

Implementation of Mutual Recognition and Voluntary Standardization via Sharing of Expertise in Education of Electrical Engineers

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Abstract—The education of electrical engineers is popular subject in universities curricula's as in Europe, as worldwide. The methodological approach and needed qualification is standardized in national level, however the technological development level and carrier perspectives requires mutual recognition of education between counties. This article aimed to collect the best practice and experience of Riga Technical University in creation of curricula for electrical engineers in the frame of TEMPUS, Erasmus, DAAD and several bilateral agreements. The ways how to create compatible curricula for student training and its carrier development are discussed. The development e – learning methods and special virtual laboratories, as well as using e – learning platforms Moodle and Blackboard, its advantages and disadvantages are analyzed. The recommendations towards mutual recognition and voluntary standardization of education approaches for electrical engineers are offered.

Keywords- *mutual recognition, voluntary standardization, education of electrical engineers, e – learning platforms, curricula for electrical engineers.*

I. INTRODUCTION

Education in Power and Electrical Engineering is set as the priority in many countries, because people have to find ways, how to substitute petroleum and other diminishing natural energy recourses by introduction more efficient and safe approaches for the use of energy resources [1]. In Latvia energy and environment issues [2] are settled as the priority for research funding at the state level.

The working strategy of Institute of Industrial Electronics and Electrical Engineering (IEEI) is to fulfill the research program „Computer control of electrical technologies” in the field of industrial electronics and electrical engineering with the specializations in power electronics, adjustable electric drive, automation of electrical technologies and electric transport. The working strategy also aims to supply the industry with graduates, which are competitive at the world labor market.

Education in power engineering covers education in energy production and transmission in a study program “Electrical and Power Engineering”, ensures education in energy consumption and control in the study program “Computer Control of Electrical Technologies” and provides education in the field of

decreasing the impact on environment in a study program “Environmental Engineering”. Furthermore students of the study program “Computer Control of Electrical Technologies” obtain practical skills and theoretical knowledge in control, designing and operation of the computerized electric technical devices. For successful students with good knowledge of foreign languages (English or German), IEEI provides a possibility of partial training abroad.

The resent amendments in Latvian legislation allow teaching students in all European languages. This measure encourages the growth of the foreign student’s number in the state universities and other higher education establishments. The legislative changes stimulated increasing student’s amount in English language study program of RTU four-fold in the last two years.

II. THE STRUCTURE OF EDUCATION

The education process in RTU covers all steps of academic and professional high education (se Fig. 1) in full time and part time groups.

The critical point differs Professional branch from Academic one is the possibility for students to have a practical training in the cooperation with our industrial partners. In the graduation professionals in addition to bachelor level have got also qualification of engineers. The professional baccalaureate programme is extremely popular amongst Latvian students, as it gives possibility to start professional activities in four years, having professional experience in the field, which increases employability and carrier perspectives. The same study programs are available in Latvian and English languages. However the education of foreign students is organized in different way. The formally leadership of all study programs for foreign students is coordinated by foreign student department of Riga Technical University. This approach allows coordinating students’ hostelling, legal support (visas) in one place. In fact foreign student department has theirs own time planning, financial and other administrative instruments separated from routine ones.

The education of foreign students is based on module’s principle. It is possible to study some subjects which are not foreseen for Latvian students in particular semester, in order to provide flexibility and to have mutual recognition with other

study programs within Erasmus and other student's exchange programs.

