

Cooperation as a key element of Human-Centred Factories

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Abstract. This article deals with the necessity of education of employees and young people for the needs of Factories of the Future. People should be creating the core of enterprises and ICT should be only means for acceleration of enterprise's development. Below, the best practices are described for development of knowledge base of employees, students, postgraduate students and young scientific workers that are being trained for the needs of Slovak industry and for Factories of the Future.

Keywords: knowledge base, Factories of the Future, university students for practice, ZIMS.

1 Introduction

A key topic of today is the growth of technologies supporting so called digital humanism. It is very important, even necessary, to realize that in the period of growing manifestation of digital businesses and digital workplaces there are people and their potential being in the center of interest of the progress. The overall development is heading towards further facilitation and efficiency improvement of human activities, easing them of their burden, their collaboration with machines, robots and so on. Many enterprises have already got on the imaginary way of digitalization, many other still hesitate, and others will have to face it in the future. This way requires implementation of the right technologies in the right time and having the digital talents needed, that understand the new vision of enterprises and that behave differently, so called Generation Y.

The term generation Y marketing describes techniques that are used to build and promote product brands among the group of consumers. Generation Y is also described as echo boomers, net generation, web generation or millennium generation. People belonging to this group are primarily characterized by their positive attitude towards information technology and Internet, which provides them a lot of information about products and services. [5], [1]

2 Objective and methodology

The 21th century will be characteristic for the development and implementation of “intelligent solutions” in all fields of human life, not excluding the economy. Manufacture and technologies are becoming intelligent. Nowadays, intelligent production systems are mainly designed as so called agent-based systems (systems with distributed intelligence). To optimize the behaviour of a production system the methods of artificial intelligence are being used (expert systems, neural networks, genetic algorithms, etc.). These systems will require also new competencies and education of employees, and specially prepared staff. [1] These systems will also use new business models, providing supplies of products in extremely short period of time for the whole world. Factories of the Future will no longer need employees with low qualifications. Sophisticated technologies, computers, various applications and so on will be used in these enterprises that have to be operated by employees with university education. As the Fig. 1 shows, their salaries have been rising since 1980 at more significant pace when compared with salaries of less educated workers. [4]

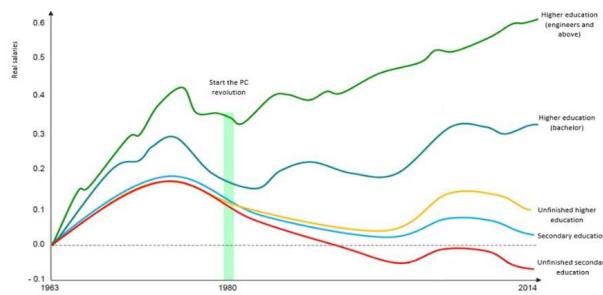


Fig. 1. Development of the real salary. [4]

The demand for educated workers will rise enormously. These days, mainly human resources officers from companies are complaining about the shortage of qualified workers. Some people even have university education, but their focus is not corresponding with the needs of the market (Fig. 2 shows an example).

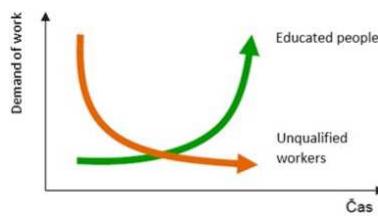


Fig. 2. The demand for educated workers. [4]

All this represents problems that will have to be solved in the future, if the mankind and individual states want to achieve sustainable development. In the University of Zilina, we are dealing with these challenges of the future. Within our region, several significant projects have been successfully organized, such as building the CEIT (Central European Institute of Technology), ZIMS (Zilina Intelligent Manufacturing System), joining the national project Universities as Engines of Development of Knowledge Society, joining various international projects for the development of level of education of the new generation of workers, etc. [4], [6]

The main objective of the ZIMS initiative is to create research facility of European level. Future development of the ZIMS is oriented on deciding factors of productive and efficient manufacture, which supports competitiveness of production base of the Slovak Republic. New intelligent production systems will require also new competencies of workers. Therefore there is, as a part of the ZIMS, also the module of innovative training of professionals and young research workers being created in collaboration of the CEIT, the Faculty of Mechanical Engineering and the Institute of Competitiveness and Innovations of the University of Zilina. The approach named the Learning University (Fig. 3 shows an example) uses the latest educational technologies and supports process of selection and long-term training of new research workers and professionals for business practice.

