

# **We need engineers!**

## **How to promote technical studies**

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### **Abstract**

This article presents the initiatives undertaken by two large Polish technical universities to increase the interest in technical studies. Only initiatives which were not typical and which required the introduction of organizational solutions are presented.

The European universities have been struggling for many years with insufficient number of candidates for technical studies as well as with their insufficient technical knowledge. In Poland in 2005 a new system of recruitment for studies was introduced. In this system, the results obtained during matriculation i.e., results from the exam from foreign language and from two subjects chosen by the graduate constitute the basis for admission to the universities. Unfortunately, some years ago on the basis of a decision taken by the Polish educational authorities, mathematics ceased to be an obligatory subject during matriculation. Due to this fact, the level of candidates' preparation for technical studies from subjects such as mathematics, physics and chemistry is very low. Decreasing number of abiturients, which is linked to demographic depression, is another unfavorable factor.

The authorities of the Technical University of Lodz (TUL) and the Warsaw University of Technology (WUT) have undertaken numerous initiatives to maintain their leading position in the educational market. Apart from typical activities such as promotional actions, organization of "open doors" and educational fairs, visits in schools or preparatory courses, a lot of effort was put into more sophisticated promotional methods.

*Keywords:* recruitment, promotion, Internet studies

## **1. INTRODUCTION - SHORTLY ABOUT THE CHANGES IN POLISH EDUCATIONAL SYSTEM**

For many decades the engineering profession was very attractive to young people and it was often selected by them. The national industry was developing without a technical and technological cooperation with Europe because of the geopolitical conditions, but on the other hand, relatively small number of universities resulted in a strong competition for admission. Until late 1970s of the last century, the study programs were imposed by the authorities responsible for higher education. Seventeen technical programs were promoted by the Ministry of higher education.

In the 1980s there was a liberalization of the study programs for engineers. Higher education institutions could create different study programs and obtained a right to set limits for the number of new students. At the beginning of 1990s, together with political changes, the universities in Poland received a lot of autonomy which resulted in a rapid creation of many private universities. As the result, the number of students grew from 400 thousand in 1989 to 2 million in 2007. The biggest growth was in the field of humanistic studies, which became the largest part of the offer of the 300 newly created private universities [4]. The number of fields of study grew up to almost 130. Already at that time first signals appeared showing the difference between the preferences of the candidates in the choice of a field of study and the needs of the labor market. A more detailed analysis of this phenomenon will be presented below.

The late 1990s and the beginning of the 21<sup>st</sup> century was the beginning of an implementation of the Bologna Process. Polish higher education system started solving problems that were common in many European countries

and the emphasis was put on the adoption of the system of education that would address the needs of the European labor market and especially on a harmony between the offered fields of study and the possibilities of employment of the graduates. The Act on *Polish Higher Education* from 2005 introduced another big reform. Following its recommendations, from the academic year 2007/2008 the universities have introduced three cycle system. The transition to the three cycle system required thorough and carefully thought out preparation of new study programs. TUL and WUT are among the universities which offer modernized study programs..

Unfortunately, the efforts made by our universities combined with the development of the infrastructure and research base, which enable preparation of an attractive didactical offer are not visible enough to young people from the secondary schools as they are still more likely to choose education in the humanistic fields [3,4].

The studies offered in foreign languages together with some currently fashionable fields of studies such as architecture, biotechnology, informatics and civil engineering are exceptions to this rule.

**2. GENERAL DESCRIPTION OF THE SITUATION IN TECHNICAL STUDIES**

As mentioned above, the decrease in interest in engineering studies is a phenomenon widely observed in Europe. The decrease in the number of students in technical and pure sciences (below the 10% of total number of students) happened in the majority of European countries [7] but not in China or India, where every year there are hundreds of thousand of graduates with engineering diplomas.

At the beginning, this phenomenon was not very visible due to the crisis in the Polish industry caused by the transformation of the economy from a central to a liberal one. It was accompanied by the growth in the number of offered fields of studies and it led to the increase in the number of students and the number of candidates and problems of quality was overcome by a general optimism derived from a higher rate of graduations.

Today there is no doubt that this situation needs decisive actions and public universities, which by nature are less flexible because of their traditions and seize, are to be more aggressive and have to fight strongly for the minds and souls of the graduates of secondary schools. However, not only the number of candidates, but also their quality and level of knowledge must be taken into consideration.

The Polish labor market suffers from a shortage of laborers as well as highly qualified specialists.