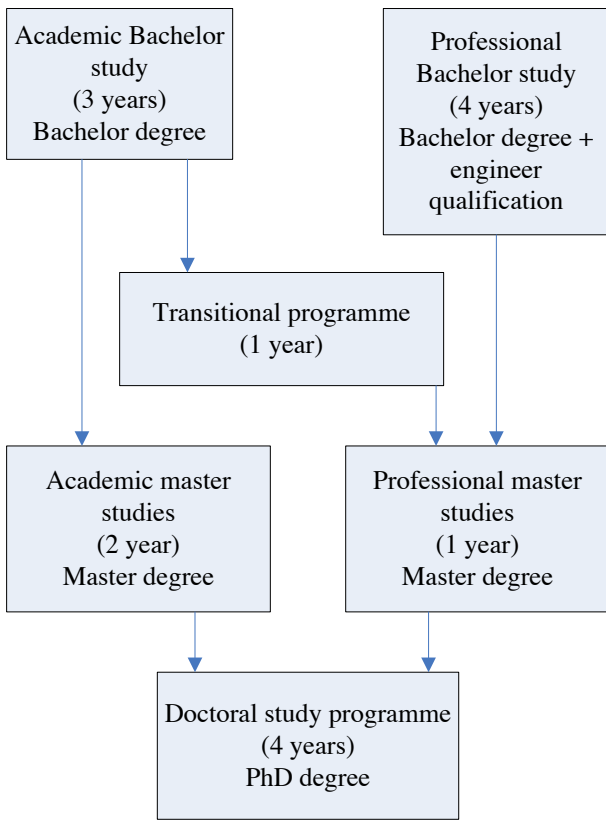


Figure 1. Study levels and education duration for a study programme computer control of electrical technologies.

The baccalaureate study programs are available in full time, and in three types of part – time education. It includes the studies in evening groups, during week end, and in life learning mode. It is possible to have different study subjects together with existing group and, after successful finalization of the course special certificate is issued. The student may study in this way different subjects from study program, without taking all courses. This type of education is interesting for professionals from industry in case of retraining, as they don't need new diploma, but only specific training.

Masters level academics program are used mainly by those students, who are going to continue education in the PhD level. The professionals from industry used to choose professional master study program or the transitional program professional master study (after academics program level).

The PhD studies last 4 years, thus during this time period PhD students should finalize as educational, as well as academical part of their education. As the topics of PhDs are quite different, there are possible to adjust study subjects from B and C parts of study program.

The study programme computer control of electrical technologies is a research based educational programme.

III. DEVELOPMENT OF CURRICULAS

The development and improvement of curricula's is in a scope of University's staff daily responsibilities. The technology development and labor market requires the frequent adjustment of study program. The formal national legal requirements states that study program should be accredited for 6 years. During this 6 years the study process should be performed according to approved list of study subjects, however in order to fulfill market requirements the content of study subject could be adjusted. The improvement of laboratory base and introduction new testing methodologies and approaches facilitate significant improvements in the methodology of education, which bring immediate result.

The regulation of The Cabinet of Ministers declares that study program is strictly related with the education level and specialization, defined in the classificatory of specialties [4]. This list of professions is legal bases for all employers in the country. The main challenge in the development and improvement of curricula's is immediate deployment of new technologies in the study program. The rapid technological development in engineering is obvious, and the unpacking of new technologies, even in the level of examples in study program requires continuous approach in modernization of curricula's. Obviously it is not possible to deploy all technological novelties in the study program, but there are two practical approaches how to keep sufficient level of student's expertise for market. The first approach is to follow the feed – back from industry, and second one is participation in new researches in order to get technology before it will be implemented in the market. The knowledge level description is presented in Fig. 2.

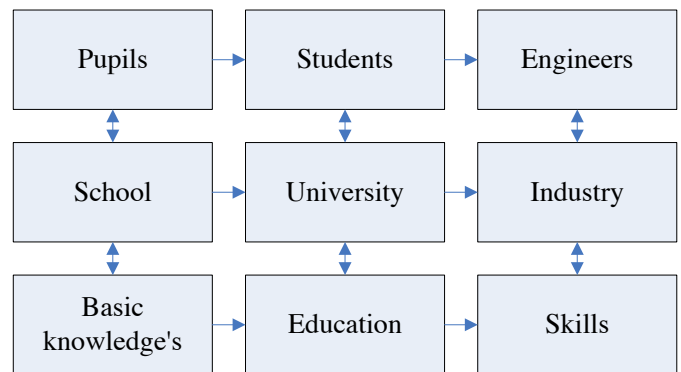


Figure 2. The knowledge level description.

