

# Research-based approach application for electrical engineering education of bachelor program students in Riga Technical University

Leonids Ribickis

Vice-rector for Research, Academician., Dr. habil. sc. ing.  
Director of Institute of Electrical Engineering and Electronics,  
Faculty of Power and Electrical Engineering Riga Technical  
University  
Riga, Latvia  
Leonids.Ribickis@rtu.lv

Nadezhda Kunicina and Anastasija Zhiravecka

Dr.sc.ing., prof. assoc., senior researchers  
Institute of Electrical Engineering and Electronics, Faculty of  
Power and Electrical Engineering Riga Technical University  
Riga, Latvia  
Nadezda.Kunicina@rtu.lv, Zhiravecka@eef.rtu.lv

Yelena Chaiko

senior researcher  
Institute of Electrical Engineering and Electronics, Faculty of  
Power and Electrical Engineering Riga Technical University  
Riga, Latvia  
Jelena.Caiko@rtu.lv

Antons Patlins

researcher  
Institute of Electrical Engineering and Electronics, Faculty of  
Power and Electrical Engineering Riga Technical University  
Riga, Latvia  
Antons.Patlins@rtu.lv

**Abstract**—*Research based approach in education is important for engineering specialties. The implementation of this approach is interesting for students also. The research possibilities involve all level of education process: pupil's interest is higher, average mark of students is increasing; the number of graduate students is increasing with introduction of research-based approach.*

**Keywords**- *Research-based approach, electrical engineering, bachelor program*

## I. INTRODUCTION

The education in Power and Electrical Engineering is set as priority in many countries, because people have to find ways to substitute petroleum and natural energy resources, which are decreasing in the world each day, to introduce more efficient and safe approaches to the use of present energy resources and significantly decrease unnecessary losses of energy. In different countries, there are large discussions about the rational use of power resources: gradual transition to bio-fuel, use of hydrogen power in transport systems, development of cars with hybrid transmission and electro mobiles.

The countries of the European Union also have declared the beginning of the power engineering revolution towards the same purposes like the same program in the USA does.

The existing contacts with other universities in Europe allow wide use of Erasmus students exchange programme, especially during the process of final papers preparation, such as bachelor and master thesis. According to statistical data from Ministry of Education and Science the number of students of Riga Technical University studying abroad in 2008 was 89 (table 1). The study programme "Computer control of electrical technologies" is popular at international level, at the present moment five of international undergraduate students

are studying at our institute Also students from Latvia are going abroad, for example Vladimirs Skopis and Julija Soboleva the students of professional bachelor program within the frames of Erasmus programme, and now they study in Sweden in King Technology institute / Kungliga Tekniska Högskolan. By financial support for master studies in Germany from German academic exchange centre (DAAD – Deutscher Akademischer Austausch Dienst) this year awarded Armands Senfelds and Edgars Ivanovs .

It is great opportunity to have an experience in international groups, which allows having an international carrier in future. This is a great benefit from Bologna process introduction.

TABLE I. STATISTICAL DATA FROM MINISTRY OF EDUCATION AND SCIENCE THE NUMBER OF RIGA TECHNICAL UNIVERSITY STUDENTS STUDING ABROAD (2008)

Germany	20	Spain	6
Italy	13	Austria	4
Sweden	12	Czech Republic	4
Portugal	10	France	2
Denmark	10	UK	1
The Netherlands	6	Finland	1
Total 89			

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

A leader in Latvia in the electrical engineers education and training is Riga Technical University (RTU), Faculty of Power and Electrical Engineering, Institute of Power engineering, Institute of Industrial electronics and electrical engineering and Environmental engineering Institute.

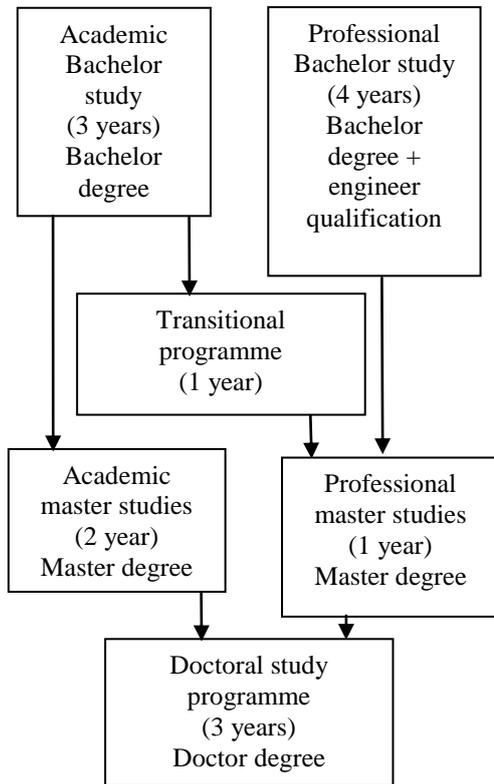


Figure 1. Study levels and education duration for study programme computer control of electrical technologies

Principles of integration of educational process and scientific researches are radical ways of improvement of quality of preparation of electrical engineers education and training in efficient energy production and consumption. The training and research integration principles are presented as efficient way for training of energy-and-resources-saving specialists. Faculty of Power and Electrical Engineering in RTU provides several study programs: Electrical and Power Engineering; Computer Control of Electrical Technologies; Environmental Engineering. Each year more than 250 students enter for the first year studies.

