Reshaped Partnerships for Competitiveness and Innovation
Potentials in Mechanical Engineering

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INTRODUCTION

The competitiveness of European industry is a vital requirement for wellbeing in Europe. Companies have a constant need for product, process and production development. Most European higher education institutions (HEIs) provide high-quality engineering education and research, but their resources are not utilised to broadly support industry. The Reshaped Partnerships for Competitiveness and Innovation Potentials in Mechanical Engineering (RePCI) project collated the needs of industry and found new ways to respond to them in order to support the competitiveness of European mechanical engineering companies.

In the RePCI project, four main fundamental changes to university-company cooperation were promoted:
1) From random to strategic cooperation
2) A competency coaching programme for companies
3) A real-life problem-solving process to facilitate new industrial cooperation for students and staff members
4) Connections of the HEI network to provide a strong supply of expertise.

RePCI created new value-adding and goal-oriented operational and sustainable partnerships between companies and HEIs. New learning and teaching methods in companies and in HEIs were created and demonstrated during the project. Trained competency coaches from partner companies and HEIs analysed together the learning needs of the staff of companies and planned and monitored the implementation of tailored in-company educational solutions focusing on removing the bottlenecks for competitiveness. Real-life problem solving processes involved students solving problems given by the companies. A platform was built to serve the cooperation of HEIs and companies with an emphasis on easy access and the usability of the

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platform. All activities were done in international cooperation, bringing additional value to companies, staff and the students of HEIs. Close cooperation in the processes exposed both company and HEI staff (and students) to new ways of thinking and new ideas, creating a perfect environment for improving skills and new innovations [1].

The RePCI www.repci.eu) project was funded by the EU Lifelong Learning Programme and was carried out in 2013-2015. Four HEIs and five companies from four European countries (Finland, Germany, Hungary and Romania) took part in the project as full partners. The project also involved 11 companies and organisations from three European countries (Finland, Hungary and Romania) as associated partners. Full partners from Finland were JAMK University of Applied Sciences (the coordinator of the project, www.jamk.fi) and Elomatic Oy (www.elomatic.com), from Germany Esslingen University of Applied Sciences (www.hs-esslingen.de/en) and Festo (www.festo.com), from Hungary University of Miskolc (www.uni-miskolc.hu/en), Konecranes (www.konecranes.com) and FUX Zrt. (www.fux.hu/en) and from Romania Technical University of Cluj-Napoca (www.utcluj.ro/en) and SC Prototip SRL (www.prototip-construct.ro). The full company partners included small-and medium-sized companies (SMEs) as well as some of large companies. Two of HEI partners were academic universities and two of them universities of applied sciences. The partnership comprised a perfect variety of different types of organisations and professionals. This provided very interesting and fruitful cooperation with different perspectives on each aspect of the project.

All partners shared the opinion that all partners worked well together, learned a lot from each other, gained many new and useful experiences and wanted to continue cooperation after the project.

The partners cooperated intensively and felt that they were not only partners but part of a big family. This paper explains the main outcomes of the RePCI project, the difficulties encountered during the project and the future plans of the partnership.

1 STRATEGY-BASED COMPANY - HEI COOPERATION AND AGREEMENTS

During the RePCI project the HEIs and companies established and tested cooperation, which was driven by the strategies of both parties and guided by a shared understanding about the requirements of global competitiveness. The leading principle was to move away from the traditional way, and allow the human resources department to lead cooperation planning in a novel way with the main planning of cooperation being done by business line management. This was a “mechanical way” to shift the emphasis away from the human resource production (student for summer jobs and internships, final theses, etc. and recruitment of graduates) to broaden the range of cooperation. The new way also supports the learning of HEI personnel. The new management model for HEI-company cooperation was structured to be coherent, clear in communication and easy to reproduce in other HEIs and companies. At the beginning of the project, the present situation was recorded and analysed. The analysis frame was based on the novelty factors of the fundamentals of the project. These novelty factors are summarised in *Table 1*. The analytic approach examined the efficiency of the novel cooperation, reflecting the results for industrial competitiveness, the success of cooperation management, clarity and the accessibility of the forms of cooperation activities.

