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Engineering education in the context of labour market requirements and expectations - Polish experiences

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ABSTRACT: The article outlines the determinants of the process of engineering education in Poland. The most important issues, challenges and problems connected with higher education are described, such as educational trends, the low quality of education at schools (in the opinion of academics), demographic gaps and the lack of monitoring of labour market requirements. The article highlights system solutions of engineering education and activities that support engineering education such as career service, technology transfer, co-operation between employers and universities, and research on matters relating to students' and graduates' careers. The author has discussed the following research question: what are the determinants and perspectives of engineering education in Poland?

Keywords: Engineering education, graduate careers, labour market requirements, career service

INTRODUCTION

In the situation of economic crisis in southern European countries, engineering education becomes more and more important. Problems with the employment of young people and discrepancies between labour market needs and requirements, and university graduates' expectations are expanding the role of educational engineering. Structurally, the Polish system of higher education comprises 470 academic institutions, including 132 public universities.

Presently, there are over 200 fields of study, including unique fields and macro-fields. The biggest group of students study economics and administration (23%). Distribution of enrolments in other fields is as follows: 14% study human sciences, 12% - pedagogy, 9% - engineering fields, 6% - medicine, 5% - computer sciences, 5% - welfare studies, 4% - law and 3% - environmental studies. Students can complete a degree with the title of engineer at 22 technical universities in Poland. This level of education is available to everybody who has completed the matriculation examination at the required level.

Despite many activities (e.g. fields promoted by the Ministry of Science and Higher Education - students who decided to study those fields receive a scholarship), active engagement of career services, co-operation with industry and employers, and the functioning of scientific technological parks and incubators of entrepreneurship, engineering education is not so popular and it does not match labour market requirements. Engineering fields, and mathematics and natural science fields are not very popular among graduates of secondary schools.

The Ministry of Education is to blame for the increasing number of students of human sciences. The educational aspirations of young persons have a range of determinants, and the concept of a graduate career is not created on the basis of labour market needs, requirements and expectations, but according to actual trends in their interests. The present trend that *everybody can study* has brought many negative consequences for education, society and the national economy.

According to the author's research, the most important problems connected with the trend that *everybody can study* are:

1. Increasing number of lower secondary school graduates choosing general secondary schools and willing to continue their education at universities. Students and parents feel that university is a *school* and do not understand

the difference. At school, teachers teach, explain, help as much as possible, provide additional consultation and take care of the students. At university, academics demand first of all independence and the ability to self study and achieve a knowledge background. Because of demographic gaps, universities have to promote their services and lower recruitment requirements to accept students who would not have been accepted ten years ago. Consequently, universities (on average, but not high-level universities), have lowered their requirements of students' abilities and expectations. Further, the depreciation of higher degrees has a negative influence on all economic sectors [8].

2. Decreasing interest in vocational education. This is a consequence of educational trends. The labour market's search for workers with individual qualifications, knowledge, attitudes, skills and ability to work in teams reveal the need for workers with diploma training but without higher education knowledge and higher education qualifications. No sector of industry will manage without qualified workers (unqualified labour makes mistakes and generates losses). In particular, they can stimulate or disrupt the stimulation of innovation and competitiveness. These specialists do not have to have completed university education, but social pressure is so strong that qualified workers are no longer respected as much as in the past.
3. Lack of information of labour market requirements and insufficient co-operation between the labour market and educational system. At the school level, the co-operation does not work properly but at the university level it develops appropriately (e.g. the role of career services described below).

In the article, the author also discusses the research question: what are the determinants and perspectives of engineering education in Poland?

ENGINEERING EDUCATION IN POLAND - SYSTEM SOLUTIONS

Engineering education in the Polish educational system is comprised of two levels. The first one covers three and a half years of study and ends with the preparation of an engineering project and a complex examination. Students work on an engineering project during two semesters in co-operation with a manufacturing company. The examination includes problems and questions about the whole study programme. Students that complete all requirements receive the title *engineer*. The second level lasts a year and a half and is finished by the preparation of a Master's project and a Master's examination. The Master's project is based on studies in a company and should present an individual solution worked out by the student.

Academics in universities of technology point out that preparation of secondary school graduates for studying has declined considerably. Their knowledge is comparably poorer than the knowledge of students ten years ago. The lower standards of mathematical competence required by students make teaching more difficult and students, therefore, require additional, supplementary courses. The second problem is connected with students' competence and skills. They are not able to work individually and independently.