## II. DESCRIPTION OF EDUCATION STRUCTURE

The study programme computer control of electrical technologies is a research based educational programme. Every day research activities are an integral part of the routine work of the staff of the Institute of Industrial electronics and electrical engineering (IEEI). The group of seven senior researchers are realizing research process in the institute. For that branch of activities IEEI has been legally

registered in the state as a scientific institution. This allows applying for European structural funds support programs for modernisation of institution research equipment and financing of young researcher's attraction. Based on the research the staff of the Institute proposed sixteen new patents in 2008. During the same period of time in the institute twenty one patents are submitted. The Institute has published four scientific monographies and forty seven scientific publications in proceedings of international conferences abroad. The students of the Institute defended twenty seven bachelor theses, fifteen engineer projects, twenty three master theses and three PhD theses.

The IEEI working strategy is to fulfil the program „Computer control of electrical technologies” in the fields of industrial electronics and electrical engineering with the specializations in power electronics, adjustable electric drive, automatization of electrical technologies and electric transport, to develop scientific investigations in the field of industrial electronics and electrical engineering, realizing the program, which meets the needs of industry and the graduates of which are competitive at the world labour market.

The education in power engineering on one hand covers education in Energy production and transmission as a study program of Electrical and Power Engineering, on the other hand energy consumption and control in study program Computer Control of Electrical Technologies (figure 2) and possibilities of the decreasing of the impact on the environment in study program Environmental Engineering.



Figure 2. Bachelor students are examining regulation theory application for electrical technologies, using computer simulation

The students of study program Computer Control of Electrical Technologies obtain practical skills and theoretical knowledge in control, designing and operation of the computerised electric technical devices. For successful students with good knowledge of foreign languages (English or German), IEEI provides a possibility of partial training abroad.

The level of technology development demands high qualification and effectiveness of education in the field of electrical engineering.

The number of students of different levels and directions of the studies (including the students of evening and extramural department) is presented in table 2.

TABLE II. THE NUMBER OF STUDENTS OF DIFFERENT LEVELS AND DIRECTIONS OF THE STUDIES

Levels of studies, programs and directions	Number of students total	Nr of graduates
Bachelor studies total	180	27
Bachelor studies (B)	56	13
Bachelor studies (C) profes.	124	14
Master studies (acad)	7	0
2 level professional post-bachelor studies (G)	57	23
Students total amount	244	50
<i>Doctoral studies in „Computer Control of Electrical Technologies”</i>	22	3

Academic studies last three years, during this time the students have basic courses and are to defend bachelor thesis at the end.

During the professional studies the students have in addition practical working experience at industrial enterprises. This industrial practice lasts 6,5 months.

The industrial practice of students (figure 3, 4) is the major part of process of preparation of highly skilled specialists. Practice will be organised in various branches of a national economy at the leading industrial enterprises, firms and establishments of the Latvian republic. According to the program Computer Control of Electrical Technologies, during the industrial practice the student's master practical skills in the work with electric motors and systems, and in automatic control of such systems. Main principles and ways of automatic control, and also possibility of automation of industrial technological process by means of computer management accustom, there is a development of modern techniques, the students receive practical skills in installation and operation of new modern devices and elements in manufacture.

Main areas for research results application are the companies, which produce electrical and electromechanical equipment as well as in designing, process optimisation and service processes, in electrical engineering and technologies supervision and control.

The skills received in the course of an industrial practice, and also materials of any particular production, the device or object of automation, can be used for writing bachelor, engineer or

master degree works. The content of practice, and also the terms of it are defined according to the confirmed curricula and programs.



Figure 3. Bachelor students Maris Gureckis, Ugis Sirmelis are studying industrial power drives in Latvenergo division TEC-2.

Practice is provided both for the professional bachelor and master programs. In programs of the professional bachelor "ECO0" the volume of a practical training is 26KP that in a time equivalent makes work at the place of practice within 16 weeks or  $26 \times 16 = 416$  hours. Since 2009./2010 academic year this practice, in the programs of day training of students is included in the 6<sup>th</sup> semester with the volume of 5KP (80 hours), in the 7<sup>th</sup> semester with 12KP (192 hours), and in the 8<sup>th</sup> semester with – 9KP (144 hours).