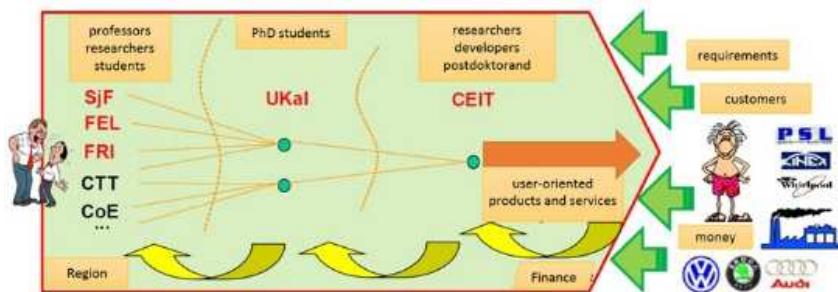


Fig. 3. Model of learning of university. [4]

The research in field of intelligent production systems and the training of new generation of workers touch also the research and innovative priorities (Fig. 4 shows an example) that have been defined by EFFRA – European Factories of the Future Research Association for the Factories of the Future.

Clusters are effective connection between the companies to each other and also with the wider surroundings: universities, banks, self-government, R&D etc. In the cluster concept the cooperation is the most important process. This kind of cooperation must be effective, long term running and serious. Another cluster feature is the repression of mutual competitive relations. The immediate competitors can join together and be strong on foreign or global markets, but they are still competing regionally. [8]

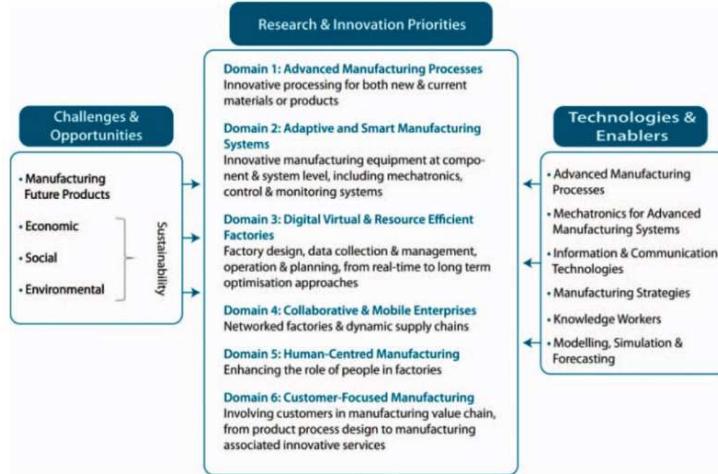


Fig. 4. The Factories of the Future roadmap framework (EFFRA). [2]

The realization of the research and innovation objectives of the Factories of the Future PPP will require a public funding budget of EUR 500 million/year which the private sector is committed to match with equivalent contribution in kind. The overall resulting size of the Factories of the Future programme within Horizon 2020 will then become EUR 7 billion. [2]

3 The main goal is the collaboration as a necessity of education of young talent

Knowledge creation, circulation and exploitation are the key elements of modern research and development (R&D) and innovation systems and underpin the evolution of so-called knowledge-based economies and societies. [3]

Žilina Innovation Policy (ZIP) was the first step to the region potential in-depth-analysis. It's a multidisciplinary team built with members of University of Žilina and partner organizations. Funding mechanism was provided by the EU and also from Self-Governing Region. It is the Regional Innovation Strategy creation process – these activities start in every Slovak region. Project starts in June 2005 within the 6th Framework Program of the EU. ZIP is focused on long-lasting activities bringing together R&D environment, business sector and the potential for innovation in Žilina region for continuous development. “Key objective of ZIP is to set up basis for regional institutional structures for innovation support, based on collaborative networks between existing institutions and organizations, and to implement a strategic innovation framework that will enable existing firms to introduce more innovation at all levels and create a positive culture for new entrepreneurs. [11]

Project partner organizations: University of Zilina, Žilina Self-Governing Region, Lower Austria Region, Region Södermanland, Sweden, BIC Group, Bratislava. Part-

nership and cooperation bring the ZIP project much further. Partners' skills and experience was significant help for project activities. Žilina Self-Governing Region adopted the project results as a strategy for development in the field of innovations and clustering. [8]

Main regional problematic areas:

- lack of access to qualified workforce,
- underdeveloped infrastructure (services, roads, railways etc.),
- small amount of making use of the EU funds,
- lack of cooperative activities.