Students treat university as another type of school and do not feel the difference between secondary school and studying at a university. Schools do not teach students how to study, but rather give them ready-made solutions. Moreover, school students do not have much opportunity to undertake creative experiments, usually because of a lack of finances for well equipped laboratories and modern equipment. On the other hand, university departments offering difficult and unpopular fields are forced to decrease the level of education. Those departments would not otherwise have had much problem with recruitment and providing jobs for its scientists.

The most important threats for the innovative economy are the demographic gap and the lack of an entrance examination (recruitment is based on high-school matriculation examination results). The demographic gap that presently exists in secondary schools is also becoming visible at the university level. Despite the educational boom (*everybody is going to study*) the structure of universities is very wide and universities try to recruit as many students as possible.

The number of places at university depends on the structure of employment and is mostly constant but the number of good candidates (with good results at the matriculation examination) is decreasing in accordance with demographic trends. Entrance knowledge and the skills level of future engineers (first year students) has been declining for ten years, ever since the first lower secondary school graduates (completed secondary school education) entered universities.

Treating the education of engineers as a process based on entrance and exit provides information about the knowledge, skills, behaviour and attitudes, which can be transformed, developed and evaluated. All educational processes aim to prepare graduates to enter the labour market, economy and society. Basically, the lower the knowledge and skills of first year university students, the more difficult it is to educate a good engineer.

Polish engineers strengthen the innovative process, especially in the creation and transfer of technology and the Polish economy can become more innovative. Innovation and competitiveness are the determinants of a functioning and developing economy. Most research on measurement systems of innovation include aspects of the importance of higher education [6][9].

According to Murat Ar and Baki, there are seven drivers of innovation that describe creative capability, which is, among other things, connected with employment creativity [7]. Barro, R.J. [1] and Crescenzi [2] highlight the role of investment in human capital and education on economic growth.

Particular workers with their individual qualifications, knowledge, attitudes, skills and ability to work in teams can stimulate or disrupt the stimulation of innovation and competitiveness. They are:

1. qualified workers (vocational school graduates) - users and exploiters of technology and innovation, and
2. engineers and technologists (technical university graduates) - creators and initiators of technology and innovation.

The innovative economy requires both groups of workers, and both groups have considerable influence on the creation of an innovative climate. New technology and new results are mostly created and designed by well educated, qualified and skilled university graduates. No sector of industry will manage without qualified workers, and some need them more e.g. individual production and the mining industry, and some less, e.g. the IT industry or mass production. The most advanced production technology needs highly qualified professionals as unqualified personnel make mistakes and generate big losses.

The staff most-required by industry are (according to the author's research): welders, metalworkers, electricians and electronic specialists - so not entrepreneurs (managers and administrators) but those who can design and make a numeric tool or device, and can repair electronic elements. Maintenance services are based (or should be based) on qualified workers.

Engineers cannot be replaced by economists, sociologists, financiers and entrepreneurs. The specificity of engineers' work requires the creation of innovation in current work and looking for new ideas and solutions. Moreover, that work is connected with considerable risks, responsibility and the necessity of making quick decisions.

It is important to focus on Prof. Dietrych's model of meeting the needs and requirements of the process [4][5]. According to the model, there are the following engineering activities such as rp – indication of need; pr – projecting; ks – constructing; wt – production; ep – exploiting. This is a closed cycle.

New technologies created by innovators are inputs into the economy by production. Qualified workers put the project and construction into activity by producing particular products and services. Rp – indication of need is a task of both groups. Turbulence in any activity disrupts the functioning of the closed cycle, particularly, the quality of education have a great influence on the functioning of the cycle.