The experiences and outcomes were compared between participating countries. The benefits of international knowledge alliance were reflected against the need

and availability of expertise, as well as against the possible obstacles to cooperation in an international network.

Table 1. Novelty factors

	Traditional	New	Comments
Initiative	Individuals	Organisational	Cooperation is not depending on individual intentions but strategies
Driver	Opportunities	Strategy	
Industrial interface	Department of Human Resource Management	Business Line Management	Person's position reflects the interest and guides the focus of cooperation
Activities	Randomly scattered	Focused for achieving the strategic goals	
Operator basis	"One-man-show" Risk for continuity	Organised team Contacts shared Secured continuity	Cooperation is organisational growth by its nature
Outcomes	Sudden and often single activities like courses, seminars, laboratory tests	Activities in line towards increased competitiveness	Effectiveness of cooperation can reach new level
Staff members of HEIs	On their comfortable area	In new situation, facing challenging needs and requirements	Being out of the comfortable area provides development & freshness for teaching
Interface	Establishing external body to cooperate	HEI cooperates directly with its existing structure	Advances will be gathered into HEI operators instead of the outsourced organisation => direct gains for teachers, professors and other staff members

1.1 Strategy-Based Company-HEI Cooperation

One important outcome of the project was to start strategy-based company-HEI cooperation in all four partner countries. During the RePCI project, all company partners realised the potential of the HEIs, not only as a source of new engineers but also as important partners in a continuous dialogue of future competencies in the competitive global market of mechanical engineering products. All HEI partners realised the benefits of close cooperation with companies in collecting the newest information, updating their knowledge and teaching materials, and finding new possible project topics and other cooperation possibilities for students and HEI experts. Long-term and organisation-based cooperation greatly benefits both HEIs and companies. In the RePCI project, HEI and company partners managed to walk hand-in-hand in a goal-oriented and strategic way, which they all also wanted to continue after the project.

1.2 Strategy-Based Company-HEI Agreement

During the RePCI project, HEI and company partners in every partner country created and signed the strategical level bilateral cooperation agreement, which will help them to continue and deepen their cooperation even after the project. These strategy-based

company-HEI agreements also consist of annual company-HEI meetings where partners check the present situation together, study achievements and possible problems and plan new goals and future activities.

2 COMPETENCY COACHING

Competence development was and still is an increasingly vital part of the company's management and requires a new kind of leadership. The competence coaching programme is for persons representing the middle management of the company and whose duties include management and development work as well as the care of the know-how of the staff in their companies. This new type of coaching can be used to increase the competitiveness of the organisation [2]. It strengthens mutual understanding between companies and HEIs and deepens and broadens the relationships and cooperation at different levels of action.

The main idea of competence coaching is to convert the development of know-how and skills in companies to a systematic, continuous and natural part of operations based on the Competence Coaching Concept [3]. This concept followed the main goal of the RePCI project: to increase cooperation between HEIs and companies, especially companies in mechanical engineering, and to help them increase their competitiveness.

2.1 Competence Coaching Pilots

The idea of Competence Coaching Pilots was to train selected employees within the partner companies as competency coaches based on newly developed, special teaching material and methodology, in order to be able to identify the learning needs of the companies' personnel. Training materials for Training of Competency Coaches have been developed jointly by pedagogical experts at HEIs and by in-company trainers. These materials are easily adaptable for use in all partner countries.

During the RePCI project, the Competence Coaching Pilots were implemented in three partner companies: one Romanian company, Prototip, and two Hungarian companies, Konecranes and FUX. All three companies are SMEs and the main object of their activities is related to general mechanical engineering. Prototip is a Romanian company that offers a large variety of mechanical processing like shaping and turning, different milling, rectifications, accuracy processing, combined processing and the production of sub-assemblies and metal structures. Konecranes is the Hungarian representative of a multinational company dealing primarily with the production, commissioning, maintenance and service of different types of cranes and lifting equipment. FUX is a Hungarian company producing a wide range of ropes, cables and conductors.

In these pilots, the needs of the companies were analysed and the educational solutions for removing the bottlenecks to increasing the competitiveness of the company were identified and planned. Flexible in-company education solutions, which fitted the business idea and improved competitiveness were created and implemented in cooperation by company and HEI personnel. The competence coaching pilots provided new experiences of the different possibilities and ways of learning at work. This knowledge benefits the companies and HEIs.