Main regional positive areas:

- high credit of University of Žilina,
- demand for cooperation,
- high credit of R&D facilities,
- development in sectors of ICT, automotive industry, finance sector and tourism industry,
- clustering potential.

A survey of foreign literature and examples of good practice from abroad show the importance of various institutions involved in promoting brain circulation and reintegration of researchers as well as the existence of a unified re-integration system, which would be supported by the government of the country. However, the research conducted in Slovak enterprises showed that even enterprises themselves are not systematically prepared for adoption of reintegrated researchers. Therefore, the main identified problems and recommendations are focused on improving the situation directly in enterprises and on national and regional level. [9]

Nowadays are developed varied programs for young talent, for example PhD. students or young researcher. Good example is Israel. The Ministry of Aliyah and Immigrant Absorption offers new-immigrant and returning-resident scientists and researchers diverse forms of assistance for promoting integration into the R&D sector in Israel. The Ministry offers you, scientists and researchers, professional counseling and guidance, along with financial help, in order to facilitate and improve your chances of integrating into research and development in Israel's public and private sectors. The Center for Absorption in Science operates a variety of programs for promoting your vocational integration, and provides research grants, participation in salaries, and other forms of assistance. We believe that suitable professional support will enable you to integrate into the cutting edge of Israeli R&D, helping to lead the country to excellence in science and research. [7]

4 Best practice from Slovak republic

Within the Slovak Republic, under the auspices of the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Centre of Scientific and Technical Information, the national project University Students for Practice – Universities as Engines of Development of Knowledge Society was realized. Its objective was to adapt university education to the needs of knowledge society. It should be done with the development of innovative forms of education and development of active coopera-

tion of universities with private sector. And that while creating new fields of study and study programmes, and also while rationalizing and making the existing fields of study and study programmes of universities to be of higher quality. The cooperation should also be present in the process of education (Fig. 5, Fig. 6 shows an example). Also the engagement of universities in international cooperation should be higher.

The national project Universities as Engines of Development of Knowledge Society was created as a reaction to the need of better interconnection of university education with the needs of labour market, and to identify and support those fields of study that are the most desirable on the labour market in the business sphere. And that should be done especially in fields with high added value for the growth of the Slovak Republic. The national project was co-funded by resources of the European Union within Operational Programme Education. It was focused on students studying at universities in the whole area of Slovakia with exception for self-governing region of Bratislava.

Objectives set to fulfil the project were these: [10]

- 1) Adapt university education for the needs of knowledge society, i.e. the development of innovative forms of education, rationalization of study programmes of universities while making them of higher quality including the support of career consultancy.
- 2) Adapt university education for the needs of knowledge society, i.e. support of development of human resources in research and development.
- 3) Adapt university education for the needs of knowledge society, i.e. support of active cooperation of universities and private sector in creation of new fields of study and study programmes and in the process of education.
- 4) Adapt university education for the needs of knowledge society, i.e. increase in engagement of universities and other organizations of research and development in international cooperation and networks of development and innovations.



Fig. 5. Students on excursion in factory.

Projects of similar orientation are known in democratic world for a long time. An example can be found in Austria, which despite “crisis” managed to maintain the lowest unemployment rate in Euro Area. Austria and also Switzerland have highly-developed system of practical education of young people already from the apprenticeship. For example, the state supports practical education in family companies. These create the core of healthy economy. Many of them invest also in Slovakia. The highest numbers of students are required by big enterprises, but there are also many small

companies among applicants. According to the document of Ranking of Collaborations, the total number of offered positions was 3,024. It was a great opportunity not only for students and employees of registered enterprises, but also for teachers, because there works the triangle: student – teacher – lecturer form practice, in the project (Fig. 6 shows an example).