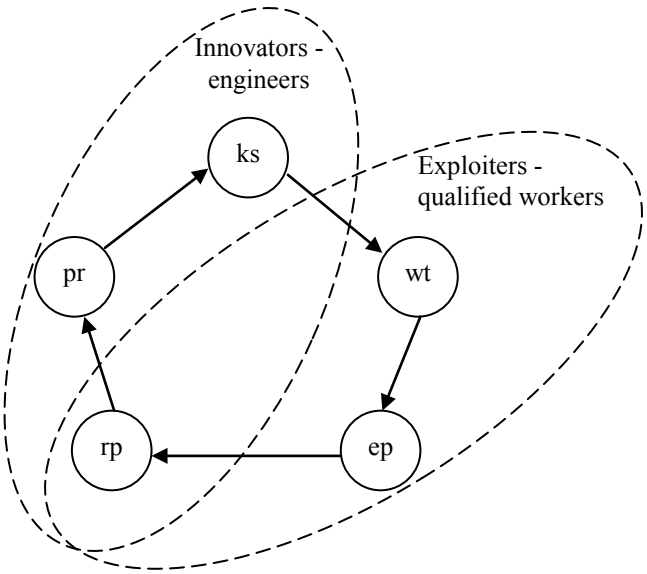

Figure 1: Role of innovators and exploiters in Prof. Dietrych's model of meeting the needs of the process [1].

There are several advantages of the Polish universities of technology systems that have a positive influence on engineering education:

- Autonomy in the creation of programmes (syllabi).
- To complete subsequent semesters, students must prepare projects in several subjects. They involve careful study, and are concentrated on improvement of existing results and seeking new ones - creative and innovative.

- Cooperation with business (industry), ability for students to undertake vocational training in companies from a wide range of economy sectors.
- Strong positions of career service offices at Polish universities. They play the role of recruitment offices, cooperate with employers, organise training and offer vocational advice.
- Creation skills of independence, creativity, decision making, dealing with risk during the whole study process.
- Increasing the role of technology parks (transfer of technology).
- Promotion of enterprise among students (spin - off and spin - out businesses).

The education process of engineers is strongly connected with additional, supplemental activities presented in the data flow diagram (DFD) as presented in Figure 2.

