INTERNATIONAL SUMMER SCHOOL AS A TEACHING TOOL FOR DEVELOPMENT OF STUDENTS' CREATIVITY

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ABSTRACT
The authors' of this paper present their experiences based on introduction of a teaching tool dedicated for students of a technical university, as well as for an industry. Its major objective is to develop students' creativity and to improve quality of their knowledge by solving technical problems and providing innovative solutions to the companies.
The above mentioned teaching tool is called International summer school of solving technical problems in mechanics, material sciences and transportation (ISS). It was created in 2000. As an annual one week workshop it is organized in the middle of September and it gathers around 50 students from different countries (e.g. Poland, Czech Republic, Slovakia, Portugal), companies from Poland representing different branches of industry (e.g. production of filling/closing machines, production of cookers, production and distribution of car parts), and university representatives.
The authors present Poznan University of Technology (PUT), Faculty of Machines and Transportation (FMT), where the project was introduced. There are described major assumptions and the most important steps of the initiative. The last part of this paper presents ISS advantages, which can be seen among students, participating companies and the university.

Keywords: teaching tool, students' creativity, technical problems, industry

1 INTRODUCTION

Most of the universities in Europe meet the problem of attracting candidates for being students and then keeping them, especially the best ones. The same situation is in Poland, where transformation processes and changes concern the higher education sector, too. Growing students' needs and expectations, as well as high potential of practical, usually sophisticated problems in industry, became an input to create an educational initiative called International Summer School of Solving Technical Problems in Mechanics, Material Sciences and Transportation. The project was introduced at Poznan University of Technology, Faculty of Machines and Transportation and it was also considered as an opportunity to innovate an educational process. PUT is located in Poznan, the town with population of 580 000 inhabitants and more than 100 000 students. Poznan is the capital of Wielkopolska, the industrial-rural region located in central-western Poland and is the third academic centre after Warsaw and Cracow, as far as the number of students is concerned. There are 17 institutions of higher education here, among others Adam Mickiewicz University, Poznan Academy of

Economics, Poznan Academy of Medicine, Poznan Academy of Agriculture and also Poznan University of Technology.
The tradition of the latter dates back to more than 100 years, when the first higher technical institution called Royal Higher School of Mechanical Engineering was founded. The State Higher School of Mechanical Engineering in the year 1919. The Higher School was given the status of university in 1945. Finally, during a number of transformations, the university received the present name in 1955. At the beginning Poznan University of Technology had 3 faculties: Electrical, Civil Engineering and Mechanical. Those faculties were transformed. The last one was changing its profile and considerably its present name i.e. Faculty of Machines and Transportation was given in 2000.
Today within the faculty one can distinguish Institute of Machines and Motor Vehicles, Institute of Internal Combustion Engines and Transportation, Chair of Thermal Engineering and Chair of Basics of Machine Design. The two fields of study which students can study are mechanics and mechanical engineering, and transportation.
Students' growing interest within the fields of studies became a challenge for the universities, including PUT and FMT. There is observed a trend directed to new mechanical solutions, logistics aspects and ecology. As the result, the number of specialization among fields of studies is still changing. Today there are offered eight specializations within mechanics and mechanical engineering field, such as: working machines, food industry machines and equipment, mechatronics, mass transportation vehicles, cars and tractors, internal combustion engines, thermal engineering and virtual design engineering; and five specializations within transportation field, such as: road transportation, railroad transportation, ecology in transportation, food transportation and transportation logistics.
To make the FMT more attractive some serial events for students are organized, which are as follows:

- Mechatronics Design Seminar,
- Academic Working Group in Mechanics,
- International Summer School of Solving Technical Problems in Mechanics, Material Sciences and Transportation.

The last two of the above mentioned activities are dedicated for students from both fields of studies. The Academic Working Group in Mechanics consists of 3 sections i.e. transportation, solving technical problems by computational methods and exploitation of machines. This event is coordinated and supported by the representatives of the faculty. The main activity is concentrated on the monthly sessions where presentations of research done by students are delivered. To summarize the main achievements, there is also organized Students' Research Review Session in May. Within this meeting the participants present results of their research. Those presentations are judged and the best one is rewarded. Selected results of the research are published in Working Papers of PUT.
The most important assumptions as well as the organizing details of the International Summer School of Solving Technical Problems in Mechanics, Material Sciences and Transportation will be described in the next sections. The last part is devoted to the main sources of success of the teaching tool.

