ENGINEERING EDUCATION AS A STAGE FOR SUCCESSFUL PROFESSIONAL CAREER

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ABSTRACT

The paper presents some statistical data about changes in engineering education and women engineering students in Bulgaria and European Union as whole. The results confirm sustainable trends in education enrolment and women in engineering.

Analyses of the reasons for the trends are presented. On the basis of our research on engineering education methods to adapt it to the needs of modern economy are proposed. Industry needs and employability skills are identified.

This will help young engineers see their role in the society and motivate their desire to define and set objectives. Understanding business processes is a necessary condition for successful professional career.

Keywords: higher engineering education, interdisciplinary, women, employability

1. INTRODUCTION

The economical development of every country in the contemporary environment is depending on knowledge and skills on labour force with higher qualification. Underlying foundation of innovation must largely come from the field of engineering.

Nowadays engineers need to have an opportunity to focus on the pieces of the business puzzle and their place there. This will help them see their role in the system and motivate their desire to define and set objectives. The first to promote the idea that an engineer should be an economist, too, was Henry Towne in as early as 1886 [1]. He proposed that engineer should have a "practical knowledge" of all those aspects of business that today's manager's take for granted. "The Engineer determs not only how physical problems may be solved, but also how they may be solved most economically…Therefore, the Engineer is, by the nature of his vocation, an economist" [2].

In the decades that followed these observations, there was an increase in specialization and division of labour, complemented by hierarchical organizations in firms, in academia and in other institutions – quite in contrast with this perspective.

Today's development is in the opposite direction towards greater integration, a fact that is confirmed by experience in realization of today's engineers and their employers' requirements".

Employers, universities and professional bodies agree that they need to develop professionals who are highly skilled and responsive to economic, social, technical and environmental change and can work flexibly and intelligently across business contexts.

The industry requires new graduates who understand the part they play in building their organizations. However, really contributing in the workplace means more than having the necessary technical skills. It means engaging with the organization and its goals, understanding the dynamics of the workplace. It also means applying a range of employability skills learned in many contexts.

Engineering education is adapted to the general needs of modern economy, dominated by the globalizations, aiming to assure a better employability of young specialists.

Unfortunately, over the past two decades, the modern economic trends will coexist with increasing 'graduate unemployment' and 'underemployment', because working places direct to Asia. It is argued that the focus of education should be broadened to focus on the economical structure and the way it both enables and constrains engineers' employability.

For the actual Bulgarian policy to accelerate the economical development and European integration, the acquisition of modern learning methodologies will improve the capacity of young specialist to understand and use adequate tools in industry and research. Answers are needed to questions such as, what does employability mean in the context of countries, where the reality is that there is scant research done in these areas.

2. TERTIARY ENGINEERING EDUCATION

Tertiary education - provided by colleges, universities and polytechnic institutes - is the level of education following secondary schooling. Tertiary – level engineering education is offered at five universities in Bulgaria.

The total number of university students in Bulgaria for the study period of 2008/2009 – including the students in the four educational degrees (professional bachelor, bachelor, magister and doctor) – is 274.2 thousand. This number is with 5.65% more than in 2007/2008 academic year and with 6.24% more than in previous year. For ten years period (between 1998 and 2008) the total number of students increased by 5.26%, despite declines in students numbers in the mid-2000s, as given in fig.1.

In recent years the most popular field of study for all tertiary students is management & commerce with 41.1% enrolment. The relative share of engineering students in Bulgaria is 20% (fig.1). The largest bands 79.4% of all people who are undertaking tertiary study are the 25–34 year olds.

Some 8.0 % of the tertiary education student population in Bulgaria in 2008 was found to be studying in another country. Some of the most popular destinations for foreign students include countries where English, French or German are spoken, such as the United Kingdom, Austria, Belgium, Germany or France.