The boom in education in the field of marketing and management led to the infusion to the labor market of a large number of graduates in this field. However, there is a question. Who will be managed by these qualified people if this is not accompanied by a growth of the industry? The statistical data are really frightening- the engineering and technical students constitute only 13 % of all the students (see Fig.1) [3]. The owners of the companies complain about the lack of the IT specialists, civil engineering specialists, electrical and production engineers. The migration for financial reasons deteriorated the situation. Well educated graduates of the Polish universities, mainly technical ones, find attractive and well paid jobs abroad. The Polish market alerts that “it’s time for engineers” and although the universities are ready for that, the young people from secondary schools are not likely to change their preferences.

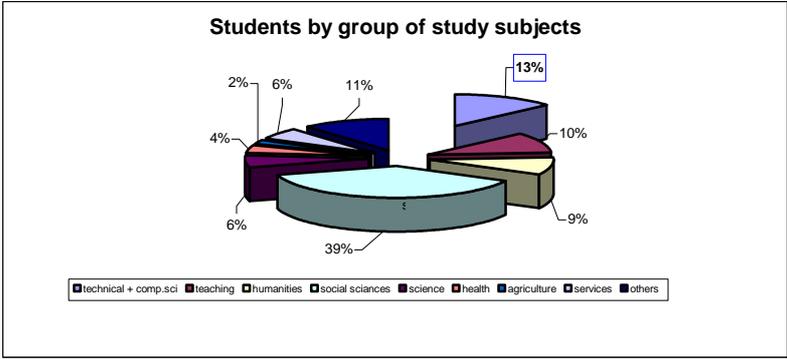


FIGURE 1. Students by group of study subjects.

### 3. WHAT ARE THE MAIN REASONS FOR PROBLEMS WITH RECRUITMENT FOR TECHNICAL STUDIES?

There are numerous reasons for why technical studies do not seem to be attractive to young people. We would like to concentrate on the most important ones. The first one lies in the mental sphere- there is a deeply rooted opinion that engineering studies are difficult, much more difficult than the humanistic ones. It has to be clearly stated that this opinion is quite true. Among other reasons of such situation, one can cite a high degree of abstraction and separation of education from the everyday experiences and interests of young people. The universities must do their best to alter this situation. They also need to start arguments with the way media show the engineering profession and fight with its social and material depreciation.

There are also more objective reasons. The demographical data show a dramatic decrease in the number of 19 year old people who are potential candidates for the studies (Fig.2) [5,6].

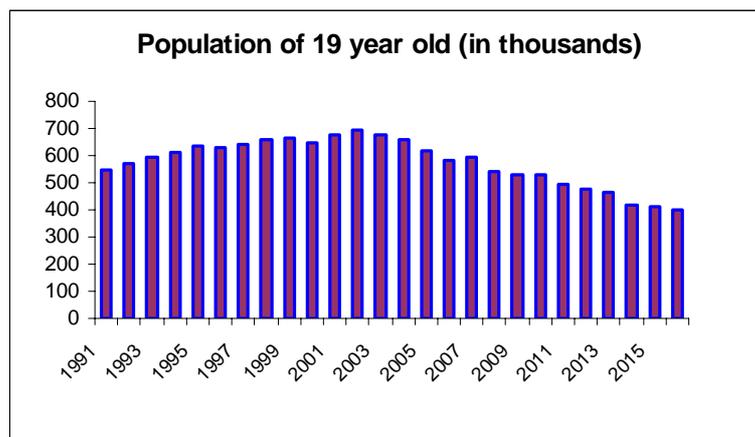


FIGURE 2. Demographic data and a prognosis for years 1991-2017.

As can be observed, after having reached almost maximum level of seven hundred thousand in 2002, the population of the 19 years olds is diminishing rapidly, to about 380 000 in 2017- which means that the number of potential candidates for studies will be lower by a factor of two.

Thus, the problem of a decrease in the number of candidates appeared a few years ago. At first it influenced a number of small public universities, which in the last 5 years decreased the number of recruited students or have even ceased education in certain programs. Some of these universities were closed down. Large and public universities do not suffer so much from the decrease in the number of students, although for example at WUT, the number of candidates decreased by 20% but it is still two times larger than the number of places available. However, having such perspectives, the technical universities are to do their best to fight for the best candidates to study pure science and engineering. The competition in the education market will widely increase in the coming years and it will not always be fair.