Figure 4. RTU supervisor prof. asoc. A. Ziravecka, Supervisor from industrial partner U. Anitens and student A. Shapovalovs at experimental results monitoring of relay systems Latvenergo division at Jelgava city.

If a student has completed the training under the academic program and starts further training under the master program then he/she is enlisted into the transitive program "EGOB" and in the first half of the year passes practice with volume 14KP, and in the second - with 12KP, completing thus the necessary qualification of the professional bachelor practice of 26KP.

Both in the program of the professional bachelor, and during the transitive master year, the student, mainly, pays attention to gathering of a material for the future engineering project the

defending of which provides an obtaining of professional qualification.

The purpose of the practice:

- to apply practically knowledge and the skills received in the course of training under the program of a professional master "Computer Control of Electrical Technologies";
- to get an acquaintance for students with work of the enterprises, and teachers with requirements of the enterprises;
- to involve into the process of formation the organisations-partners, organising practice outside the educational institution;
- to provide cooperation with large, middle and branch small enterprises.

### III. PROJECT-BASED LEARNING METHODOLOGY

The use of project-based learning (PBL) [1] method is the important methodological issue to get sustainable development of economy in Latvia. The RTU is the main higher education structure in Latvia, according to the total amount of students, so the technical development of Latvia is strongly related to the level of education in Riga Technical University. The PBL introducing in RTU is extremely important, for developing innovations, and technical progress in Latvia.

PBL [1, 2, 3] in general provides complex tasks based on challenging questions or problems that involve the students' problem solving, decision making, investigative skills, and reflection that include teacher facilitation, but not direction. Project Based Learning is focused on questions that initiate students to encounter the central concepts and principles of a subject hands-on.



Figure 5. A. Morozovs is now a Bachelor student of study programme Computer Control of Electrical Technologies experiment on material dielectric density measurement in RTU

The main PBL advantages in general [2] are that it: overcomes the dichotomy between knowledge and thinking,

helping students to both "know" and "do."; supports students in learning and practicing skills in problem solving, communication, and self-management; encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success; integrates curriculum areas, thematic instruction, and community issues; assesses performance on content and skills using criteria similar to those in the real work world, thus encouraging accountability, goal setting, and improved performance; creates positive communication and collaborative relationships among diverse groups of students; meets the needs of learners with varying skill levels and learning styles; engages and motivates bored or indifferent students. The main problems of introducing the PBL in RTU are changing the way of thinking of academic staff and students, talking about technical problems to solve it.

### IV. PROJECT-BASED LEARNING METHODOLOGY APPLICATION

The project based methodology application within the frames of study programme Computer Control of Electrical Technologies starts before studies in RTU. IEEI has cooperation agreements and experience to involve in research process also pupils from secondary schools. Pupils during annual project week make research, using RTU facilities, equipment and staff consultation. During the project realisation Riga Ukrainian 12<sup>th</sup> school pupil Aleksandrs Morozs made a research in dialectical features of materials and used RTU staff experience and facilities. Now he is the 1<sup>st</sup> year student of the considered programme (figure 5).

TABLE III. THE NUMBER OF APPLICATIONS FOR THE 1<sup>ST</sup> YEAR FULL TIME PROGRAM IN 2009

Study program	City	State financial places	Priority	Number of applications
REBO0	Rīga	20	1	25
			2	48
			3	8
RECO0	Rīga	35	1	38
			2	15
			3	11
VEBO0	Ventspils	3	1	2
			2	5
			3	1
LECO0	Liepāja	6	1	7
			2	4

There is also quite a large difference in pupil's interests in academic and professional studies. The tendency of last 3 years is that application amount of professional study programme is higher than in academic programme (Tables 3 and 4). In code of programme REBO0 means: is Riga Electric Bachelor (Academic) O Computer control study programme 0 number of group; in

other code RECO0: C means Bachelor (Professional). L and V means education place in Latvian cities Ventspils and Liepaja.

TABLE IV. THE NUMBER OF ACCEPTED STUDENTS FOR THE 1<sup>ST</sup> YEAR FULL TIME PROGRAM IN 2009

Study program	City	State financial places	Priority	Number of registrations
REBO0	Rīga	20	1	8
			2	20
			3	3
RECO0	Rīga	35	1	18
			2	7
			3	1
VEBO0	Ventspils	3	1	2
			2	3
			3	1
LECO0	Liepāja	6	1	2
			2	4

Main advantage in pupil’s questionnaires is a possibility to have practical skills and choose place of future job during practice time.