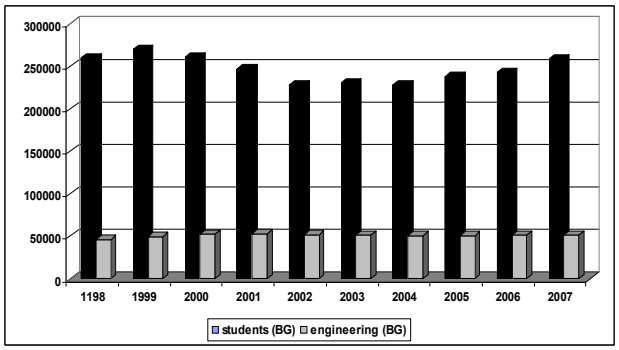

Fig1. Tertiary education students (ISCED 5-6) in Bulgaria

Across the whole of Europe, more women than men are graduating from tertiary education institutes. Moreover, in general, the new Member States have higher proportions of women graduates. As shown in fig.2, in Bulgaria more than half of all students are women. The statistical data shows that for the period 1998-2003 the number of women students slowly decreases. After 2003 this number slightly arises [3].

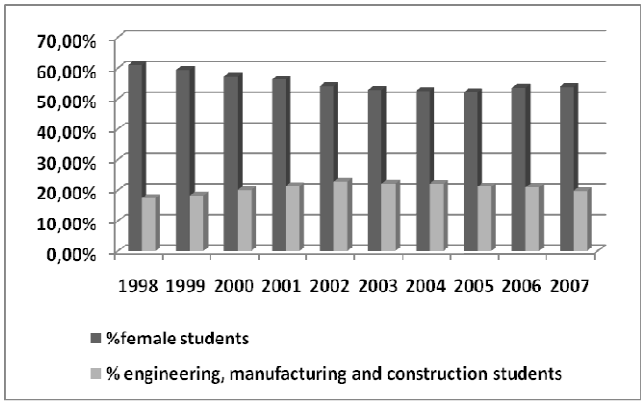

Fig 2. Trends in tertiary education in Bulgaria

3. TRENDS IN ENGINEERING EDUCATION IN BULGARIA

While higher education enrollment has increased over the past decade, the proportion of Bulgarian engineering students remains around 20%. In academic year 2007–2008, about 51,000 are students in engineering fields – of which more than half (68. 86 %) are men, as shown in fig. 3.

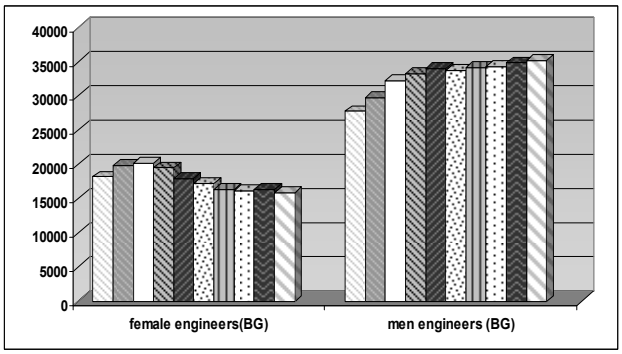

Fig 3.Trends in the number of engineering students in Bulgaria

Despite increases in enrollment and degree attainment by women, the number of female engineers considerably fell from academic year 1997–1998 to academic year 2007–2008 (12%). It is clearly seen from fig.4 that more than 40% of women prefer studying social sciences, business and law and only about 10% of them engineering, manufacturing and construction [4].

