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DISCIPLINE OF PROFESSIONAL TRAINING IN ENGLISH AND LIFELONG LEARNING OF FUTURE SPECIALISTS IN POWER ENGINEERING

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Abstract- In the paper author represents the influence of mastering the professional disciplines in English for the future specialists' competences in power engineering, the impact of the special subject courses in non-native language for lifelong learning. The bachelor and master degree student curriculum are analyzed according to share of disciplines contact hours. The results of integrating the new engineering tasks of the top levels of Bloom's taxonomy are described in details. Anonymous survey of undergraduate and graduate respondents illustrates the successfulness of the designed class structure. The recently developed tasks for laboratory works are granted and possible scenarios for their adoption in the educational process are illustrated.

Keywords: Lifelong Learning, Curriculum, Fundamental Discipline, Professional Discipline, Hard Skills, Soft Skills, Power Engineer, Bloom's Taxonomy.

1. INTRODUCTION

Nowadays, the processes of science and technology are characterized by amazing rate, everything is changing very quickly being developed and improved. Modern engineer as well as a high school graduate should be able to acquire information, apply the relevant achievements of science and technology, and interact with colleagues abroad. Moreover, innovative solutions of professional problems require an approach beyond the traditional limits. Obviously, polytechnic universities all around the world should focus on the professional training in English by implementing modern educational technologies.

It is evident that the higher education institutions should focus on the modernization of the training path of future specialists. In this context, the new ways in the educational process gives to the engineering schools an opportunity to meet the requirements of the industry. New challenges and possibilities for academic staff and students require upgrading of educational programs. The combination of hard skills (professional disciplines mainly) and soft skills (English proficiency, for instance) requires:

1) authentic materials as the educational resources (for lectures, seminars, etc.);
2) a new approach for outcomes assessment;
3) modern technologies for effective educational process arrangement.

Progress in power engineering equipment, design, and technologies lead to rapid "aging" of graduates' knowledge. Therefore, most of obtained knowledge may become irrelevant within 10-15 years in average. In this case the crucial goal of modern education - is to develop sustainable hard and soft skills and to motivate to lifelong learning [1, 2]. For example, the South Korea priorities the e-learning as an instrument for enduring study and have founded few cyber universities with electronic educational services that are focused on conception of professional knowledge and competences growth. The lack of natural resources of the country are substituted by the human resources and new breakthrough in science and technology. Graduating the university all students are taking the English exam as very important soft skill for future engineers despite the plans and prospects of further studying abroad or been employed in international company.

Solving the modern engineering challenges requires to take into account not only sophisticated devices choice but also economic, environmental aspects, footprint of designed installation [3]. Therefore, the once obtained knowledge educational way is replaced by the process of progressive self-education. Teachers' responsibility in this case consists in:

- To apply the innovative professional information, up-to-date technologies in educational process,
- To structure the authentic materials and design assignments and projects according the Bloom's taxonomy,
- To synchronize the course materials with initial English level.

Contemporary professional competences are formed by taking into account the regular amendment of the disciplines content. Thus, it becomes visible that the modern teachers and students should be ready for continuous adapting to a constantly changing world [4]. Assuredly, the Bloom's taxonomy may be applied to course design and lectures, practical training and labs planning as an effective tool.

2. CURRICULUM ANALYSIS

For analysis, the curriculum for bachelor and master degree students training of the Tomsk Polytechnic University, Russia was chosen, the specialty is "Automation of Power Plants and Power Systems".

2.1. Bachelor Degree Curriculum

Entering the university for bachelor training, students are firstly study the fundamental (general) disciplines that are the basis for professional knowledge. From semester to semester the general or fundamental disciplines quantity is reduced while the professional disciplines are becoming predominant (Figure 1).

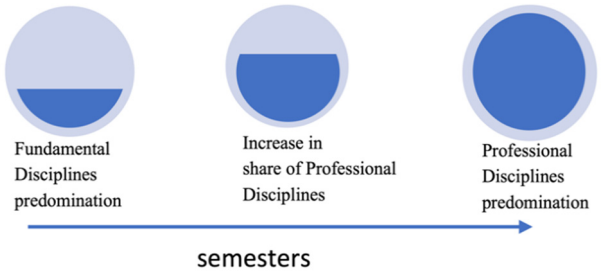

Figure 1. Distribution of the disciplines through semesters [5, 6]

In bachelor degree curriculum:

– "General English" discipline - 432 hours in total (were included in general/fundamental disciplines). Students are trained by linguistic teachers.

– "Professional Training in English" - 288 hours were included in professional disciplines (Figure 2). These disciplines are delivered by professors of engineering departments. Requirements to language and pedagogical skills of such instructors are considered as ultimately high [5].