2.2 Handbook for Competency Coaches

The Handbook for Competency Coaches was created during the RePCI project. This handbook is especially designed for competency coaches and aims at supporting competence management and leadership, as well as competence development efforts in organisations. The basic content of the handbook is shown in *Table 2*. The handbook is electronically available for all project partners and can be easily adapted to the modern electronic learning environment.

Table 2. The content of the initial Handbook for Competency Coaches

1. Introduction
2. Basic key concepts
3. The competence management model
4. The competence development model
5. Conceptualisation and foresight
5.1 History of the company and conceptualisation of competence importance
5.2 Foresight of Competences, and future competence needs
5.3 Mission, aims and strategy of the organization
5.4 Customers and services
5.5 Environment
5.6 Internal environment
5.7 Future competences – job-related skills & Human Resources
6. Identification and determination
6.1 Core competences
6.2 The workshop
7. Building the competence map
7.1 Defining the competence profile and the target level
8. Competence mapping
8.1 Self-assessment - supervisor evaluation
8.2 The Competence matrix
8.3 Identifying gaps
9. Competence discussions and/or performance appraisals
10. Actions in competence development
10.1 Methods of developing competences
11. Implementation of development actions
12. Evaluation of competence development/management
13. Commitment of personnel
13.1 What is motivation?
13.2 Sources of Motivation
14. Competence coaching – the final words

3 INTERNATIONAL RESOURCE POOL FOR COMPANIES AND HEIs

The HEI partners explored their resources in company cooperation, including human resources (professors, teachers and experts), facilities, laboratories, equipment, devices and services. During the RePCI project, an International Resource Pool was formed with the participation of companies and HEIs. This pool is easily available and helps to improve the competitiveness of companies. It also helps to improve scientific

capabilities, to give significant improvement in research and innovation performance and to build constructive partnerships.

3.1 The Needs of Companies for Cooperation and Fields of Expertise in HEIs

The needs of partner companies were identified and collaboration potential for HEI-company cooperation was analysed in each partner country. Partner HEIs explored and identified their fields of expertise, which could be used to increase competitiveness in mechanical engineering companies. The expertise was also explored based on the partnership as a whole to identify joint activities.

Partner HEIs established expertise-based entities comprising experts and professors, related research and testing instruments, laboratories and other facilities. All HEIs verified their fields of expertise and entities in order to connect their potential supply together. These entities formed the basis for the international supply of the support activities for industry. In this way the resources of HEIs were utilised more efficiently than if they had operated only nationally. The expertise-based entities had to be and must still be applicable to industry. It required expertise to be available in different forms depending on the needs of companies. Some of the activities could be student projects and some extremely demanding specialist work by professors in the form of consulting or research projects. All the supply had to be formed so that these activities were easy to explain, easy to understand and there was a clear process and “rules” for providing the activities.

Categorising of the activities in university-company cooperation meant the classification of the processes and their qualities. Reflected in novelty factors (innovative elements), the activities were in different process categories and, with the description of the qualities of each process, the analysis produced a taxonomy of university-company cooperation.

3.2 Planning, Monitoring and Evaluating the Implementation of Pilot Services

All HEI partners involved in the RePCI project initiated a series of meetings with potential new company partners where HEI expertise was presented. During these discussions and negotiations, business line management staff from both sides were present, which was a very important issue. After these meetings, HEI partners selected some activities to implement as pilot cases. It was crucial for each HEI partner to have more than one type of activity because it was necessary to leave the comfort zone of existing situations and to gather experiences.

The pilot cases generated experiences, after which:
• HEIs evaluated their processes and learning,
• Companies evaluated the effectiveness and usefulness of the activities.

The main activities (common research and development projects, technology transfer activities, student projects and internships and others) focused on achieving some strategic goals of companies working towards diversification of products and services. In some cases a continuity of cooperation was ensured. The cooperation was not dependent on individual intentions but on the goal-oriented strategy of the companies.