2 INNOVATION PROJECT AS A TEACHING TOOL

The generation, exploitation and diffusion of knowledge are fundamental to economic growth, development and the well being of nations. On the other hand there is observed a societies' demand for sustainable development and high quality of products and

services. With this perspective it is essential to provide an education to perform research in technology, which meets all those expectations [4].

Central to this is the necessity of creating and implementing the innovations. Over time, the nature and landscape of innovation has changed but the need of innovation is constantly increasing. "The knowledge-based economy" is an expression coined to describe trends in advanced economies towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sectors. Knowledge and technology have become increasingly complex, raising the importance of links between companies and other organizations as a way to acquire specialized knowledge.

Those connections can be seen between universities and industry. However, in the literature their aim and specific role is emphasized in a different manner. R. Wellington and I. Thomas [11] present the course designed at Monash University, Australia, prepared for students from fields of industrial engineering, accounting, marketing and industrial design. The participants work within one semester on multidisciplinary project on real problems supplied by local industries. The goal of this initiative is to evaluate students' attitudes to other disciplines and to determine the effect of the close working relationships. The other perspective of the cooperation between university and industry present H.P. Jensen and M. Gundstrup [4]. The authors put a stress on the language skills, which are essential for engineers who are operating in the increasingly global environment. One of the most vivid aspects of this connection is described by K.M. Yusof at al. [12]. Their experience is an example of the efforts in prompting the implementation of Problem-Based Learning at the Universiti Teknologi Malaysia.

Owing to advances in technologies and greater flows of information, knowledge and innovation is more and more viewed as a central driver of economic growth. Yet, we do not fully understand how these factors affect innovation [2]. Moreover, it is still not obvious that from innovation is the straight way to achieve the excellence in business. To meet these needs halfway the International Summer School idea was risen and elaborated.

The organizers of the project put an attention on a self-learning. It comes through the learning by doing and interacting with experts. This kind of experimentation is defined by S. El-Raghy [1] as one of three of the most important quality engineering education skills. This is the time when learning, according to New Learning Paradigm presented by G. Hills and D. Tedford [3], is seen as an active process in which concepts are acquired, incorporated into appropriate schemes and tested in action.

Next very important feature of the workshop is a communication. The language, which is meant as the carrier of ideas during conversation or in writing [1], students operate is English. S. El-Raghy [1] indicates that it is essential for practicing engineer to know at least one foreign language and H.P. Jensen, M. Gundstrup [4] and M.J. Riemer [8] emphasize the role the English language plays for today "global" engineer.

During the workshop students can also improve their communication skills by working in groups. It is an input for a multicultural engineering workforce. Students have an opportunity to learn more about cultural differences, different points of view and to accept them.

Learning by experience, strongly recommended by K.J. McDermott, Ő. Gől and A. Nafalski [5], reveals among the group of students abilities of leaders, managers as well as effective team members. The effectiveness of the group strongly depends on the cooperation between its members. J. Trzcieniecki [10] adds to this another two aspects, i.e. communication and motivation. The last one factor is also mentioned as the most

powerful in goal achieving by G. Hills and D. Tedford [3]. Motivation can have different forms. It can be considered with a perspective of a personal benefit, as a group success.

3 CHARACTERISTIC OF THE INTERNATIONAL SUMMER SCHOOL

The project International Summer School of Solving Technical Problems in Mechanics, Material Sciences and Transportation was initiated in 2000. From that time, this annual 5-days workshop is organized in the middle of September. It focuses an attention on 40-50 students from Poland, Czech Republic, Slovakia, Germany and Portugal, each year.
The idea of the International Summer School is concentrated on cooperation between students and different local companies. There are two main objectives of the project. The first one puts a stress on development of students' knowledge and creativity. As future engineers students play there a role of complex problems' solvers [3]. The second one is dedicated to companies and it is concentrated on improvement of quality in different areas of company, e.g. production line, transportation process.
The companies represent different branches of industry. The problems they present are always vivid. The most important features of those subjects are as follows:

- precisely defined problem situations;
- interdisciplinary character; most of them link different aspects, i.e. technical, economical, organizational;
- a uniqueness, which is a result of a very specific problem formulation.

Students' potential can be seen in their solutions, which are expected to be creative, innovative, including all the goals, assumptions and thresholds.
An organization of the workshop starts at the beginning of the calendar year. It is a time when an organizing committee consisting mainly of Ph.D. students is formed. The inviting letters are prepared and send to companies, potential participants of this event.
Next, information about a workshop is delivered to students. It has different forms, such as meetings with them, posters and leaflets, distributed in the area of PUT. Potential participants can visit web site with detailed information about the ISS. There is also available a registration form which can be sent to the workshop secretariat.