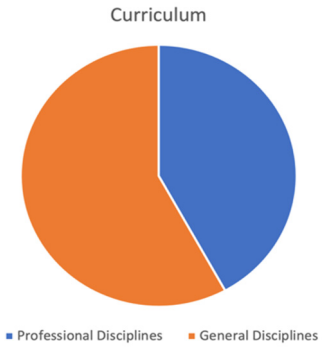

Figure 2. Share of general and professional disciplines for the B.Sc. curriculum [5]

General English is delivered at first two years of education and on the learning outcomes the next foreign language training is based. Traditionally, students are prepared for passing equivalent of Cambridge exam in the end of the eight semesters. From fifth to eight semesters scholars study the special subjects in English. Professors of the Institute of Power Engineering are involved in delivering classes on "Professional Training in English". Therefore, the classes content is focused on materials related to the future specialty of students.

2.2. Master Degree Curriculum

The "Professional Training in English" discipline, 216 hours in total, were included in share of professional disciplines (Figure 3) [6].

Figure 3. Share of general and professional disciplines for the M.Sc. curriculum [6]

Achieving the learning outcomes is provided by authentic literature (textbooks, scientific papers) or video resources of equipment manufacturers (Alstom, Siemens, General Electric, Prefetch, etc.), catalogs of power equipment of world well-known companies, reference books, schemes of the electrical connection of power plants and part of power systems, labs, conferences, presentations, online course in LMS Moodle [7, 8]. The final task is to write one chapter of master degree thesis in English. Optionally all the thesis may be completely fulfilled and defended in English. Obviously, the language knowledge of student is expected to be extremely high in this case.

For analysis, students survey was conducted between bachelor and master degree students of the Tomsk polytechnic university at the entering and before graduating the course "Professional Training in English" [9, 10]. Students were asked to assess their ability and readiness (from 0% to 100%) to be involved in various tasks that were used for achieving the learning outcomes (Table 1). The percentage in the chart indicates:

- Tasks focused on memorizing the information are the most suitable for starting the professional course in non-native language.
- Paper based assignments are psychologically more comfortable than listening and speaking tasks.
- Creative tasks are challenging for most students at the entering the course.

It should be noticed that master students have no obligation to use traditional solution for project tasks. Freedom in solving engineering tasks inspired them to find creative solution and overcome language barrier, be more familiar with nameplate parameters of electrical equipment in English, be able to find appropriate information for power system protection design projects, for instance, and for the compulsory master thesis chapter written in English consequently.

Table 1. Survey of B.Sc. and M.Sc. students

Participants / Tasks	Bachelor students		Master students	
	before %	after %	before %	after %
1. authentic texts (reading, translating, fill in the gaps, reconstruction)	58	94	78	99
2. tests, quizzes	55	93	67	98
3. authentic video (to watch, to answer the questions, to fill in the gaps)	33	79	63	86
4. labs (topics are not new)	64	91	70	99
5. individual projects	28	88	36	92
6. presentation (individual topic)	21	77	40	91
7. conferences, discussions	8	52	35	69

3. CREATIVE PROFESSIONAL TASKS

Taking into account few years' experiences of delivering professional topics in English and relying on deep analysis of some scientific papers devoted to the Bloom's taxonomy application to designing courses for future engineers tasks are recommended to be formed in accordance with cognitive levels (Figure 4), from the terms repeating at the very beginning to the analysis of the calculation results, proposing the better technical solution, and finally evaluating the chosen in the project equipment [11].

Figure 4. Bloom's taxonomy cognitive levels [11]

Choosing the proper materials for master students trained by the "Professional Training in English" discipline is obligatory to analyze the next initial information:

– Students' background on professional disciplines,
– Students' English language level,
– Hours for face-to-face classes,
– Declared in syllabus the learning outcomes after graduating the course.

In average, master degree students have the intermediate or even upper intermediate English level, what is enough for future success in professional activity and readiness for self-mastering new information connected with progress in power industry. For master students the creative tasks are more practical, interesting and effective.

3.1. Switching Procedure Simulation

Last year the new lab assignment was developed and involved in the educational process. The main idea is to focus more on switching procedure instead of English (Figure 5). Scholars were very enthusiastic at implementing simulation of switching procedure for the scheme with two work buses and transfer bus, traditionally used for 110 and 220 kV switchyards in Russia. This scheme was chosen for lab as the widely used in the course project "Power Plants and Substation Design", delivered in Russian. Listeners were asked to explain the procedure of circuit breaker repair with no power supply interruption. Errors are alarmed in visual and sound way with comments of load lost, for example. Having fulfilled the procedure, students overcome some inconvenience in using English for professional tasks and also noticed the better terms memorization.