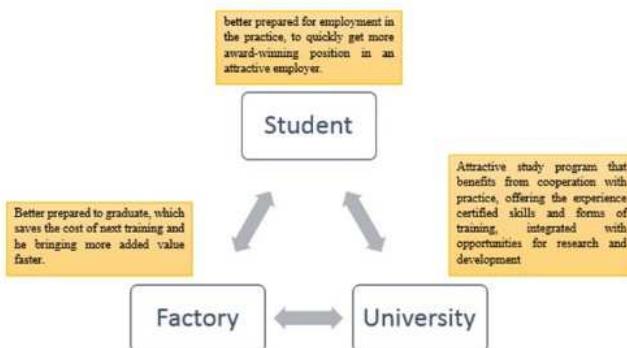


Fig. 6. Triangle of collaboration.

5 National project

The national project Universities as Engines of Development of Knowledge Society was created as a reaction to the need of better interconnection of university education with the needs of labour market, and of identification and support of those study programmes that are most desired by labour market in business sphere, especially in fields with high added value for economic growth of the Slovak Republic. It is co-funded from resources of the European Union and EUR 17.072 mil. was allocated on its realization within Operational Programme Edu-ducation and its part Reform of Education System and Professional Training.

The project was intended for all kinds of university studies – Bachelor, Master, Master of Science, and also for Postgraduate studies. Students could join the project in forms varying from short-term excursions to long-term internships in conditions of business practice. Students were given the task to process specific professional topics during the set period. Alongside, educational bases were created at universities that will bring the environment of universities closer to the conditions of practice. The project was implemented in the Region of Trnava, Trenčín, Nitra, Žilina, Banská Bystrica, Prešov and Košice.

The project was implemented in following four activities: [10]

Activity 1.1 Evaluation of efficiency of study programmes of universities from the perspective of current and possible future needs of labour market and cooperation with business sphere.

The objective of this activity was to create methodology and to evaluate all relevant study programmes within eligible universities from the perspective of priority needs of practice and predictions of development of labour market. Based on this, optimization of procedures of adaptation of university education to the needs of employers and prospects of economic growth of the country was designed. The need of practice is understood especially as those segments of labour market that nowadays and in the predicted development contribute to the growth of GDP most significantly and correspond with the priorities of the National Plan of Building of Infrastructure of Research and Development 2012. Besides implementation of created methodology for selected study programmes, the importance will lie on designs for adaptation of new contents and forms of studies in 100 highly-promising study programmes. It will create the basis for improvement of training of graduates and for increase of their successfullness in employment on the labour market, as well as for the increase of their actual value for the subject of labour market. Overall outcome of this activity should bring system recommendations in the subject area.

Activity 1.2 Active creating of networks of cooperation of universities and business sphere.

This activity is focused on creating and supporting the relations and cooperation of universities and private sector in the process of education. Activity 1.2 is the largest one from the whole national project. Its basic operation is creating prerequisites of practical education of university students and their engagement in recognition of real needs and real solutions of problems and innovations in practice.

Cooperation of universities and private sector will support creation of con-tents and forms of university education for real needs of labour market, as well as for the requirements of business sphere. There will be a space open for education of university students in real conditions of business practice. The intent is to create a pilot network of cooperation between universities (in case of already existing relationships, these will be supported and strengthened) and enterprises. An efficient system will be made, in which students will be educated in pre-agreed conditions and will acquire practical competencies directly in business practice or in established educational centres at university facilities of schools participating in the project. That will create the prerequisite of their efficient employment on the labour market after finishing their studies.

Activity 1.3 Improvement of education content and support of innovative forms of education for the needs of labour market in selected promising fields of study.

The purpose of implementation of this activity is to improve university education through implementation of innovations into education content, as well as to support innovative forms of education for the needs of requirements of labour market in selected promising study programmers.

