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Reforms of higher education and current engineering education developments in Lithuania

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ABSTRACT: Higher education reform is dealt with in this article, in addition to the international and internal factors that influence engineering education following the adoption in Lithuania of the new Law on Higher Education and Research. The funding of higher education, quality assurance, benchmarking and the impact of labour market changes on higher education are also considered.

Keywords: higher education, engineering education, reform of higher education, quality assessment, sustainable development

INTRODUCTION

Engineering education is an integral part of higher education and plays a very important role in industry. Analyses of current world developments indicate that Europe very soon will face a shortage of engineering graduates, given the demand from industry. An engineer is expected to have a strong scientific background, good technical skills, a sharp awareness of the societal concerns linked to his/her activities, a deep sense of safety and security, ethical behaviour; and be open to foreign and different cultures, and open to geographical and professional mobility, etc. Innovative learning opportunities in engineering education are of key relevance to Europe's economy considered in a global context. The increasing complexity of engineering projects in the globalised world does require that engineering graduates, without being experts themselves, have a degree of non-technical *skills* in order to be productive in their working environments. Such skills include the ability to understand the legal implications of projects, the managerial requirements and evaluation of the costs. Engineering education should aim to develop entrepreneurship in students and the building of responsibilities towards enterprises and society as a whole. The government and industry, in the past, saw problems ahead and reacted by adopting a new Law on Higher Education and Research to better equip graduates to deal with continuous external changes.

EXTERNAL CHALLENGES AND NEW LAW ON HIGHER EDUCATION

The Law on Higher Education and Research came into effect on 12 May 2009. The Law provided for the reform of the *legal status, management and funding* of the state's academic institutions. This is the third law on Higher Education and Research since the restoration of Lithuanian independence in 1990. The first law was in 1991 and the second in 2000. The frequent changes of the law are associated with political changes in Eastern Europe, the implementation of the Bologna strategy and the very rapid grow of the student population. After the legal status and management of higher education establishments are reformed by the end of 2011, state universities and colleges will own their real estate and control their earnings. The management of state universities and colleges will include social representatives of the public, as well as the academic community.

During the first year of the new Law on Higher Education and Research major steps were undertaken to modernise the system of higher education and research, and implement key objectives of the reform. They include the quality and accessibility of studies, the development of modern technologies and ending the *brain-drain*. The reform is being carried out with finance from EU Structural Funds. The network of research institutions has been optimised: before the reform there were 45 state education establishments. With common research trends combined, 17 institutions have been integrated into universities and the rest combined into 5 research centres. Five integrated centres (valleys) of research, studies and business have laid the groundwork for breakthroughs in modern technologies. The plan is that, after the reform is completed, investment in 2020 will amount to 2% of GDP. Currently, it accounts for 0.8% of GDP.

From 2009, the state has been allocating all the necessary funding, which is *twice* the amount per student as before the reform. In 2010, the state plans to fund the studies of almost 19,000 first-year students, including 9,700 in universities and 9,200 in colleges. About half of all entrants will be able to study in universities and colleges for free. Direct investment in the quality of studies amounts to half a billion EU funds.

Engineering attracts jobs, improves the standard of living and adds to the comfort of life. Engineering involves academics, students, graduates, employers and those in the society striving for wealth creation. Higher education institutions must meet the expectations of all involved. The most clearly involved are students and employers. A student's expectation is to gain a qualification that will lead to a lifelong career, providing a high, secure and well-paid position in society. The employer expects to attract high quality people to undertake a broad range of engineering tasks and to aid production. Examples show that neither students nor employers are fully satisfied. In mass media and society in general, engineering is seen to be relatively unimportant. Many secondary school leavers believe being a lawyer or a show-business personality, or a manager, is more important than being an engineer. This is reflected in salary differences. Philippe Wauters, the Secretary General of the European Federation of National Engineering Associations (FEANI), writes that FEANI and other bodies have evidence of the need for co-ordinated action at the European level to reverse the decline of young people's interest in engineering and science education [1].