The knowledge up taking structure in technology and research oriented education is described in Fig. 3.



Figure 3. The knowledge up taking structure.

IV. EXCHANGE PROGRAMS

The participation in staff exchange programs, and other international activities allows to evaluate the study methodology applied in one or another study subject in comparison with similar courses in other universities. The ERASMUS exchange network allows getting a feedback from students, arriving from other European universities on baccalaureate and master level RTU participation in ERASMUS program provided exchange opportunities for staff and reading lecturers as well for students in other EU universities. The list of ERASMUS partner universities contains more than 200 cooperation partners. This opportunity is used to invite visiting professors in RTU, and to share expertise with colleagues in other universities. Moreover availability of new IT platforms developed in ERASMUS allows using virtual environment for student's education.

Recently RTU was accepted as coordinator of TEMPUS IV project "Development of Training Network for Improving Education in Energy Efficiency". The project aims to develop and improve curricula, teaching materials in such areas: energy efficiency, energy savings, energy efficient materials, and renewable energy sources. In this project 14 universities from nine countries will work together in order to share the best practice in academic work. The high level of IEEI expertise allows to share experience of study program Computerized control of electrical technologies within EU and neighborhood countries. The project is focused on the development and modernization of a set of compatible study programs (including lecture courses, laboratory classes and appropriated didactic materials) in 4 declared directions: enhancement of energy efficiency, energy saving energy effective materials and use of renewable sources.

Participation of Consortium Partners in the development and modernization study programs allows creating a Joint Educational Platform as a system of enhanced compatible Lecture synopsis (more than 10), Laboratory Classes (more than 6) and didactic materials. This will encourage academic staff to transfer experience of the Universities of EU Member Countries to the Partners Countries Universities and to exchange experience inside of Sub-Consortia (between Partner Countries).

Academic staff of the Universities of EU Member Countries will be involved into coordination of the modernization and developing of unified curricula and study programs making them compatible with EU standards. Furthermore the academic staff of the Universities of Partners` Countries will be involved into training process in EU Members Countries (mobility), modernization and developing of compatible and unified curricula with appropriated didactic materials, as well as in training of bachelor and master students.

V. SHARING OF EXPERTISE IN EDUCATION OF ELECTRICAL ENGINEERS WITHIN EUROPEAN UNION

The amount of foreign students in the Institute of Industrial electronics and electrical engineering (IEEI) is growing steadily. This fact forces RTU to undertake measures aiming implementation of Mutual Recognition and Voluntary

Standardization via Sharing of Expertise in Education of Electrical Engineers as within European Union, as with other countries.



Figure 4. Andrea Pasqualin (Italy), Thomas Duvail (France) presentation on annual Students scientific conference.

The structuring education programs taking into account Bologna Process allows to share study programs in order to go step forward to mutual recognition of study programs within EU. The experience of Riga Technical University allows saying that students achieve good results in international groups and have synergy effects in developing of common projects. A good example is shearing expertise between Latvian and foreign students in annual Students scientific conference organized by Riga Technical University. In Fig. 4 Andrea Pasqualin (Italy), Thomas Duvail (France) 2nd year master students present research results of "Modeling of power generation on photovoltaic panels in different weather conditions" at the section "Computer control of electrical technologies" on 18 April of 2012.

On doctoral level the European initiatives like Cooperation for science and technologies (COST actions) allow sharing experience with other European countries, and other partners in such projects. The participation of Riga Technical in COST Action 356 "Towards the definition of a measurable environmentally sustainable transport (EST)" [5] allowed sharing expertise in area of development alternatives in transport projects. The PhD students from Riga Technical University participated in the project meetings, in a congress as well as in Short term scientific mission to Technical University of Madrid, Transport Research Centre (TRANSYT). They also participated in elaboration of publicly available report "Indicators of environmental sustainability in transport: an interdisciplinary approach to methods" [6].