Coming toward an end, one must mention one more reason for this alarming situation in the market of engineering education. The secondary level of education has for many years been reducing the numbers of subjects devoted to pure sciences such as: mathematics, physics and chemistry- which are subjects necessary in the education of future engineers. A good knowledge of these subjects is necessary for admission to the technical universities. Endless experiments and changes in the study programs were also detrimental to the recruitment efforts. After 1980s, when the programs were vastly expanded and enriched with new and ambitious topics in mathematical analysis, algebra, set theory, probability theory, the situation has changed dramatically from one year to another.

Fifteen years ago there was a turning point in decreasing the role of teaching mathematics in general education in secondary schools, when the state authorities decided to give up the requirement of taking mathematics during the final exam of the secondary school. In the year 2002 there was an attempt to reintroduce this requirement but it was turned down due to political reasons. This was a critical point that made the technical studies difficult since there is an obvious correlation between the knowledge of mathematics and the future effects of the technical education. This correlation is confirmed by the results of the mathematics tests which have been conducted for many years among the first year students.

In connection with the fact that ministerial authorities promise to reintroduce the obligation to take mathematics during final exams in 2010, the rectors of the technical universities hope that this will lead to the growth of popularity of technical studies and that better candidates will be attracted to these studies.

#### **4. EXAMPLES OF ACTIONS TAKEN TO POPULARIZE TECHNICAL STUDIES**

Since we are already familiar with the main reasons for the problems with the recruitment for technical studies, it is time to present some examples of the actions which were taken by TUL and WUT, which are not only to increase the number of candidates but also to encourage the right ones. The last effort stems for the fact that quite a large number of students accepted for the technical studies, seem not to be suitably qualified. Lack of competition to enter the university in less popular fields of study enables students with insufficient knowledge to be admitted. The basic and traditional action is the promotion of educational offer of our universities. Traditional methods of promotion, in order to be effective, must be supported by unconventional ones, which aim at reaching suitable high school students.

As mentioned above, both universities have done enormous work on preparation of new study programs taking into account the needs of the labor market. They have very good didactical and research base and they enable their students to do practical training both inside the country and abroad. Both technical universities have a leading position among the students who most often participate in the studies abroad. They both enable students to do complete study programs in English and in TUL, also in French [8,9]. That constitutes just an element of an offer ensuring quality of education offered to future engineers. These aspects of the university life are widely advertised by means of easily accessible and widely available marketing and advertising tools .

Our information booklets present our offer in an easy and comprehensive way emphasizing successes and the fact that our education offer is unique. Bearing in mind the importance of the internet, TUL has created a dynamic portal which became an important element of information management.

Both universities actively participate in the Educational Fairs during which young people from secondary schools can get familiar with the offer of studies and they can also see laboratories and obtain information from older students about the aspects of students' life. In TUL and WUT here are numerous active international students associations which promote a model of modern, open-minded engineer, open to the world and new technologies. These young people can be treated as "live advertisement" traveling all over the country and all over the world with their brilliant ideas and projects. They receive numerous prizes in different national and international competitions. The effort made by TUL is also visible in our position in IAESTE practical trainings- in the last 9 years almost 1200 students of our University gained experiences thanks to these practical trainings. The exchange organized by TUL can be compared with the exchange in the framework of IAESTE by the whole countries such as Norway, Sweden, Mexico, Japan and the students of TUL constitute the majority of the exchange in Poland.

The Labor Fairs organized by the Career Offices also seem to be vital for the promotion of technical studies. Participation of a considerable number of companies who want in this way to find their perspective employees or trainees shows that such people are widely needed in all sectors of the economy.

##### **4.1. Promotion with „diffusion effect”**

Apart from direct promotion targeted at potential engineers, both universities try to exert influence also on external environment offering participation in projects aimed at different social groups.

Among such actions one should mention "Open Universities" which were inaugurated in 2006. Although they are not directly connected with normal studies, they fulfill a very important role. First of all, they enable hundreds of people with the average age of 60 to be active when they finish their professional careers. These universities offer courses connected with technology, environmental protection, culture and art, psychology, sociology, finances and law, but also computer science and foreign languages. Big demand for the services offered by the Open University of TUL resulted in an increased popularity of the university in this social group. The grandparents of our future candidates become for their grandchildren "promoters" of our University.