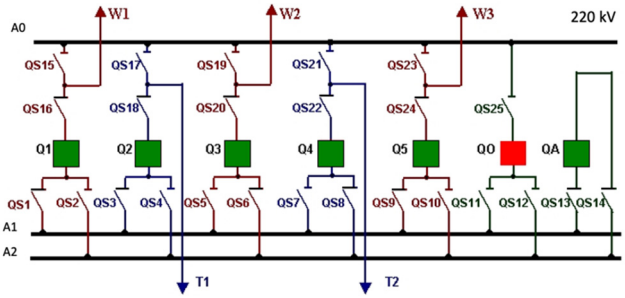

Figure 5. Simulation of the switching procedure [8]

3.2. Switchyard Modernization Analysis

In the discipline "Power Plants Design" that is delivered in Russian, students have to complete the individual course project. Traditionally, the main scheme solutions and chosen equipment are characterized by conventional approach and rather obsolete design. For the same course delivered in English it was proposed to retrofit the high voltage switchyard from the design power station with the replacement of:

- Air blast circuit breakers and free-standing horizontal center break disconnectors with modern disconnecting circuit breakers (DCB),
- Measuring oil-filled current and voltage transformers with modern optical current and voltage sensors,
- Reduce the switchyard footprint as one of the contemporary demands.

Students were asked to find solutions beyond their previous educational experience. There were only two requirements, modern solution and authentic literature as the sources of information.

The one of the variants of final 500 kV switchgear scheme layout by applying the catalogues of world leaders in power industry manufacturers and ABB-Hitachi simulation is represented at the Figure 6 [12]. The footprint reduction approximately 90% by using DCB and ring bus scheme and about 35% only for breaker and a half scheme layout.

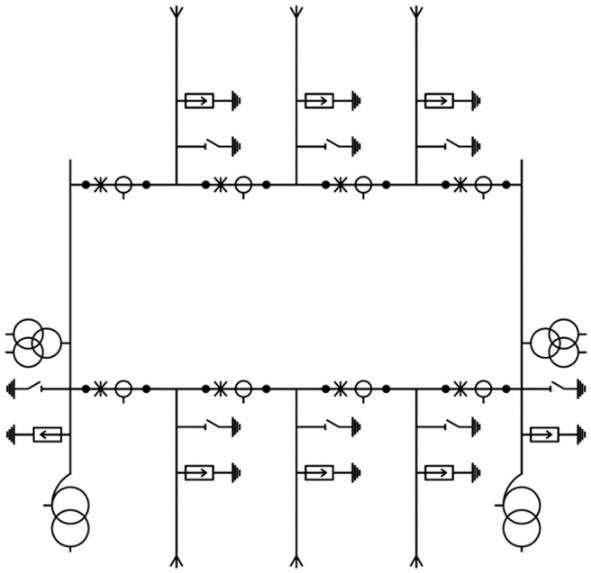

Figure 6. The principal scheme of modernized 500 kV power plant switchyard [12]

3.3. Online Substation Design

Based on the course project task and with support of educational aid the web page for online substation design was developed by master degree student. At the current stage the HV switchyard parameters in normal and abnormal conditions for further scheme components selection are available [13]. Students are able to choose the voltage level, consumer category, other important parameters of the electric installation as a part of power system. For high voltage substation design was chosen the scheme with two power systems and two autotransformers connecting three switchgears. The initial parameters that are obligatory for online substation design are:

- Voltage levels of sources and loads
- Systems apparent power in MVA and per unit reactance
- Length of transmission lines entering the switchyards
- Quantity and capacity of load connections at medium and low voltage levels
- Ratio of load simultaneously
- Power factor magnitudes
- Maximum operating hours for loads
- Consumer categories

The list of switchyards for 220-750 kV according to the last recommendations of Russian Ministry of Power Engineering is available with comments about quantity of bays and voltage level. The online procedure completely satisfies the requirements to modern substation design and form the new competences, hard and soft skills of future specialist in power engineering, like:

– Ability to apply new technology for labs or problems solving,

– To analyze initial data, to assess calculated parameters and to find the best engineering solution for the substation project,

– To be able to use English in the professional activity (active vocabulary is formed rapidly compare to the traditional approach of terms learning by heart, for example).

At labs the scholars follow the individual variants of input data for HV substation switchyard design and download the report with data:

- Power demands at medium and low voltage levels,
- Total power demand for three windings transformer or autotransformer sizing choice,
- Rated current in normal mode,
- Equivalent reactance of the scheme according to the place of short circuit,
- Periodic current at zero time of short circuit,
- Aperiodic current of short circuit,
- Peak current of short circuit,
- Short circuit thermal withstanding magnitude.

For correct report result the timing of circuit breaker contacts opening, minimal time of protective relaying and auto reclosure time have to be analyzed and selected.