After this STSM another three STSM were implemented by one post doctoral and two PhD students from Faculty of Power and Electrical Engineering of RTU. Five PhD students participated in the first Training schools of actions IC0806 "Intelligent Monitoring, Control and Security of Critical Infrastructure Systems" and in MP1004 "Hybrid Energy Storage Devices and Systems for Mobile and Stationary Applications".

The approach towards mutual recognition of study programs, as well as new improvements in Latvian legislation,

which allowed teaching students in languages of European Union in the state universities, increased a number of foreign and exchanging students. The Erasmus students exchange data by faculty of Riga Technical University total 2005 – 2011 are presented in Fig. 5.

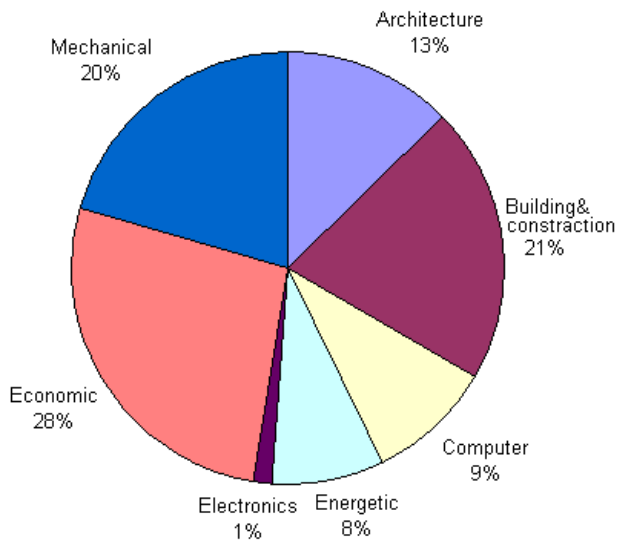


Figure 5. Erasmus students exchange data by faculty of Riga Technical University total 2005 – 2011.

VI. SHARING OF EXPERTISE IN EDUCATION OF ELECTRICAL ENGINEERS WITH OTHER COUNTRIES

Since the beginning of the 2000s, the Bologna Process has expanded from the European Union towards the neighboring countries and Bologna Declaration by now has been signed by 47 countries. In addition, an increasing number of countries have been expressed their interest in the process by implementing most of its recommendations and tools on a voluntary basis and by including it in policy goals, without officially joining the intergovernmental process [7]. This process does allow Sharing of Expertise in Education with neighboring countries. The common understanding of study structure and the common logics of curricula's allows exchanging students at least with the part of neighboring countries. The common experience deriving from the soviet times, where curricula's was developed by the same structure, approved by Ministry of Education, gives possibility to universities in Baltic Countries to share expertise with Belarusian and Azerbaijan universities based on common understanding of curricula's of the Soviet Union. This paradigm is extremely useful in cooperation with Byelorussian partners within the TEMPUS project Energy. The Sharing of Expertise in Education of Electrical Engineers with other countries is based on common understanding of technological paradigms and topics. The Soviet standardization in education was based on standard study programmes, like Automation and Remote Control (0606), Industrial Electronics (0612) and etc. The curricula consist of topics, which were strictly specified: all practical works were strictly defined by books issued with a prior acceptance of

Ministry of Education. Those booklets still are useful, especially for topics covered theoretical aspects of curricula.

Nowadays, when education process is standardized on national level, the exchange of students becomes more complicated. Even if on level of curricula the universities programs are similar, the overall assignment of subjects per semester could be different, and it makes cooperation rather complicate. In this case bilateral agreements with strict definition of cooperation structure are useful. Riga Technical University organizes studies in module structure in order to give possibility for students to choose the appropriate module.