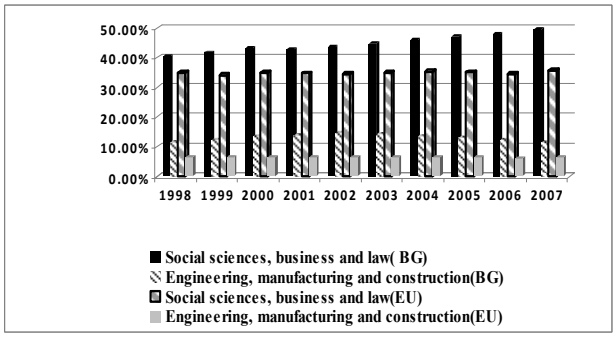

Fig.4.Trends in women education in Bulgaria

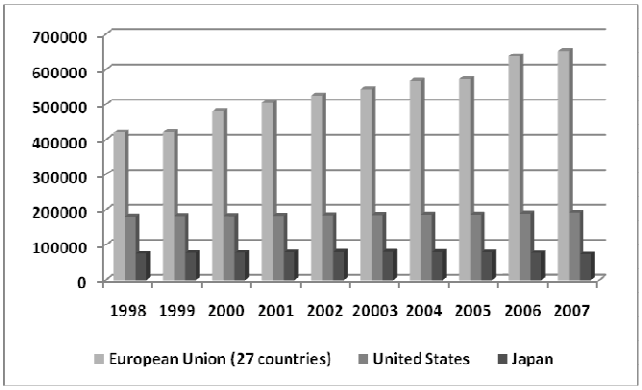

Fig 5. The total number of women engineering students

The situation in most countries in Europe does not look like in Bulgaria. As it is illustrated in fig.5, between 1998 and 2007 the total number of women engineering students has increased by 55.63%. In USA the percentage increases in numbers of female engineering students is only 5.83% for the same period. But elsewhere, such as in Japan the trends in the number of women in engineering field holds nearly constant [5].

As the emphasis placed on qualifications grows in relation to entering further education or obtaining a job, it is important to note that the participation rate of young women in education after the completion of compulsory education is higher than that for young men in most country in Europe. It is shown in fig.6 that in USA about 57% of all students are women and only 2% of them studying engineering disciplines.

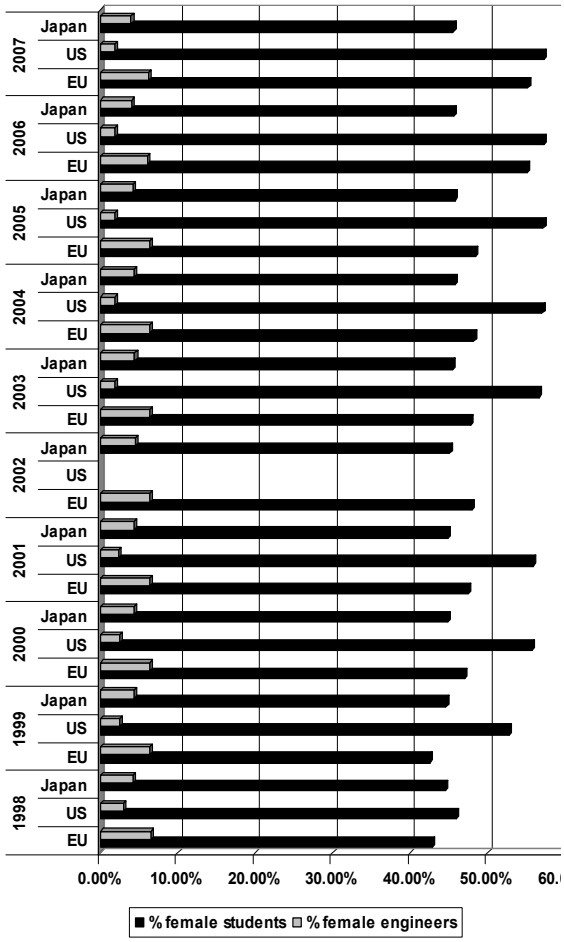

Fig.6 Trends in women education in EU, USA and Japan

However, educational policies have increasingly shifted to promote particular subject areas, where take-up among female students remains relatively low (for example, science, mathematics and computing, or engineering, manufacturing and construction-related studies).

Instead, women appear to have a higher propensity to study health and welfare, humanities and arts, social sciences, business and law, while a higher proportion of men chose to study science and technology-related subjects, as well as agriculture and veterinary subjects. Some 35.6 % of tertiary students in science, mathematics and computing disciplines in the EU were female in 2007, while the proportion of female students among those studying engineering, manufacturing and construction was 6.26 %, both these values marked an increase compared with the year before.

In 2007, the students in European Union, USA and Japan are almost 40 million and almost 4.5 million of these are in engineering field. As it is displayed on fig.7 students are significantly under-represented in engineering discipline in European Union, USA and Japan. Japan has the highest percentage of engineering students – 15.78%. In Europe students in engineering fields account for about 14% of total students. USA is the country with lowest percentage of engineering students (7%).

These worldwide totals include only countries for which relatively recent data are available, and therefore are likely an underestimation.