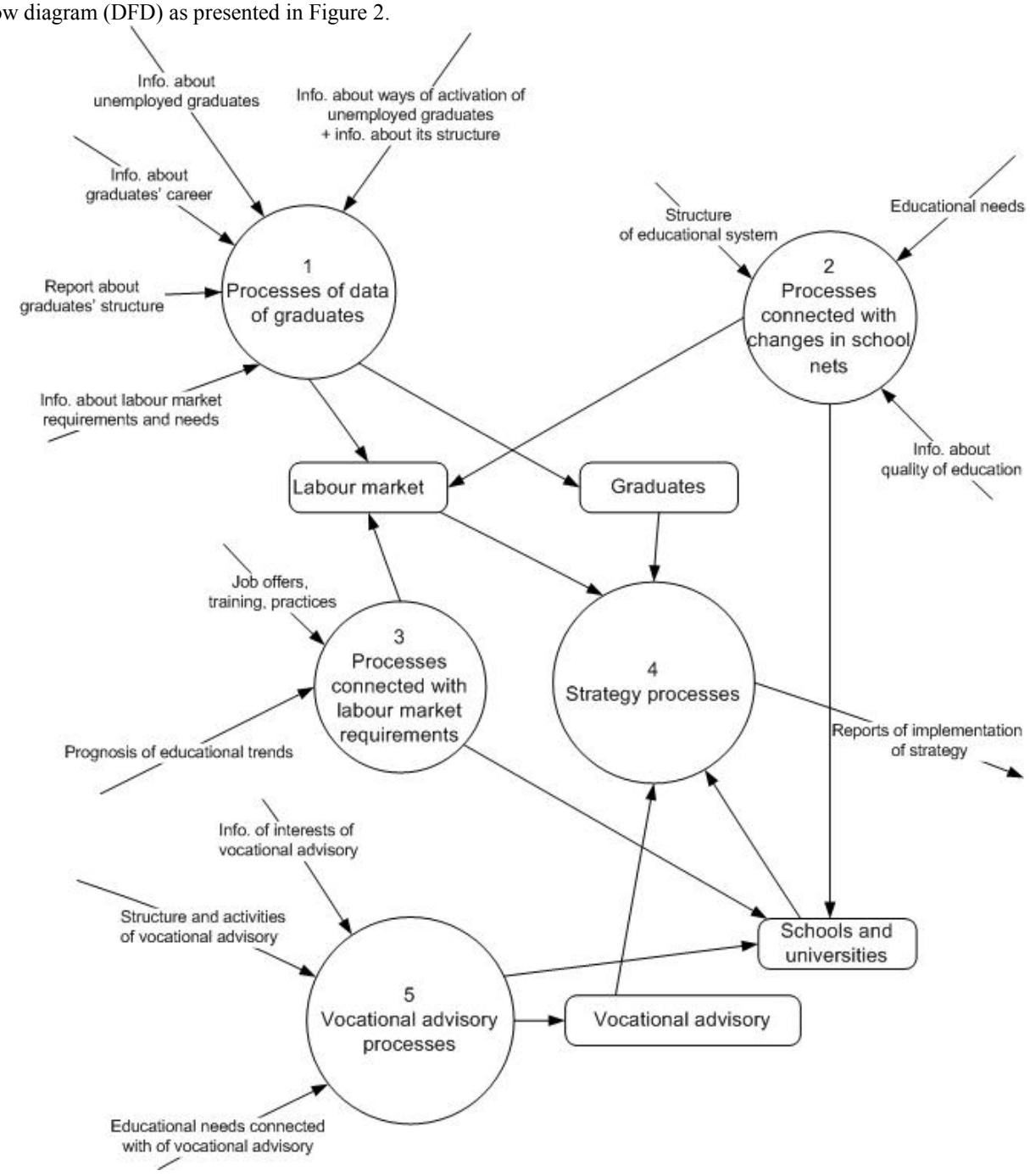

Figure 2: Data flow diagram of the engineering education process.

As presented in Figure 2, the process of engineering education is supplemented by five integral, partial processes. They describe the areas as follows:

- schools (responsible for preparation school students to continue education in universities);
- the labour market - its abilities, requirements, needs;
- graduates and types of information about their career and feedback information from the labour market;
- vocational advice and co-operation between the labour market and university;
- strategy of engineering education created by the university.

There is a lot to be done in Poland to integrate educational needs, aspirations of school students, university students and graduates with labour market requirements, abilities and expectations.

EDUCATIONAL ASPIRATIONS VERSUS LABOUR MARKET EXPECTATIONS AND REQUIREMENTS

Research on 649 secondary school graduates in Poland was carried out, including final year students from lower secondary schools and all types of secondary schools (basic vocational schools - BVS, technical and vocational secondary schools - TVSS, general secondary schools - GSS and general secondary schools with a profile - GSSP). The research was carried out in three schools of each type between March and May 2011, the measurement tool was a survey (see Table 1).

Table 1: Educational aspirations of secondary schools graduates.

Educational aspirations of graduates	Basic vocational school	Technical and vocational secondary schools	General secondary schools with profile	General secondary schools
Work in learnt occupation	35.80%	36.19%		
Work in any job	31.48%	37.14%	16.87%	20.00%
Emigration for work	20.99%	22.86%	12.05%	20.00%
No plans for future (answer: *I do not want to do anything*)	0.62%	3.81%	1.20%	0.00%
Start own business	8.02%	13.33%	4.82%	4.00%
Continue education	36.42%	43.81%	96.39%	60.00%
Undecided	7.41%	8.57%	2.41%	16.00%
Other plans	3.70%	3.81%	3.61%	12.00%

The workflow diagram, created on the basis of research, presents tendencies in the educational area and in the labour market. School graduates mostly wish to continue their education at university (on average 67%), while 21.42% intend to enter the labour market. The diagram does not include those who continue their education at other schools. In Poland, since 2005, people without any occupation and with a general education (general secondary schools and general secondary schools with a profile) belong to the group with the highest rate of unemployment, that is, 15%. The best situation in the labour market is for engineers - this is where the most job offers are. Unemployment is higher among graduates of human sciences.

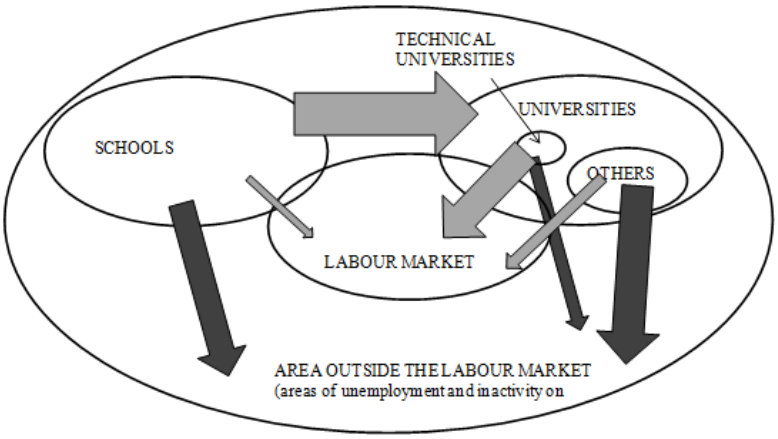

Figure 3: Workflow diagram of graduates.