VII. E – LEARNING PLATFORMS

The developing and using of e – tools is daily academic process in IEEI. The e – platform is used as a storage of study materials. There are both popular platforms used in RTU blackboard and moodle. The introduction of e-education IT applications and automation of administrative procedures leads to sufficient steps forward the creation of the general IT environment. The RTU strategy related to development of e – course for each study subject is specified as one of the University development priorities. The main administrative and e-education tool of RTU named Ortus www.ortus.rtu.lv allows making sufficient and structured content of lectures available for all groups of students at the same time. ORTUS is developed on moodle platform.

The specific training is used at the first stage of education, which includes the special self – made virtual laboratories. For example, in the topic of analyses of control system qualitative parameters the several virtual laboratories are used by students on daily basis. Those laboratories are situated on RTU home page <http://etdv.rtu.lv/index.php/lv/virtula-laboratorija>. This tool is helpful, but for the time being it is not still integrated in common educational e – platform.

The special e – learning course is developed on Blackboard platform. This course covers topic of introduction in control theory. The use of Blackboard platform allows organizing virtual tests and self checking exercises for the students. This methodological approach allows achieving very good results in student's final tests, as well as increasing level of skills developed during the same number of academic hours in comparison with other courses.

The development of common methodological base for study subject's curricula in a frame of TEMPUS project foresees new methodological requirements for e – learning platform. This platform has to integrate all courses in national languages into one technological platform that will allow managing them as shared recourses in daily work with the students. This new approach has to be launched in a frame of new cooperation paradigms in the TEMPUS project "Development of Training Network for Improving Education in Energy Efficiency" (The project has been started in October of 2012). The similar platform will be used also in a frame of bilateral agreements with other partner universities, like agreement between RTU and Almaty University of Energy and Telecommunications of Kazakhstan.

VIII. SHARING EXPERTISE WITH INDUSTRIAL PARTNERS

In order to develop successful carrier of students, and get optimal market uptake of new engineers in frame of professional branch of study program „Computer control of electrical technologies” student practice is foreseen and is very popular among students (see Fig. 6). The relevant practice during the studies gives possibilities to students to find appropriate job in Latvia, but for study program administration gives feed back from employers. In last 10 years the structure of industrial practice has been strictly defined and standardized in frame of study program. Besides that 9 projects financed by European Social Fund were implemented in IEEI for improvement of practice for professional bachelor and study program Computerized Control of Electrical Technology. Employers, which were involved into the implementation of the projects, provided practice places for students. Therefore each student was provided with a mentor – a head of the practice from the enterprise – who performed the teaching of the students and provided everything necessary for the successful process of the practice realization. Among industrial partners where famous Latvian companies: „ABB”, Power supply company A/S Latvenergo Highvoltage networks Latvenergo sub branch TEC-2, SIA „ETM”, SIA „Beijer Electronics”, SIA „OMS”, SIA „Amerilat-MD”, SIA „BST”, Concern “Latvian railways”.

The specialists from enterprises provided the students with some additional teaching of information technologies and software used for control of electrical technologies.



Figure 6. Students during industrial practice in Latvenergo.

The close contact with enterprises and other employers from Latvia allows developing study programs according to the industry requirements for baccalaureate and master level students. Often PhD students are working directly to improve existing technology in order to increase efficiency of a company, or its operations. For example U. Sirmelis has practical results achieved during PhD for improving of public transport vehicles parameters. Installation of energy storage devices in public electrical transport system allows recovering the braking energy of vehicles, thus increasing system efficiency. Energy storage devices have obvious advantages, for example: saving the braking energy decreases operating

expenditures and shortens payback period, flattens the power peaks from substation, etc. In case of transport model optimisation vehicles schedule, parameters of traction substation, energy storage devices (energy and power capability, cyclability, temperature) and price of electrical energy also must be taken into account [8].