Activities will bring the content of education closer to the needs of business practice and to the requirements of labour market. Because of providing educational contact centres with modern educational tools according to the definitions of needs by business practice, the improved educational content and form will be made for students of promising study programmes in compliance with rules of the Operational Programme Education and with European Social Fund. These meth-ods will correspond directly with requirements and needs of labour market. Alongside it will be possible to educate students of universities engaged in the national project in men-

tioned contact centres using innovative forms of education, and also by direct engagement of students in solving of tasks at the work-place during their educational stays in the enterprise.

Activity 1.4 Popularization of studies in promising fields of study and of cooperation between universities and business sphere.

The essential element in this part of the project is, by using standard communication procedures, to create prerequisites of increased society-wide interest in the national project and in its individual intentions in a targeted way, and to increase awareness of needs of interconnection of education with the needs of business practice. Another objective is to increase the interest of universities and enterprises themselves in mutual interaction and creating of prerequisites for cooperation oriented especially on utilization of development potential of young people for the economic growth and increase of competitiveness. Following that, objective is also to motivate students of first years of universities, studying in promising or more challenging study programmes, to actively use possibilities of the national project. So that they, through using practical education, find already as fresh graduates fast and promising employment on labour market and in business. Within individual media activities, also opinions of experts on positive system changes in university education will be presented.

6 Experience from universities

Study programmes integrated into technical sciences are the ones dominating in cooperation with business sphere, and that especially study programmes from:

- Technical university of Košice,
- University of Žilina,
- Faculty of Materials Science and Technology in Trnava (Slovak University of Technology),
- Slovak University of Agriculture in Nitra.

The highest number of collaborations with enterprises is reached by study programmes focused on technical sciences – 75 %, the second place is taken by study programmes focused on economic sciences – 11 %. Top 50 places in the Ranking of Collaborations are represented by these companies (cooperation between company and university was mutually confirmed):

- Falck Záchranná, a.s.,
- Volkswagen Slovakia, a.s.,
- Vysokoškolský poľnohospodársky podnik SPU, s.r.o.,
- INA Kysuce, spol. s r.o.,
- PSA Peugeot Citroen, Slovakia, s.r.o.,
- Zlatý ónyx Levice, s.r.o.,
- Prvá zváračská, a.s., Bratislava,
- Swedwood Slovakia spol. s r.o., o.z. Spartan,
- Spinea Technologies, s.r.o.,
- CEIT Consulting, s.r.o.,
- Železnice Slovenskej republiky.

Table 1. Number and percentage of identified collaborations from the perspective of orientation of study programme.

Orientation of study programme	Number of collaborations	Percentage
Technical sciences	2,076	75%
Economic sciences	316	11%
Natural sciences	80	3%
Agricultural-forestry and veterinary sciences	80	3%
Military and security sciences	72	3%
Health care	57	2%
Social sciences	46	2%
Other	28	1%
Sciences in culture and art	0	0%

Table 2. Number and percentage of identified collaborations of students.

Degree of study	Enterprises (%) [*]	Enterprises (number)
II. Degree	85	305
I. Degree	49	174
III. Degree	27	96

*As enterprises had a possibility to choose multiple answers simultaneously, cumulative percentage exceeds 100%.

6.1 Experience from Faculty of Mechanical Engineering, University of Žilina

Practice in particular enterprises is always a valuable school for university students, but also their inspiring ideas can be a contribution for companies. That is how post-graduate student MUDMILA Závodská summed up the significance of interconnection of academic community and industry. She has tried already during her studies work in particular companies in Slovakia and also abroad, and she guides other students to it too. Young resident of Žilina, after finishing her studies of management, wanted to focus more on manufacturing and logistical processes, therefore she continued at the Department of Industrial Engineering of the Faculty of Mechanical Engineering at the University of Žilina. After she attended practice as an intern in CEIT in Žilina, she had the opportunity to try out the optimization of material flow also in German city of Mönchengladbach.

She was studying management as a field of study at the Faculty of Management Science and Informatics, and already in her third year there, operations management, manufacturing processes and especially logistics have attracted her attention. She wanted her diploma thesis to be “tailored” for a particular enterprise. Therefore, she addressed Scheidt&Bachmann Slovensko, company being in a long-term cooperation with the University of Žilina. It is a daughter company of German manufacturer of systems for car parks, railway security systems, petrol stations and equipment for passengers (Fig. 7 shows an example).