4 ORGANIZATION OF THE PROJECT

The ISS always starts on Monday by a students' registration. The participants receive a work package including a detailed schedule of the workshop, technical drawings, companies' prospects, description of the problem to solve and other informational materials. After a registration the opening ceremony begins. During this time there is delivered an invited lecture. Main subjects of these lectures focus on the methodology of the engineering problems creative solving. There is also introduced an organizational information. The representatives of the companies present their problems.
Students are divided into the groups of around 3-4 persons. Each group is composed of the students representing different faculties' specializations. To provide an international character of the teams the ISS organizers' make an effort to integrate participants. As the result it is a principle that the foreign students join the different groups. Each problem is solved by two competing teams. Groups of students can cooperate, but the proposed solutions must be different and unique. It is also possible that one group is working on more than one solution of a problem, indicating on their advantages and disadvantages. Most of the teams start solving the problem from the brainstorming [6]. This creativity technique designed to generate a set of ideas for the solution to a problem lets them create different scenarios from evolutionary to revolutionary one. Synthesis i.e. combination of two or more ideas into a third one, is the most frequent

decision made after collecting all the new, fresh problem's solutions. Monday is also a day when in the evening a social trip is organized.
Within this workshop students visit companies (usually on Tuesday), especially those located in Poznan or nearby, learning more about them and the problem to solve. Students can also consult their ideas of solutions with employees.
A very important roles play university staff members, who are supervisors and advisers, very helpful in providing a methodological background to students' work. Participants can consult their ideas from Tuesday until Thursday. Thursday is also the last day of their work. Until 8 p.m. they are obliged to prepare and deliver the report to the Organizing Committee. This is a formal document, which finally goes to the companies. It contains the most important information of the project, such as title, team members, presentation of the problem and its solution, conclusions and enclosures.
Finally, in the last day of ISS (Friday) students present the results of their work. The time for each presentation is limited to 15-20 minutes, with 5-10 minutes for discussion. The number of presenters per group is not defined.
Each project is judged by a jury (commission), i.e. the representatives of the university and companies - 10 persons. One of the most important features is its objectiveness [7]. The members of the jury are not directly engaged in projects. They meet after all presentations and notes for each group are given. Similarly as in the case presented by T.D. Short, J.A. Garside and E. Appleton [9] (section: Assessment) the factors that are taken into account are as follows:

- creativeness and uniqueness (initiative and ideas),
- level of problem understanding (understanding of the work),
- advancement of the project realization (effort and overall achievement).

All those factors are listed in the form and each jury member precise its opinion giving the final note from 1 to 10. Then the points given by jury are collected in the final form and the average value is calculated. The maximum note the group can receive equals 10 points. The quality of the presentation is also marked and the notes are as follows: -1, 0 and 1. It forces students to show also their entrepreneurial skills.
The final notes are presented during the closing ceremony, which is on Friday afternoon. This standing party gives the frames to direct meetings between students from the one side and representatives of companies and university from the other side. The more advanced and more interested solutions are rewarded. All students also receive a certificate of participation with the note they get.

5 CONCLUSIONS

The FMT has developed an environment for both education and training, and the ISS became a successful innovation project. As a not obligatory event it is very popular within the best students' community. A lot of them participate at least twice. Based on the informal interview within the participants as well as authors' observations the reasons of success are as follows:

- students find ISS as a good opportunity to familiarize with practical problems, use their knowledge and start to use their creativity by solving real problems;
- this is a competence training for them, leading to even patented solutions;
- the solved project can be an inspiration and motivation for students to their master or even doctoral thesis;
- this is a good experience for them in finding a job, usually offered by the ISS participating companies.

This workshop became also very popular within companies because of:

- the opportunity for closer contact with university,
- the chance for finding interesting personalities among the students,
- the opportunity to recruit fresh staff members,
- finding many rational solutions of their problems.

And finally, there are also the benefits for the university:

- the attractiveness of this innovation means that there is a need of such initiatives;
- such popularity within students indicates that the delivering theoretical knowledge is not enough in their education process;
- students are looking for the cooperation with companies, where both theoretical and practical aspects are highly related;
- the problems presented by the companies are characterized by the complexity, linking technical, economical, and organizational aspects, giving the university audience an opportunity to see the current real problems occurring in economy;
- quality improvement of education at the FMT.

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