Research among young learners (aged 15) from more than 40 countries revealed that the more developed a country, the less young people are inclined towards an engineering education. A study made by the European Roundtable of Industrialists reveal three findings typical for societies as they move to higher wealth levels. As a society gets wealthier, its citizens become proficient users of technology, but at the same time they also become less interested in technology and how *things* work. As a society gets wealthier, its youngsters are less attracted to science and technology studies and careers. There is also the decline of professional training in basic education schools [2].

Central and Eastern European countries (Bulgaria, Slovak Republic, Lithuania, Czech Republic and Estonia) mostly have a large share of graduate engineers not working in engineering. More than 68.5% of employees in Lithuania, who had acquired an engineering degree, were not working in their profession. During communism, these countries encouraged students to study engineering. Hence, the number of engineering graduates was exceptionally high. This could explain the high percentage of graduate engineers working outside the engineering profession. As this group gradually leaves the labour market, the demand for fresh engineering graduates is crucial to the balanced development of the economies.

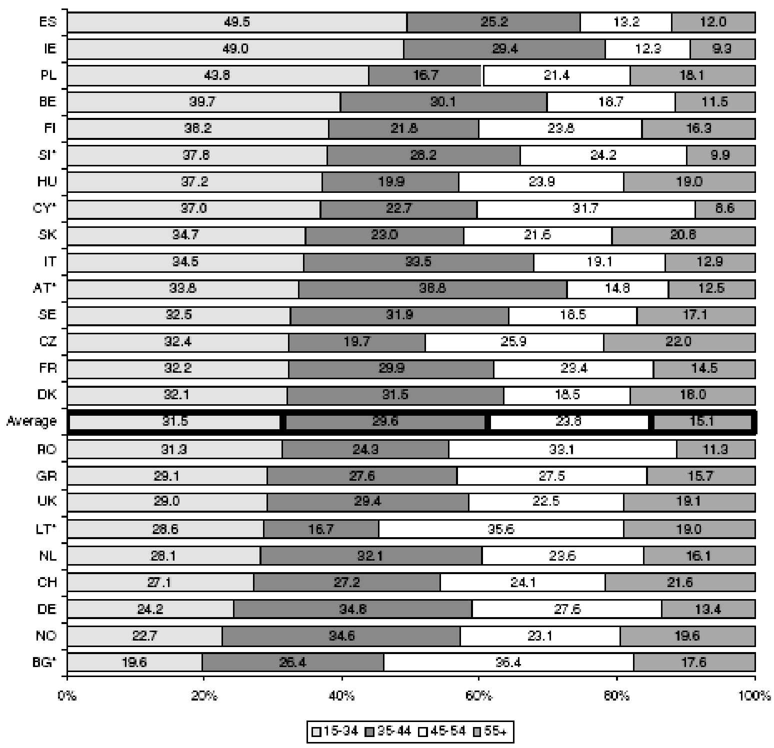

Figure 1: Age structure of employed engineering workers in 2007 [3].