After receiving the online report with calculated scheme parameters their task is to select the circuit breakers, disconnectors, instrument transformers, scheme layout. It is a non-verbal part. Improving speaking skills is accomplished at the defending the completely designed modern switchgear by answering the instructor question or group discussion. In the future the medium and low voltage level parameters calculation, catalogues of different manufacturers with nameplate parameters of modern equipment will be developed and include in the appendixes of web page.

4. LIFELONG LEARNING COMPETENCES FORMATION

Creative tasks in the course design are the crucial motivational tools, which have to be implemented in the educational process for outstanding learning outcomes. Independent learning and motivation to lifelong learning of power engineers in the future could be considered as the challenging educational and professional growth paradigm of 21st century education [14, 15, 16]. The post-industrial economy requires specialists with high motivation for self-development, engineering curiosity and constant researches for innovations in technological process of generating, transmitting and consuming the electrical energy, which is possible with the integrating of a personalized approach in education.

The simulation of professional tasks in English by deploying in educational process is a unique method that will provoke students for:

– Adopting, adapting, applying best international achievements in science and technology, like state-of-the art-equipment

– Using materials, data, parameters in both, native language and English

– Becoming a digital engineer

– Studying all their life

Having delivered the classes on "Professional Training in English" for about ten years, conducting annual students survey, analyzing the learning outcomes achievements it is possible to declare that combination of

professional and English skills is the best tool for modern engineers training and their lifelong learning encouragement.

The lifelong learning competences formation of cutting-edge engineers may be described as the result of overlapping the professional and fundamental disciplines, general and professional English (Figure 7). Outstanding learning outcomes maybe achieved by integrating creative tasks in English close to real engineering practice at electrical installations.

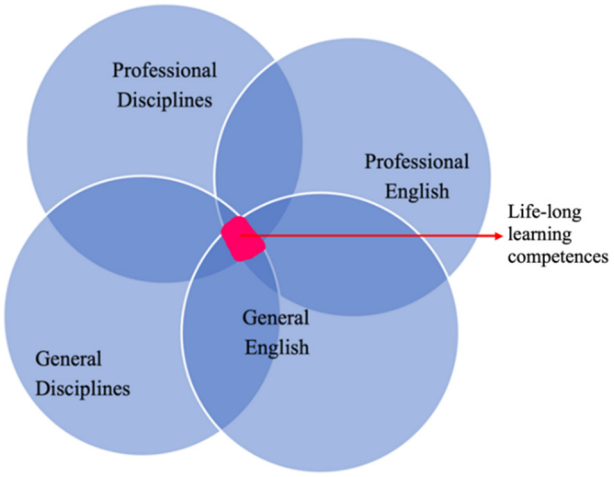

Figure 7. Lifelong learning competences formation [2]

In addition, the fifth and very important component - industry internships, as for purposes of new engineer formation, may be considered as supporting technology with capability to examine modern equipment and reliable cooperation between manufacturers and power objects personnel. Notwithstanding real practice significance the result is highly dependent on the company, the head of the internship and the installed equipment. Currently, the main problem is some mismatch of energy sector real time expectations and the high school's orientation to innovative specialists training.

It should be noted that the organization of the internship should be focused not on the traditional format in education, but be out of frames, be flexible in terms of orientation to the current requirements of the labor market. In recent years, the concept of "half-life of knowledge" has been introduced. At the stage of formation of the energy sector, this period was at least 10-15 years. Now, according to various estimates, knowledge becomes obsolete within 2-5 years. Objectively, the development, implementation and improvement of optical measuring transformers, DCB, GIL, digital protections and automation require constant skills and knowledge mastering from the electrical engineer.

Unfortunately, the economic realities and constraints of last years caused by the coronavirus pandemic have limited internship opportunities.

5. CONCLUSIONS

The lifelong learning is a topical issue for new specialists training in the field of power engineering at a current moment. Updating requirements to power industry oblige engineers to find new technological solution both for existed objects (for retrofitting) and for new mounting electric installations. Forming the professional competences demanded by the 21st century power objects is not possible to fulfill without integrating English in the curriculum of bachelor and master degree students training as non-native speakers. Language knowledge as soft skill is crucial and an integral part for further self-studying success, motivating for cutting edge equipment application with decreased level of human errors connected by some misunderstanding.

Real practice provided by the manuals and authentic text translation by specialists in linguistics do not reflect the correctness of technical terms which are of paramount importance for making the right decisions in the field of design and operation. Supporting the professional disciplines in English by special software, simulations, other new technologies is really significant. Extremely important that all the means and devices for labs are designed with maximum similarity to the actual operating conditions of electrical installations that future specialists will face upon graduation the university.

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