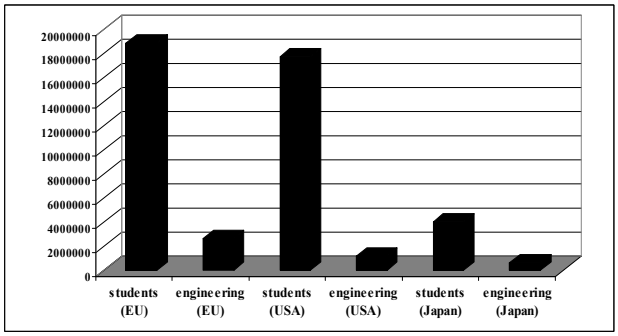

Fig.7 Trends in engineering education in EU, USA and Japan in 2007

4. WAYS TO STIMULATE ENGINIEERS' EMPLOYABILITY

The statistical investigations show two trends in higher education: one to direct human services, the other to areas of expressive creativity. Analysis of the reasons for the trends, especially from students who have not chosen engineering shows that teachers, parents and peers are known to be major influencers on prospective students' preferences. Contributing factors to the decline of engineering preferences frequently cited amongst the community stereotype about engineers and engineering education [6]

One of them is that engineering is highly specialized and continually changing, and it is safer to choose a less dynamic area. Much engineering work is undertaken in remote sites and in situations that are unsuitable for women.

4.1. Industry needs

The modern globalization world needs a technically literate society and an engineering-minded workforce. Engineers' realization in the economic situation of the last years has shown that young engineers need more complex skills along with their narrow specialization so that they are able to build up a successful career. It has appeared that the most successful engineers are the ones who combine in themselves the ability to do great things in technical and administrative fields [7].

Recent surveys of employers' views show that the employers' requirements concern the engineer's ability to adapt to a

business environment and its demands. That is how the necessity forces an engineering education which gives knowledge of business as a manageable process and highlights the engineer's position in it [8]

The trend of engineering companies toward more project-oriented work and greater complexity and effective innovations, means there is an increasing need for professionals who blend technical knowledge with management and business capabilities. Many of engineers enter a management position within their working life.

Technical interdisciplinary provides benefits for any engineering career. Its importance increases as the technologies become more complex

4.2. Identifying and developing employability skills

The modern globalization world needs a technically literate Businesses aspire to be more competitive, more effective and more innovative. The graduate workforce is a key part to further these objectives. Universities clearly want to produce graduates with the skills that are highly regarded by employers.

The higher education sector is characterized by diversity. Course and student profiles are different and universities aim to develop students with distinct characteristics. Universities have taken different approaches in which they develop graduate employability skills.

In addition to the part that universities play in developing students' employability skills, it should be recognized that most students are concurrently developing these skills through part-time employment, volunteer work and community participation.

Developing employability skills is an ongoing process. Many students obtain their first experience as employees throughout their education.

Research commissioned by Hewitt Associate (National research for professional orientation and motivation of students in Bulgaria) showed that more than half of Bulgarian students weren't working during the semester (59%). Fig.8 indicates that 23% of students were undertaking considerable paid work during the semester. Unfortunately these students reported that their job is not related with their studies. Only 18% of students have opportunity to be employed in work that corresponds to their studies and they believe it will progress their career goals. The most students think that they have to graduate before they start to work.

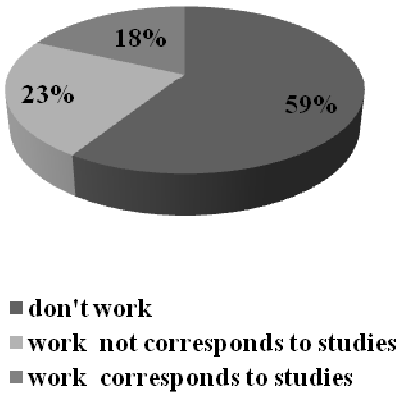

Fig.8 Students in paid employment during semester (%)

Relevant work experience during the degree program has a highly positive influence on employability as employer involvement in course design and delivery.

The educational system as a part of the contemporary society should to react adequate and overtaking of the changes. Interest in gender as an analytical category in the study of engineering and other applied sciences has grown rapidly through continuing concerns about the low numbers of women in these professions.

One of the objectives of the interdisciplinary engineering education and outcome-based curricula is to integrate the study of the non-technical skills into regular engineering studies. To develop new engineering workplace models and women friendly courses we need to work with industry and experts in labor, economy, and psychology.