There is a strong network of career services in Polish universities. The next part of the article describes their role in the education of engineering graduates. Most processes in DFD (Figure 2) belong to career service competence.

BETWEEN GRADUATE AND EMPLOYER: THE ROLE OF THE CAREER SERVICE

In the structures of Polish universities, the career service (CS) has a major role to play. Its fundamental activity is the promotion of students and graduates into the labour market and to help and support them in their search for a job, according to their abilities and expectations. Students need professional help in identifying their preferences and looking for individual career paths. The career service is a platform between students, graduates and employers, and this is a

much greater role than the one that is typical of an employment agency. Studying provides professional knowledge and skills connected with a particular field of study but educational programmes do not include courses in entrepreneurship and preparation for the move to the labour market.

Taking the Silesian University of Technology in Poland as an example, the career service has several functions, divided into several groups:

- Students/graduates area;
- Employers area;
- Integration of the university into the labour market;
- Advanced courses and support for students/graduates to prepare them according the needs of the labour market;
- Analysis of labour market.

The students/graduates area includes advisory functions connected with the preparation of application documents, self-presentation, searching for jobs and identification of individual skills and abilities. There are simulations of job interviews and personality training: investigation of strengths and predispositions, development of communication abilities and team work.

The Employers area means co-operation between the University and employers. Employers enter into agreements with the University with the assistance of the career office. Employers place their job offers and vocational training with the career office. Students and graduates have a good opportunity to look for a job and training, and employers have the opportunity to find workers with specific knowledge or skills. Strong integration is developed through *entrepreneur market*. This is organised as an annual meeting of employers and students. Moreover, active career services carries out many training projects co-funded by the European fund system. These projects provide additional training for students concentrated usually on entrepreneurship, business, transfer of technology and economics. These aspects are not included in the regular programme of engineering education but are needed in the labour market.

The final task of the career service is responsibility for labour market analysis. The career service carries out research on graduates' careers by maintaining good contacts with employers. The service receives information on graduates' qualifications and adjustment to meet employers' expectations. Research on graduates provides information about the quality of education and of the situation in the labour market from the graduates' point of view.

CONCLUSIONS

The educational system does not exist in isolation and the innovative economy demands good co-operation between the labour market and the educational area. This is understood at the university level, where co-operation between science and industry develops quickly and effectively.

Threats for engineering education:

- Secondary school graduates plan their career incidentally, without taking labour market needs and future employment into account.
- Vocational advice at the school level that is ineffective and organised without co-operation with employers.
- Demographic gap.
- Low quality of school education.

Perspectives and concepts of development:

- Increasing the number of placements for engineers.
- Cooperation between universities of technology and employers - strong position of careers service offices.
- Creation of scientific technology parks to transfer knowledge and technology from university into business (increasing number of spin out and spin off companies) [3].
- Continuation of the high level of education and not lowering student entry requirements.

The education of engineers covers many activities not directly connected with higher education (e.g. vocational advice, additional business training and research on graduates' careers). Strong and permanent co-operation between universities of technology and labour market institutions creates cluster initiatives in engineering education. It helps to make education and academic research adjust to expectations of economy.

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BIOGRAPHY

Agata Pradela graduated with a PhD from the Silesian University of Technology in Poland in 2008. Currently, she is an Adjunct at the Institute of Production Engineering at the Faculty of Organisation and Management at the Silesian University of Technology. Her research is connected with various aspects of education. In particular, she is interested in vocational education at the school level and engineering education in conjunction with the labour market. Between 2009 and 2011, she worked in the Career Service at the Silesian University of Technology and was responsible for the coordination of students' business training at five Silesian universities to make university education more effective and attractive for employers. Since 2010, she has been the project manager of a research project entitled: *Creation of the cluster initiatives in an education system*, financed by the Ministry of Science and Higher Education in Poland. She also takes part in many research projects connected with education and problems of local government employment in her province.