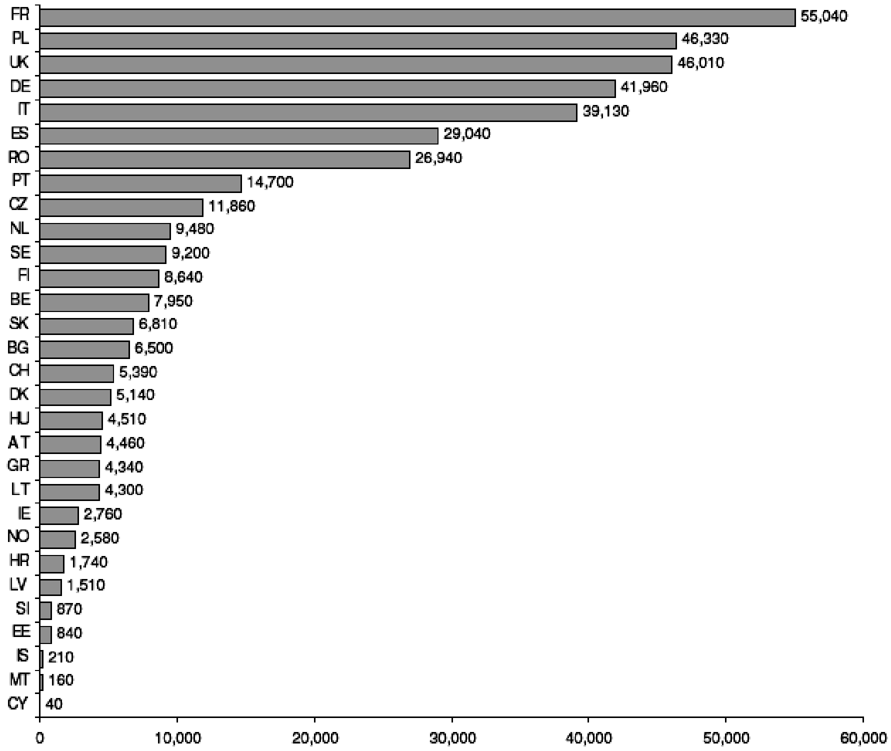

Figure 2: Number of graduations in engineering in 2007 [3].

Between 1998 and 2006, in Europe, there has been a 10.8% decline in the proportion of mathematics, science and technology (MST) students in relation to the total student population [4]. Negative demographic trends and a drop in the proportion of students choosing science and technologies are likely to have a very negative impact on absolute numbers in the years to come. Figures 1 and 2 clearly indicate that the small number of engineering graduates will be the predominant factor in an imminent shortage of engineers.

These diagrams alone should motivate political, professional and educational authorities to initiate measures to improve engineering education and adapt to today's industrial needs. According to *market-driven* research, engineering education and industry systems tend to behave as *followers* of market needs, which are characterised by high uncertainty and dynamic behaviour. Production is constrained by low time-to-market and high labour costs, as well as safety, quality and environmental constraints [5]. For Europe, science and technology play a crucial role to ensure a sustainable future in a world of increasing eco-competition. Countries need more technology produced by highly skilled people pushing forward the frontiers of technology (Figure 3).

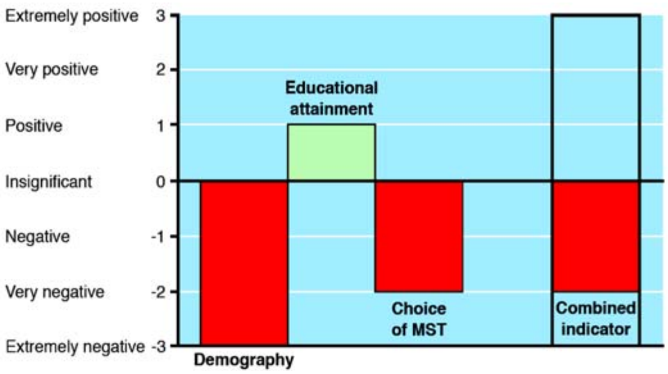

Figure 3: Trends in the supply of human resources in MST in Europe [6].

EDUCATION IN LITHUANIA: FACTS AND FIGURES

In recent years, training in business and administration, education and teacher training, engineering and engineering trades was predominant in Lithuania (Figure 4). Over the period of the academic years 2000-2001 to 2004-2005, the highest increase was seen in the number of students of business and administration: up by three times. Engineering and engineering trades students account for 22.9 % of all first cycle (undergraduate) students.

The same trends in the choice of the field of study in education as in university first cycle (undergraduate) can be observed in second cycle (graduate) studies. In recent years, the only notable change in the most popular fields of education was the number of students of engineering and engineering trades. Engineering and engineering trades students account for 17.2% of all students in university second cycle (graduate) studies. After the first cycle of engineering studies, the second cycle studies continue for 12% of students (average for all study fields is 15.4%).