This thesis was used during pupil’s attraction seminars from 2005 till 2008.

The practical experiment in education means have been shown in pupils attraction seminars in secondary schools and this approach allows to attracts “technically minded” pupils.



Figure 6. Students at factory REBIR (Rezekne, Latvia)

The research based approach education means not only writing thesis, but also visiting industrial companies. During the studies students take part in various cooperation projects with industrial partners. The first steps for Bachelor students

are visiting the partners and preliminary introduction into industry specific field and organization (Figure 6).

The next step is to choose an industrial partner for practice. All the work during practical time including the tasks of the students and their reports about the practice is organized in the way that it brings scientific benefit for the industrial partners. The RTU facilities for experimental work and specific research is of huge interest not only for day time students, but also for part time students, which mainly starts their education after colleges and many years of experience at industries companies.

As the result of research students annually have RTU scientific conference in April. Every year the best students’ works are nominated in RTU senate, and one student from each section will be named and receive gift. It is the first time, when the Cinder’s named scientific organization activity is focused on RTU that means each year the interest in researchers, students and companies is increasing. This year, conferences are organized in computer control of electrical technologies, intelligent electrical transport programming and intelligent electrical transport modelling section. There were more then 57 students and Riga State Gymnasium pupils’ scientific works results presented.



Figure 7. Student A. Braufmans is defending his bachelor work demonstrating physical results

The use of the project based approach allows adding also Bachelor and engineering projects with practical application (figure 7).

During the studies students also have been involved in research projects, the involved students are specially pointed as a criterion for support of RTU internal annual research projects. Also international cooperation projects mainly at doctoral studies level, but also some bachelor students are involved (figure 8).

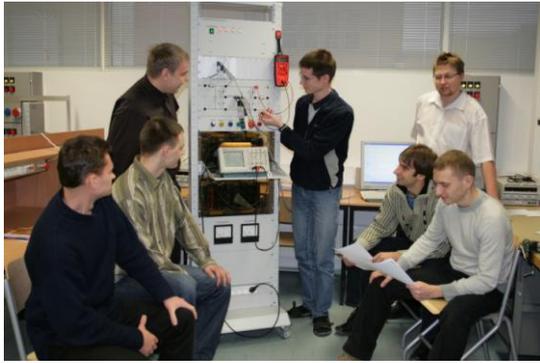


Figure 8. Students during the period of school for post-graduate student

## V. AWARDS

The best students' works annually are nominated at various competitions. Industry partners and state organisations support best student's research.



Figure 9. Prof. I. Rankis (standing the fourth at the right), prof. L. Ribickis (standing the fifth at the right) at the ceremony of winners awarding of organized by Siemens competition „Werner fon Siemens Excellence Award”, M.sc.ing. M. Pletņova (sitting the second at the right) and Dr.sc.ing. A. Vitols (sitting in the middle).

Many students within last three years have received a special prize in honor of Werner fon Simens for the best master and doctor's thesis in the sphere of the exact and technical sciences. Many students IEEI have been awarded with this honourable prize: A. Vitols (Figure 9) for doctor's thesis „Research of the power-electronic converter for bidirectional energy flow of traction substations”, O. Krievs for doctor's thesis “Investigation and development of control systems for active filters of power electronic converters” I. Rodionova for doctor's thesis "Investigation of the effectiveness of AC electric trains direct current electric drives"; M. Pletņova for her master thesis " Main Tasks and Realization of Automation of Oil Products Storage and Transportation ", A. Vilks for master thesis " Investigation of

Possibilities to Improve Electric Magnetic Compatibility of Thyristors Regulated Reactors ".

IEEI students regularly participate and are being awarded in competitions of degree works which is organised every year by the Riga Dome, the Latvian fund of formation, the Latvian association of electroenergetics and power builders, company Latvenergo and ABB Ltd.

## VI. CONCLUSION

The application of project based learning approach in electrical engineering studies is the main instrument to reach acceptable level of specialists and, as a consequence, of industry in Latvia.

The research possibilities involve all level of education process: pupil's interest is higher, average mark of students increase; the numbers of graduate students are increased after introduction of research-based approach.

At least seven activities should be continuously realized for the successful organization of the engineers and other specialists educational and training process: education should be continues, from school, the young researcher centres should be supported, the competitions and other pupils attractions should be used to attract people into engineering science; attraction of talented pupils and explanation for teachers should be made continuously; students' scientific conferences should be organized; competitions with significant prizes should be organized for pupils and students.

The analysis of case study at IEEI, which is a leader in RTU in project-based learning application, shows that such strategy application could give a two times increasing of the number of students at the program that in its turn increases the flow of financial resources of the institution more than two times as well as it can significantly improve the quality of education and the range of students' and further specialists' knowledge and skills.

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