Latvian power industry and industry association’s requirement related to managerial, social skill and ability of problem situation resolving are taking into account by IEEI. Therefore project – based learning [9] principles (PBL) become an inherent part of student’s education. According to [10] cognitive skills via PBL is associated with increased capability on the part of students for applying those learning’s in novel, problem-solving contexts. A systematic bachelor, master and particular doctoral course students’ involvement into collaborative projects appears as a more effective approach. Firstly a student participates in a project as an assistant or sometimes as a young researcher among more experienced researchers. At the next step the students develop their skills in student project team headed by experienced senior researcher. Finally the most advanced students could be authorized to independently manage a project team. Therefore student step by step moves forward starting from the projects, in which he or she acts as an assistant, by the state when the student is authorized to manage an entire project [11]

In 2003, the European Council called for a strengthening of the European research and innovation area by creating European technology platforms bringing together technological know-how, industry, regulators and financial institutions to develop a strategic agenda for leading technologies. Since that time European Energy Technology Platform for the Electricity Networks of the Future – SmartGrids has developed Vision Document – April 2006; Strategic Research Agenda – February 2007, and Strategic Deployment Document – April 2009. Those documents are helpful for development study topics for baccalaureate and master students, since industrial platforms actively take part in uptaking of industry interest in European research programs (see Fig.7)

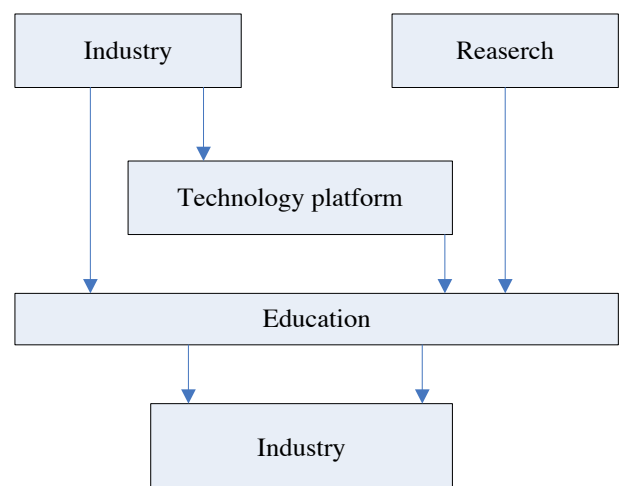


Figure 7. Technological platforms impact in education process development.

The common Platform Mission and Objectives set such targets: fostering and supporting the deployment of SmartGrids in Europe by advising and coordinating the stakeholders, and facilitating communication between the energy technology platforms that will impact the future of the grid on both the demand and generation side.

In its turn SmartGrid European Technology Platform objectives pursue objectives, which should be taking into account in electrical engineers curricula:

1. Building and maintaining a shared vision for the future of Europe's electricity networks and serving as a catalyst for its implementation;

2. To ensure that the vision and its implementation remain focused on responding to the needs of customers and the delivery of European policy;

3. Maintaining a high level strategic overview in order to efficiently communicate sector developments, opportunities, as well as potential challenges;

4. Advocating the development of sustainable energy policy for a more competitive Europe;

5. Promoting smart grids research, development, demonstration, and deployment projects.

The clear example of smart metering ETP, the information available, such as overviews and technology analyses published and disseminated through technology platforms, like "Report Mapping & Gap Analysis of current European Smart Grids" [13] shows the relation between innovations in industry and knowledge based education.

CONCLUSIONS

The implementation and continuous development of e-learning approach for electrical engineers, and in particular for subjects covered by study program „Computerized control of electrical technologies” will bring useful results for other education topics.

A systematic bachelor, master and particular doctoral course students' involvement into collaborative projects appears as a more effective approach.

The development of mutually recognized curricula, based on principle of mutual recognition of the content in native languages, will take a step forward in the development of the sufficient content. The application of such approach for different training groups, including lifelong education curricula, will enlarge the number of trainees.

The synergy of different organizations during the development of IT tools and training approaches will bring additional value due to international expertise and "hands-on cooperation", because it will bring us towards of e-learning quality standards for electrical engineers.

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