TUL also tries to be very active in the projects that aim at popularizing technology among the inhabitants of the city. For this reason, the Center for Science and Technology called Experymentarium was created under the patronage of the University. It was opened in 2007 in one of the most popular places in Lodz- Manufatura- which is a revitalized 19th century post industrial complex. Following the world wide trends, the main feature of the project is the interactivity of exhibited objects. The staff of TUL promote the usage of the exhibited objects among young people to make this activity attractive. Lessons in schools during which pupils learn trough experiments are another element of expanding the educational offer.

Both universities participate every year in numerous big events which lead to popularization of successes in technical fields such as Festivals of Science, Technique and Art. The pupils and inhabitants of the cities can for a few days participate in different lectures during which complex problems are explained in a comprehensive way. Laboratories organize different shows in order to inform the participants that technical universities conduct researches in different fields and their effects exert impacts on our everyday life.

#### **4.2. Improvement of knowledge of the secondary school graduates**

The universities support future engineers in improvement of the level of knowledge by organizing for them courses in basic subjects (mathematics/physics). In this way the pupils from secondary schools are less likely to have problems with these subjects at the beginning of their studies. Such courses are conducted by departments and different organizational units but also by students' organizations.

Warsaw University of Technology (together with the Technical University of Wroclaw) have been organizing national courses in mathematics and physics. At the beginning the courses were conducted by excellent teachers and were transmitted by television. Later, the tasks for self work were published by the press. The young people were sending the results of their tests to the academic centers, where they were checked and corrected by academics and were sent back with the correct answers and comments. In recent years a portal was created through which the preliminary phase is organized (choice of tasks, checking answers) and only a selected group of about 150 persons with the best results meet at WUT where their work is assessed by professors from this University. People with the best results have free admission in the selected fields of study.

In September 2007, after two years of intensive legislative and preparatory work involving preparation of buildings, laboratories and academic staff, TUL has opened a Public Secondary School (Liceum). This is the first Secondary School created by a technical university.

Seventy eight pupils started their education during the first year. They were chosen among the best candidates. There were 13 candidates for one place. The combination of secondary school with a university was very promising for pupils and their parents, but also for the authorities of the region and town. This secondary school offers more hours of mathematics, physics, chemistry, computer science and foreign languages. The Secondary School uses the knowledge and competences of academic staff and the university's research base. It is expected that the school will well prepare the graduates for further engineering studies.

The last initiative undertaken by TUL is Lodz Children University. It will be inaugurated in March 2008 and targeted at children 7-12 years old. The University staff has prepared special lectures for them where the level is adjusted to the age of the participants. The lectures will be connected with the world of fairies with an involvement of popular characters from cartoons and children books. In this way, the University wants to combine entertainment with advertising education and will encourage children to discover the world and to explore the world of science. The Technical University of Lodz is the first technical university in Poland which encourages children to experience studies. In a few years these children can become the best candidates for the technical studies. There was a huge interest in this initiative. We accepted about 600 children. The lectures will be also transmitted by the Internet permitting those not accepted because of the lack of places to participate. This initiative was also supported by the authorities of the Lodz Region as it enables a popularization of knowledge and technology among parents and younger children.

#### **4.3. Methods to reach and select "suitable" candidates**

One of the methods to accept suitable candidates for the studies is a preliminary selection at the secondary school level.

Many different competitions are organized in Poland in the subjects such as mathematics, physics, computer sciences, chemistry and others. Similarly, the organizations of employees also organize their own competitions (Competition of Young Masters of Technology). In order to use this method of choosing the best and the most determined candidates for a given field of study, the universities have introduced the rule of easy admission for the best participants in different competitions. The winners in the national competitions have free admission do any department and field of study. The participants of the last phases of the competitions can enter the departments which offer similar profile of education.

The universities and the departments themselves also organize local competitions (mathematics, chemistry, physics or biology). The competitions organized by universities or the departments enable the winners and participants easier admission to the universities.

For example, the Faculty of Process and Environmental Engineering of TUL has been organizing for the last 18 years a seminar devoted to the protection of the environment. This seminar is a attracts about 350 pupils from

gymnasiums and secondary schools from Lodz and the whole region. The best works are awarded “Green index” and the winners gain free admission to this department. A similar promotional event is organized by the Faculty of Material Technologies and Textiles Desigsn which offer unique education in Poland.