After starting her postgraduate studies, she has decided for “logistical” topic, for her doctoral thesis she is studying progressive approaches to the design of logistical strategy of an enterprise. After she had acquired valuable practical experience in the CEIT, which focuses among other things on optimization of material flows, Ludmila used the opportunity to take a look into a foreign enterprise.



Fig. 7. Ludmila Závodská in front of the seat of German company.

She was working at the department of production planning of railway security machinery, specifically signalling devices, where Kanban was being implemented. The manufacture of signalling lights is not complex. The more complex issue lies in the fact, that multiple components for these lights are produced by the enterprise itself. So, multiple Kanban circles are being used among storehouses and various workplaces. The principle how the system works: Kanban activates movement, manufacture or supplying. The objective is to make the flow of material in the manufacture clearer, and to eliminate storehouses gradually. However, she added, that during the seven-week-long practice in German enterprise, among other tasks she was also dealing with designs of material flow between daughter company in Žilina and parent company. It was not just the logistics inside the enterprise. She was also designing the system of communication between German enterprise and the one in Žilina. In Žilina, cable ties are being produced that are used in the manufacture of signalling devices in Germany, and it is necessary to transport them between enterprises somehow. Ludmila has created several designs using Kanban system that were approved by both sides. Based on advantages and disadvantages, managers now have to pick the most suitable one.

Before starting the practice, after consultation with the contact person in the German enterprise, the schedule of the practice was set, which included following activities:

- familiarizing with the logistical strategy of the enterprise,
- analysis of material flows,
- working with the SAP system,
- implementing the Kanban system,
- designing the improvement of organization of workplace from the perspective of material supplying.

The set goals were met from the student's point of view. While processing the given tasks, she could use her experience and knowledge gained before, but on the other hand, she had a sufficient support from employees in cases, when professional advice was needed.

Before the practice, student expected that she would get know how logistics work in a big foreign enterprise. These expectations were fulfilled. Besides activities, she had scheduled, she has learnt much more about the business logistics. Employees of the enterprise have explained her processes of material receiving, dispatching, movement of material through production, and so on. They have also explained her how information flows go, how material is planned, and how these activities look in information system SAP. She also had an opportunity to see what technologies are being used in storehouses, e.g. automated storage systems.

Alongside working on specific tasks, it was interesting for the student to observe some particularities she has not come across in another enterprise, for example, glass door on offices, or monitors turned the way that anyone could see what was on the screen. She was communicating in English, so except professional knowledge she sees improvement in the language as a big benefit too. She recommends this kind of opportunity to every student because the time spent directly in the manufacturing enterprise gives fully new dimension to the knowledge acquired in the school. And the contribution can be mutual, not only students will gain practical experience, but also their inspiring ideas can, on the other side, represent enrichment for the enterprise.

After completing the practice, it was needed to fill the final report from the educational stay abroad. This report included, except verbal description of the completed stay, also questionnaire, which was a feedback for CVTI. Each student, completing internship in Slovak or foreign enterprise, could express his opinion on how it went. The questionnaire-included questions like whether the practice fulfilled expectations, what the level of competencies before and after the stay was, what competencies were being developed during educational stay abroad and with what result, what the biggest benefit of the educational stay is, and so on. Based on results of these questionnaires, it is possible to see the satisfaction of students with the educational stay.

Conclusion

The national project Universities as Engines of Development of Knowledge Society during its implementation fulfilled its objective and met the set indicators and outputs.

It was successful also from the perspective of its acceptance by all engaged groups, as demonstrated by the active participation of target group of students, as well as the support of representatives of universities, of most significant enterprises and employers' associations in the Slovak Republic, representatives of MERDaS SR and experts from MLSAaF SR or professionals and laic public.

Continual effort to build new and sustainable research-development ecosystem, which will be able to prepare experts for designing and operation of Factories of the Future, is being produced in cooperation with the University of Žilina and CEIT. First results of the system approach to the creative environment of the future can already be seen in Žilina in these days. The new initiative gives a real form to creative ideas, in which first-class results of own innovations, or also of the training of new generation of workers for Factories of the Future, are being integrated.

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