Engineering education is based on mathematics, facts and technologies. The practice shows that a successful career in engineering depends not only on facts. As engineers advance on a career path, it is essential that they see the big business process. Education gives skills in problem analysis and problem solving but in these changing circumstances should also be focused on effectiveness, efficiency and the economical use of resources.

Lack of skills forces students to settle for non-technical jobs after graduation. Today's engineering positions involve much more than pure engineering work, so engineers need key employability skills - communication, problem solving and technical skills, team work.

National research among Bulgarian students for preferable future professional realization presented in fig.9 shows that they are interested in not pure engineering job. Actually job opportunities in engineering are expected to be good, and, indeed, prospects will be excellent in certain specialties from job growth, many openings will be created by the need to transfer to management, sales, or other occupations.

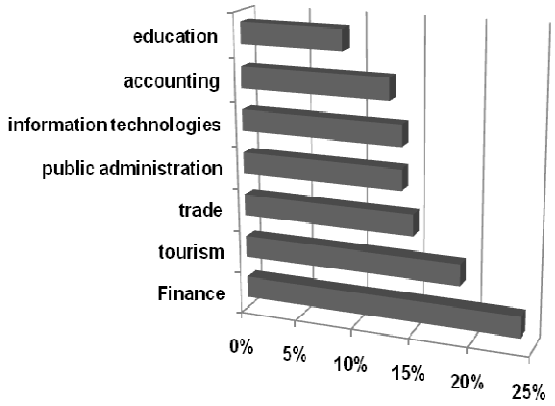

Fig.9 Preferable sector for professional realization from students

The cognitive styles of engineering and technical knowledge workers are significant issues for systems of innovation. The cerebral thinking styles are most preferred for engineering and technical workers of the innovation economy paradigm. From an education and training viewpoint, the question remains as to how to develop and enhance such psychological skills during the teaching and learning process, as this may require a

significant shift from traditional teaching approaches based mostly on the commands and control.

This probably calls for new methods of curriculum delivery to ensure that future engineering will achieve appropriate behavioral preferences, as today engineering evolve from the production economy to the knowledge and learning paradigm of the innovation generation.

Time management, interpersonal skills and economics should not be taught separately. Such supporting skills are to be incorporated into every engineering course to develop the full knowledge package. These skills should be integrated throughout the curriculum, rather than be taught in isolation, so as to give students a full picture view of real world engineering. Engineering educators are challenged to look at their curricula to incorporate non-traditional information and subject matter.

Institutions need to change pedagogical style from teacher-centric to student-centric, and include more assignments for students to independently analyse and apply tools on real life problems. Only through such changes in the teaching-learning process will the future graduates become more employable.

4.3. Communicating and marketing engineering

The process of formal borders disappearance also refers to education. In the context of international cooperation it is equally important to possess both professional knowledge necessary for good functioning of the cooperation and at the same time developed thanks to it. Thus higher education must provide the graduate with knowledge on understood rules and methods of communicating.

Today's generation of students is interesting. They are experienced internet users, they have social networks. The labour market has become more like a consumer market for today's generation. They look at work as a step in their own career.

The need for higher education institutions and universities is to focus on the skills of the graduates through sustained interactions between industry, civil societies and the communities to produce effective knowledge workers. To be ready for actions engineers should be part of the life long learning process.

Developing the education in the field of process integration, where there is a considerable demand in Bulgarian economy creates new career options.

Universities must understand program marketing as an integral part of their strategy and practice. One of the stimulus for students choice in engineering education is to provide contemporary information about engineering and engineering careers. Engineers should have good print media exposure, and to increase the number of prime time television programs related to engineering, science and invention.

5. CONCLUSION

Through its teaching and research, and other activities, the university provides the essential foundations of the knowledge-based society.

Engineers have unlimited career opportunities in the realities of this technological world. The engineering profession will prosper only if it attracts excellent students to study well conceived programs that are delivered effectively by excellent teaching staff. Educators and leaders in the engineering profession will need to continue to work together, to ensure that national and global development goals can continue to be met through engineering enterprise.

6. ACKNOWLEDGMENTS

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