Technical University of Lodz decided to replace occasional events by a permanent action proposed to secondary schools by means of a project “Technical University of Lodz is open all the time”. The idea of this action is very simple: young people visit different places at the university until they find a suitable department. People appointed in every department organize special meetings to meet specific requirements. These can include lectures on certain topics or visits to the laboratories. The aim of these actions is to change the opinion that technical studies are very difficult and not humanistic at all. We would like to show that this idea is not true. It is very important that pupils from secondary school realize that the road that leads to an engineering profession goes through interesting lectures and activities and that learning mathematics and physics can be fascinating.

**5. STUDIES VIA INTERNET**

For many people, especially from small towns, study in a “remote” city can be difficult to start- often for financial reasons. Similarly, many people already active in professional life who want to improve their qualifications cannot start neither full time nor evening/weekend studies. For those people WUT has created a Center for Distance Learning. The Center for Distance Learning and the new model of studies aimed at people living outside Warsaw, the disabled, working group or Poles living abroad was introduced and first students enrolled for the academic year 2001/02 [1,2]. The Internet and multimedia have become the basic tools of a new model of education – known as SPRINT (in Polish: Studia PRez INTerNet). The educational offer of the Center for Distance Learning includes evening/weekend studies for a degree of engineering (BSc equivalent) and master of engineering (MSc equivalent) via the Internet.

**5.1. The academic year in the SPRINT model**

The academic year is divided into four half-semester: autumn, winter, spring and summer. Each semester lasts 8 weeks and finishes with two-week examination sessions. Figure 3 shows the structure of the four-year studies. The division of the academic year into four and not two parts enables students to study no more than two subjects at the same time.

There is a three-level system of study:

- Fundamental courses, 1 year, whose program is fairly universal and basic; within the course student is required to obtain credits in 4 Major courses, 4 Minor courses and 2 Laboratory sessions, which gives minimum of 67 cps.
- Departmental courses, 2 years, whose program is dependent on the chosen faculty; student is required to obtain credit in 8 Major courses, 8 Minor courses, 2 Laboratory sessions, and take a language course, which gives 124 cps.
- Specialization courses, 1 year, one faculty can offer more than one specialization; student is required to obtain credit in 3 Major courses, 3 Minor courses and present a diploma thesis, which gives 57 cps.

Three faculties of WUT, Electrical Faculty, Faculty of Electronics and Information Technology and the Faculty of Mechatronics offer such courses.

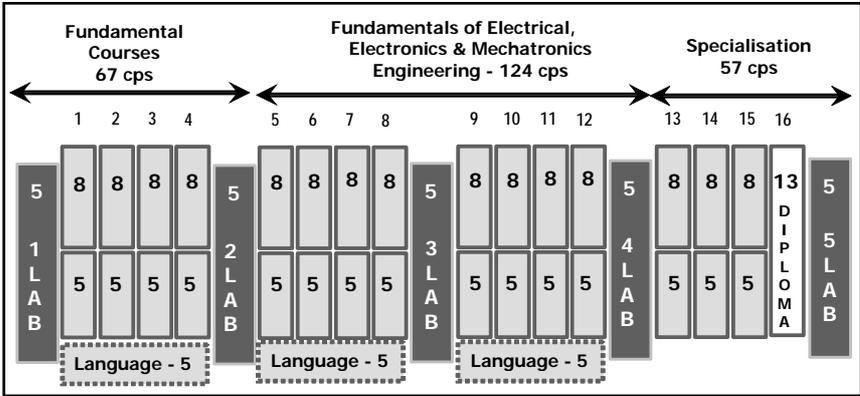


FIGURE 3. The structure of the four year studies

It was assumed that the course material would be provided in an electronic form on a CD-ROM. CD-ROM containing lecture and auxiliary materials would be provided with the HTML browsers Acrobat Reader and, according to the possibilities and needs, applications for reproduction of multimedia files.

## 6. CONCLUSION

The problem with candidates for technical studies is not only a problem peculiar to Poland. It is present in all the European countries but in the countries of a “new European Union” it is more visible. Demographic problems connected with a financial migration (up to 10% of people in the production age) cause deficiencies on the labor market, for example in civil engineering. Our universities have to change not only their way of operation but also the way of thinking. In many cases, the universities have to give up their traditional habits. Direct actions, described above, are a good step, but modern approach to the offered programs and their attractiveness are also important. Traditional lectures, tutorials and seminars must slowly be replaced by the team work and project-based work. Good modern engineers must also have good knowledge of the economy and possess managerial skills. The fight for potential candidates seems to be very strong among Polish universities but the future of the country and the economy depends on getting the right people to study at the technical universities.

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