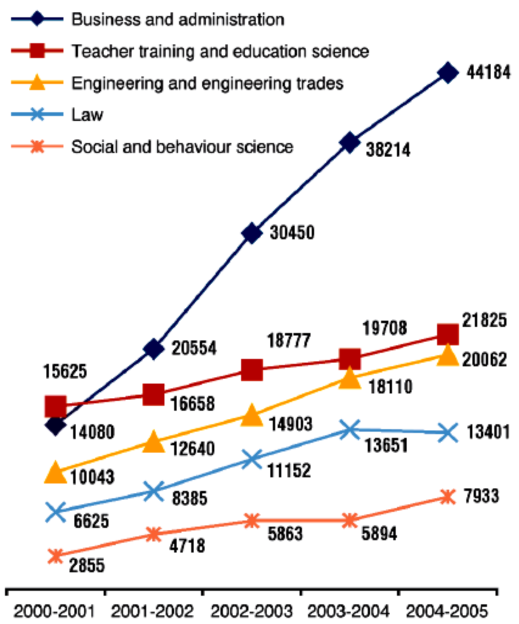

Figure 4: Number of first cycle (undergraduate) students at colleges and universities by field of education in 2004-2005 [7].

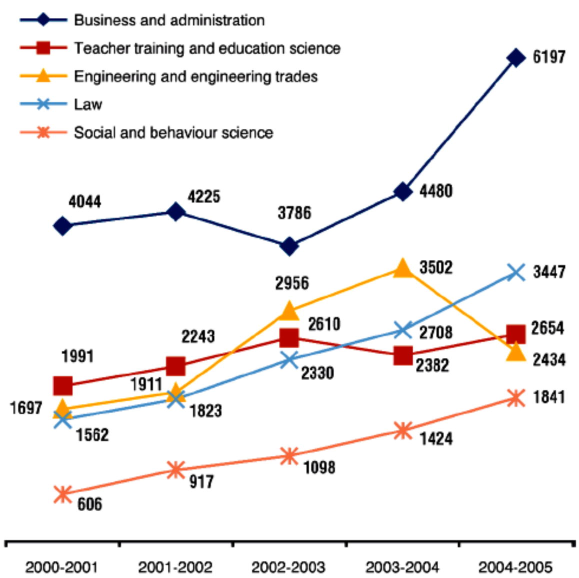

Figure 5: Number of students at second cycle (graduate) in universities by field of education in 2004-2005 [7].

Increasing the ratio of graduates in natural sciences and technologies to 1,000 of population aged 20-29 is one of the targets of European education. The Lithuanian indicator is one of the highest in Europe, and it has been increasing faster than the average for European states. The fast growth of this indicator is related to the rapidly increasing number of students in Lithuania up to the year 2009. A fast decrease in the number of engineering students was registered by 2004 (Figure 5 and Figure 6).

The proportion of students, out of the total population aged 20-24 in Lithuania, is rather high (nearly 70%) and markedly surpasses the EU average of about 56% [7]. Such rapid growth of higher education students' numbers has stressed the professional education schools and resulted in a significant decrease in the number of freshly qualified workers. The new law must correct this. In accordance with the new law, the state support for a student was doubled but the state will only support a limited number of students. In case of a failed admission into higher education institutions, the secondary school leaver has the chance to enrol into a free place at a state-supported vocational education school.

The state support for a student differs depending on the field of study. Engineering students get twice the amount of state support than students from social or humanitarian fields of study. Engineering students in the universities sector make up 21% of all state-supported students and in the colleges sector the figure is 41%. These figures demonstrate an emphasis by the state to support the balanced development of the economy.

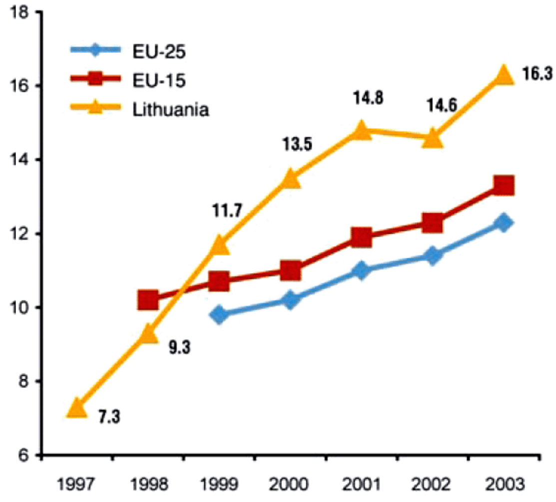

Figure 6: Number of tertiary graduates in natural sciences and technologies in European states per 1000 of the population aged 20-29 [6].

