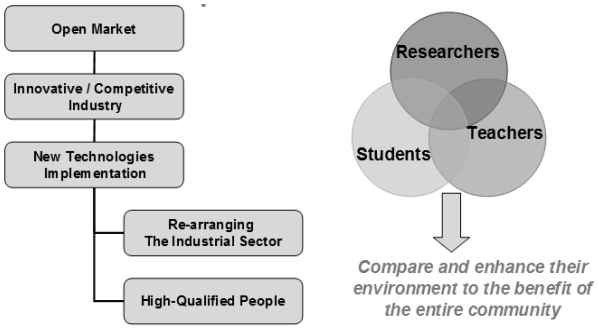


Fig.4. Impact on economy and/or society of partner countries

## 7. PERSPECTIVES FOR THE THE FUTURE

The scientific research in higher technical education plays an important role in the development of different sectors of life. The speed of changes is multiplied by the development of the E-technology. Transforming this technology in an instrument for the scientific research is an important option for keeping up. We are preparing a new project which proposes to establish the on-line communication as a base for better information in order to have better scientific research. On-line communication will bring an improvement in the scientific research in the fields of interest of the 3 or 4 partner universities. Beside the two existing partners (TUCN and ETH) we are looking for one or two new partners. By this cooperation, a multimedia lab will be set-up at the two new partner's universities, using the experience that the other two partners had in setting-up their multimedia lab. PhD students from the new partners will be trained in modalities to set-up the multimedia (necessary technology, installation etc) lab and how to use it. The PhD students from Cluj-Napoca will participate in the training bringing their experience in setting-up and for improving their knowledge in applying the technology.

Another objective of the project is to create a forum for opportunities for scientific research. PhD students from the partner universities will also be involved and will participate in a training regarding setting-up the electronic forum, where there will be defined the topics and structure of the forum, the policies for administration, the responsibilities for administration.

The new technology will be a support for students, PhD students and researchers to develop or extend their researches. The impact will be extended on strengthening the Eastern European partner universities, to a better position in the research and academic field. The new technology will be a support for the communication also with the business and industrial sector.

The project will offer to students and PhD students the chance to work for several weeks in a partner university. From the scientific and cultural exchanges created by the students' exchange and by using the new technology, there will be created a publication of the students regarding the scientific research. The new publication will offer the students the chance to publish their scientific research on one hand, and to collaborate with students from other universities on the other hand. The magazine will be published on-line on a quarterly basis or in accordance with the discussions at the preparatory meeting of the partners. The new technology will be a real help for these meetings offering the possibility for a large panel of actions: discussing, writing, sketching, planning, scheduling, editing etc.

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