The following types of activities were executed during the RePCI project:
• Education and testing services
• Research and development for

- design, modelling and simulation of a manipulation system
- reducing noise pollution
- a system of measurement

As a result of the international resource pool work, a user-friendly database of all RePCI partners was created. The database can be found in the Outcomes section of the RePCI website www.repci.eu.

4 INTERNATIONAL PRODUCT DEVELOPMENT

During the RePCI project, we held four intensive international real-life problem-solving product development courses. The main idea of these single-semester company-HEI projects was for international student groups to find solutions to real problems given by companies. Eight students from two HEIs were selected for each project. The students were divided into two groups, both of which had four students from each HEI. The two groups were given the same problem by the same company and they competed against each other for the best solution. The winning group was selected by the company.

Two professors/teachers from two HEI partners acted as supervisors and two company representatives as tutors of the project. All real-life problem-solving projects consisted of two intensive weeks, the first one at the beginning of the project and in the country and HEI where the project company was situated. The second intensive week was in the middle of the project in another partner country and HEI. The intensive weeks made it possible for the students and professors/teachers to meet face-to-face and discuss any issues about the project, to make presentations and to get feedback on the progress and ideas of the project. The first intensive week included a visit and kick-off meeting at the project company, tailored lectures by supervisors and company tutors, much group work and also some social activities. During the project, all students and supervisors had a one-week trip abroad and, as they worked on the project, they gained basic knowledge of another HEI partner and country. They all became more international and learned from each other. Between intensive weeks and after the second intensive week, there were distance-learning weeks when students worked at their own universities and communicated with other members of their groups by using secure channels such as video conferences and Skype. At the end of the project, a final project meeting was held where both student groups made the final oral presentations of their group work results. The results were also written in a final project report by students. The company tutors chose the winning group and HEI supervisors gave credit points and grades for participating students.

4.1. The First Real-Life Problem-Solving Project with Company Festo

Before the first real-life problem-solving project started, HEI partners asked the companies for reasonable and suitable topics for the real-life problem-solving product development projects and also companies other than RePCI company partners, in every partner countries. After receiving the topics, the HEI partners discussed and chose together the most suitable ones for international implementation in the RePCI project. The topic for the first project, the so-called pre-project, was given by Festo (www.festo.com) from Germany. The headline of the problem was “Alternative solutions for pneumatic drives” and the task was to find simple and cost-efficient alternative solutions for pneumatic drives. The criteria were to solve the problems related to pneumatic drives (movement, force, available space, life-time, speed) and

to ensure that costs and production and energy consumption were as low as possible. Students and supervisors from Esslingen University of Applied Sciences, Germany, and from JAMK University of Applied Sciences, Finland, took part in this pre-project. At both HEIs, suitable student groups were informed about the possibility to apply for this project. After interviews of applicants, professors/teachers chose eight students from both HEIs to take part.

The selected students formed two international groups of eight students and both student groups chose their own project manager and shared tasks with other students in their groups. During the pre-project, the supervisors created the concept of and checklist for the real-life problem-solving projects and also collected and analysed the feedback from all students, supervisors and tutors.

4.2. Bosch Tool and Leon Group Projects

After the pre-project with Festo, two new projects were carried out in the same time. The topics for these two projects were offered by Bosch Tool (www.bosch.com) in Hungary and Leon Group (www.leongroup.com) in Romania. The topic of the Bosch Tool project was to “design a multifunctional battery garden tool” and the topic of the Leon Group project was a “Multifunctional robotic arm with two degrees of freedom”. Students and supervisors from University of Miskolc, Hungary, and JAMK University of Applied Sciences, Finland, took part in the Bosch Tool project. As the results of Bosch Tool project there were introduced “Morphy the Multifunctional Cordless Garden Tool” [4] and “Branch Shaker” [5]. Students and supervisors from the Technical University of Cluj-Napoca, Romania, and Esslingen University of Applied Sciences, Germany, took part in the Leon Group project. As a result of Leon Group project there was introduced “Development of a multifunctional robotic arm for in-pipe robots” [6]. In both projects the feedback from all students, supervisors and tutors was collected and analysed.