COMPETITION IN ENGINEERING EDUCATION

Every institution tries to achieve high quality. The problem in many cases is that it is impossible to define quality objectively. Again, very often, even if we do not know what quality is, we are still able to recognise it. For example, it is generally possible to identify *intelligent people*. Quality in higher education attracts much attention worldwide. There are several international ranking systems that produce lists of the world's top universities (Shanghai Jiao Tong – Academic ranking of world universities, QS world universities rankings, Professional ranking of world universities, etc) [8]. Of course, in these systems, the quality of a higher education institution can be measured only indirectly. The rankings are based on a combination of several distinct indicators, namely: student-to-faculty ratio, academic peer review, employer review, citations per faculty member, international faculty and students, articles indexed in the Science Citation Index, etc. The last indicator shows how language influences the rating.

For scientists from non-English speaking countries, publishing in English takes more time and effort. Probably, valuable papers do not become well known because they are not published in English. The notable discrepancies between UK and Lithuanian universities are in the international student numbers as a ratio of all students. The number of international students depends on the language. For applicants from Asia, the Arabic world or Africa, it makes more sense to study in the UK, USA, Canada or Australia, learning English at the same time. Universities understand that their world status depends on their reputation being established over a long time, and it is difficult to change quickly. The *QS world universities ranking* data includes only one Lithuanian university (Vilnius University) ranked 501 out of 600 places. The Ministry of Education and Science wants to see one or two universities among the first 100 world universities.

UNIVERSITY BENCHMARKING

The new Law on Higher Education and Research covering management and funding, implementation of qualification frameworks, learning outcomes of study programmes and subjects, international assessment of institutions and study programmes, etc, requires a new *university benchmark*. The Bologna Process, for example, has been an important element of higher education reform in recent years and has formed a good stimulus for universities interested in benchmarking their accreditation, internationalisation and mobility performance. For example, the Dublin Descriptors are benchmarks that provide points of reference for all other types of descriptors: Qualification Descriptors, Programme Descriptors, Level Descriptors and Module Descriptors.

Benchmarking is a process by which management learns about their organisation and processes, including how comparable organisations arrange those processes and, hence, how those processes might be better organised. There are various approaches to benchmarking universities: *internal benchmarking* implies a comparison of activities within units of the same institution, e.g. between faculties or services; *external benchmarking* implies a comparison of activities across institutions. Also, there is another, more specific benchmarking: *process benchmarking* focuses on best-practice in a particular process areas to identify innovative approaches and solutions; *trans-institutional benchmarking* during which a team with a common interest is brought together to develop an understanding of the process; *functional benchmarking* focuses on a specific process for detailed benchmarking work; *implicit ranking* analyses performance or data about comparative performance [9].

By comparison, university leadership is interested in: fluctuations in student recruitment, funding levels, research projects, etc. This may be a problem. Benchmarking typically involves several main steps to ensure it contributes effectively to institutional performance improvement: define priorities, set targets, determine indicators and benchmarks, strategic decision-making, gather data, choose partners, develop an action plan and process monitoring. Universities often do not think in process terms, but rather in terms of their deliverables, such as teaching or research. This covers a small element of the overall contribution of the university, including the development of higher level graduates' skills and the stimulation of innovation.

Good benchmarking in outcomes, outputs, processes and inputs is crucial for a university to be competitive in the educational market. *Inputs* are the resources which have to be acquired and brought together for the processes to create the outputs, and success depends on recruiting the best from secondary school or gymnasia. *Processes*, these are the processes by which universities organise and arrange key tasks such as teaching, training and research. *Outcomes* are the high-level objectives that the university wishes to satisfy to fulfil its organisational mandate, and are typically expressed in terms of vision and mission statements. *Outcomes* also define the standard of learning expected. From top to bottom they are organised into cycle descriptors, qualification descriptors, programme descriptors and level descriptors. *Outputs* in teaching typically relate to graduates, e.g. do the graduates find employment, do they continue on to research degrees.

THE ASSESSMENT OF ENGINEERING EDUCATION QUALITY

The new Law identifies internal and external structures intended to assure quality. The main internal quality assurance structures include the Senate, which is responsible for the management and control of the quality of studies and research, and the University Council, which evaluates the higher education institutions' goals and their implementation, as well as the contribution that institutions make to the economic, social and cultural growth of the country. Engineering study programmes are assessed in two ways:

- new programmes are assessed internally according to the quality of the registration proposal documents, and
- registered programmes are assessed based on a self-study report and the results of a visit by a panel of external experts.

A self-study report addresses the programme goals and tasks, the state of related material, internal processes for quality assurance, external relations and feedback mechanisms. A group of external experts reviews the self-study report and undertakes a visit. The result of the external assessment of study programmes are *de facto* assessments of the capacity of the university to perform studies in particular fields. External assessment is an essential aspect of the quality assurance process, since it both makes a judgment of the quality of study programmes and points out areas in need of improvement. Study programmes are certified *unconditionally*, *conditionally* or *restricted*. The programmes that are certified *unconditionally* are free to function until the next certification. Those certified *conditionally* have to be amended within a given period and, then, presented again for certification. If the activity of an institution department, or study programme, for example, is found to be of especially low quality, it may be *restricted* or *terminated*. However, at present, such assessment does not fully reflect the capacity of universities to conduct studies in particular science areas.

CONCLUSIONS

The new Law on Higher Education and Research emphasises the country's determination to be an active member of the Europe Higher Education Area (EHEA). The previous legislation did not meet modern-day requirements. Still, further efforts are necessary to improve the accreditation system and implement the qualification frameworks in Lithuania so as to match the international quality assurance procedures approved by the European Commission. The quality assurance should focus not only on structural issues but also on learning outcomes.

Negative demographic trends and falls in the proportion of students choosing science and technologies, will likely have a very negative impact on absolute numbers of engineering graduates in the years to come. The small number of engineering graduates will be the main factor leading to an imminent shortage of engineers. These tendencies should motivate political, professional and educational authorities to initiate measures to improve engineering education and adapt to today's industry needs.

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BIOGRAPHIES

Algirdas Vaclovas Valiulis received his engineering diploma from the Kaunas Polytechnic Institute (Lithuania) in 1967, and in 1974 he defended his PhD thesis. He was awarded his Doctor Habilitus degree in 1997. Since 1998, he has been a professor and a member of the Lithuanian Academy of Science. Prof. A.V. Valiulis teaches welding technologies of ferrous and non-ferrous metals and polymers, materials science and surface coatings. His research interests are in welding of ferrous metals, surface coatings and curriculum development of study programmes. Between 1990 and 2006, he was a Vice-Rector of Vilnius *Gediminas* Technical University (VGTU) (Lithuania); the Dean of the Mechanical Engineering Faculty of Vilnius *Gediminas* Technical University (since 2006); and the Head of the Materials Science and Welding Department (since 2001). He is a member of the VGTU Senate.

Professor Valiulis was a Member of the European Society for Engineering Education (1993-2008), European Association for International Education (1993-2000), the European Higher Education Society (1999-2000), Universities Consortium in Science and Technology BALTECH (1998-2006), a member of the directorate of Alliance of Universities for Democracy (2004-2008), a member of EC Bologna promoters' team (2004-2008); and is a Lithuanian national representative in the European Commission Committee for Coal and Steel (since 2004), Lithuanian national representative in the EU Steel Technology Platform (since 2005); and Chairman of the Lithuanian Welders Association (since 2005). Prof. Valiulis is the author of more than 300 research, methodological, scientific and study organisation publications, including several monographs and textbooks, many study guides and manuals. He has presented more than 100 reports at international conferences.

Donatas Valiulis graduated with Bachelor of Transport Engineering from Vilnius *Gediminas* Technical University (VGTU), Lithuania, in 2004 and completed his Masters in Finance Management at VGTU in 2006. He has published several peer-refereed conference and journal papers in the field of finance management.