4.3 Heller Project

For the fourth real-life problem-solving project, the so-called post-project, the topic was offered by Heller (http://www.heller.biz/en/home/), in Germany. Students and supervisors from Esslingen University of Applied Sciences, Germany, and from JAMK University of Applied Sciences, Finland, took part in this project. The project topic was to “Design an automatic tool flow for a CNC training machine”. The feedback about this project from all students, supervisors and tutors was also collected and analysed.

4.4. Benefits of the Real-Life Problem-Solving Projects

In every project, students gained knowledge of how to carry out real-life problem-solving projects and how to work in an international group. They also increased and developed not only their professional skills but also their teamwork, project management and cultural and language skills. Students also received much valuable information about the project company. Many students were more than ready to consider taking their next international steps abroad, in terms of an exchange semester, practical training and/or final thesis. For company tutors, these projects were like a long interview of students. They had the chance to discover the differences between and skills of engineering students from two HEIs and two countries, to discuss with the supervisors of two HEIs and two countries and to identify future possibilities for cooperation with them. For supervisors, these projects allowed them to visit and

learn about the project company, to supervise some highly-motivated students and to identify future cooperation possibilities with the project company and HEI partner.

The feedback of all four projects from students, HEI supervisors and company tutors were very positive. All students mentioned that they were really satisfied and definitely wanted to take part in this kind of projects in the future and they also wanted to recommend this project to other students. The feedback of all four projects helped to develop the real life problem solving concept and to start the new projects after the RePCI project. More information about the four projects and the real life problem solving concept can be found from the Outcomes part of the RePCI web pages, www.repci.eu.

5 CHALLENGES DURING THE PROJECT

There were many challenges during the RePCI project. Some of them were due to differences in working cultures between partners, some because of cultural differences and some because of differences in English-language skills. There were also more challenges because this project was not a pure university project. For almost all company partners, this was their first EU and/or Lifelong Learning project, which meant that they needed much help, supervision, discussion and national meetings with the HEI partner during the project.

In the RePCI project, there were tasks and duties for every company and for every HEI partner. All partners understood the importance of their participation at every partner meeting but sometimes it was impossible for some companies to send any representative to a partner meeting because of an urgent and unexpected situation at the company. This made it more complicated to share all necessary information and get the opinion of every partner in time. After every partner meeting and video conference, a survey of all participants was done. Sometimes reminders were necessary to obtain important feedback from all partners.

6 SUMMARY AND ACKNOWLEDGMENTS

The RePCI project was a really fruitful and didactic project for all partners in spite of some difficulties encountered during the project, such as lack of time or money to carry out all required activities, differences in working methods, cultural differences, etc, but all important objectives were reached. Everyone learned from each other. Partner companies now know each other, their HEI partners, their facilities and cooperation possibilities and the same is true in reverse. Every partner has good possibility to identify new ways to cooperate with other RePCI partners.

It was great to find out that, after the RePCI project ended, all HEI partners were at once ready to start to create new EU-funded and other project applications. At the end of February 2016, one new project application was sent to the EU and in the end of July 2016 we got the feedback and acceptance message from EU. This means that all HEI partners of RePCI, one new HEI partner and six new company partners will start a new three-year project in the end of year 2016. The name of the new project is Smart HEI-Business collaboration for skills and competitiveness (HEIBus). The HEI partners of RePCI are currently creating another project application, which must be ready by the end of 2016. In both new applications, there are also new HEI and company partners from new countries, which gives a good opportunity to spread the outcomes of the RePCI project to a wider audience after the project. The contents of new applications are not the same as the content of the RePCI project, but they are

common to it in terms of internationality, innovation and competitiveness. A new and important issue is multidisciplinary HEI-company cooperation. In these new applications, we will concentrate on the whole Technology area, not only on Mechanical Engineering, and there will also be cooperation with the areas of Business, Management and Teacher Education.

We have also continued international real-life problem-solving projects since the end of the RePCI project. One example is this spring semester's project with Finnish SME Pikval (www.pikval.fi/en/). The topic of this project is "How to save the costs of daily work in supermarkets using technical solutions". Students and supervisors from Esslingen University of Applied Sciences, Germany, and from JAMK University of Applied Sciences, Finland, took part in this project. The basic information of this project can be found under "Activities after RePCI project" in the Outcomes section of the RePCI website www.repci.eu.

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