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Получено 01.09.2015

УДК 802.0 (045)

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MACHINE AND MECHANISM SCIENCE (MMS) STUDY IN RUSSIAN UNIVERSITIES: COMMUNICATIVE ASPECT

Introduction

The paradigm of engineering activity at the beginning of the 21st century undergoes changes related to: rapidly changing social and economic environment in most of countries; development of informational technologies; globalization of labor market; empowerment of technosphere influence on nature. The system of engineering education must also adapt to the changing environment.

Mechanism and machine science is one of the key engineering study courses largely determining the progress in the field of material production. MMS covers studying a wide range of objects and phenomena in technosphere, beginning from considering simple mechanisms up to analysis and synthesis of complex mechanical systems controlled by artificial intelligence. It accumulates the latest achievements in mathematics, computer science, and other engineering study courses.

At the same time, one should acknowledge that the quality of professional graduates has been insufficiently high in recent years. As for Russia and USSR universities, MMS educational schools have been traditionally high there and our scientists determined the level of this area of science along with foreign colleagues. However, for political reasons students were cut off the foreign academic and industrial practice of the relevant MMS. Political transformations in Russia within the latest 20 years led to opening the world-wide information media, but, on the other hand, they negatively influenced the sphere of Russian industrial production.

In recent years the critical aspects of preparing the future engineer capable of responsible creative activity within international division of labor are: application of progressive informational technologies of design and analysis of machines and mechanisms, access to international databases, and acquaintance with the advanced experience in this field.

Effective professional communication as a necessity for advanced engineers

Nowadays significant changes are taking place with regard to professional activity of a technical expert. The determining factors here are global changes in social and cultural sphere (in particular, globalization of labor markets, ability to apply international knowledge bases), common transition to information knowledge based industry, increasing the risk of technogenic disasters, increasing the level of independent professional activity and responsibility for its results, appearance of cross-discipline problems and other. These changes are of great influence on the contents and methods of professional engineering education, in particular, we observe the growth of a number of key professional competences of technical university graduates. Table 1 shows the contents of the professional engineering competence according to M.E. Jones [1]. Researches show, that representations of key professional competences of “future engineer” have the general meaning both for different countries and different branches of economy (both high-tech and less advanced ones). This can be explained by the fact that all engineering companies face the same competitive challenges in the global economy.

Table 1. **Attributes of an engineer**

Attributes of an engineer	
Technical	Ability to think mathematically
	Sound knowledge of appropriate basic science
	Good knowledge of a specific study course
	Maintenance of current knowledge and practice
Personal	Ability and willingness to learn
	Appreciation of limits to knowledge
	Good communication skills
	Appreciation of international dimensions
Professional	Commitment to high standards
	Appreciation of personal and ethical issues
	Ability to handle uncertainty
	Ability to communicate effectively
	Ability to communicate effectively in more than one language including English
Managerial	Ability to work in a team
	Appreciation of management concepts and issues
	Ability to lead and manage personal, financial and technical resources

Therefore, the latest trend is the inclusion of the communicative component (including the foreign language) into the professional competence. Both writing and spoken communication skills (including the foreign language) are the key to professional engineering success. Necessity for students to acquire these skills and necessity to develop the corresponding education programs are considered by the American Organization on ABET (Accreditation Board of Engineering and Technology) as one of 11 key criteria of evaluating the graduates and scientific programs [2].

Engineering Disciplines Teaching in English to Future Mechanical Engineers

Twenty years ago (in the mid 1990s) Kalashnikov Izhevsk State Technical University (ISTU) was the first to start the innovative at that time program of advanced teaching the students (future mechanical engineers) in English. It was initiated at the Robotic Department (nowadays called Institute of Advanced Techniques in Mechanical and Automobile Engineering and Metallurgy). The mainspring to start this program was the demand for advanced studying the foreign language at the level of professional communication (with regard to students), and the increase of the production engineer major credibility and university reputation (with regard to university administration).

The specific feature of the pilot project was that professional education process of students was adapted to the education plan standard for their major, but a certain number of classes had to be taught in English. The purpose of the project was to train graduates entirely possessing the professional competence and foreign language communicative competence within the professional scope, that is, capable to carry out professional activity in both native and foreign (English) languages. Problems and prospects of bilingual teaching have been considered in many different aspects [3–5].

English-language educational courses have been developed and successfully taught for *fundamental study courses* (Math, Physics, Philosophy, History, Computer Science, Chemistry, etc.) ; *basic and special engineering study courses* (Engineering Drawing, Mathematical Modeling, Strength of Materials, Theoretical Mechanics, Machine and Mechanism Theory, Machine Design and Drawing, Machine Parts, Fundamentals of CAD and Programming, Production Processes, etc.); *special linguistic study courses* (Fundamentals of the theoretical grammar and lexical rules, Fundamental concepts of translation theory, pragmatic, semantic and stylistic aspects of translation, Practical Course of Professionally-Oriented Translation, etc).

The beginning of integrated classes fell at the first part of 1990s when there was no wide access to foreign language educational resource databases through internet, foreign language textbooks on engineering study courses were not sold in Russia and they were extremely expensive to be bought abroad. That was why teaching instructors on engineering and fundamental study courses had to overcome significant difficulties when developing their education courses. They aimed at developing the foreign language education material not as the “calque” of the Russian-language one. They had to be self-independent, innovative and possess certain features of authenticity. Foreign language textbooks and scientific literature had been studied at the libraries of the University and Udmurt Republic, and in libraries of Moscow, Saint-Petersburg and other cities. Different bilingual specialized dictionaries and reference books had been used in the development process. The result of the thorough methodical work was publication of the following study guides and text-books in English, see some of them [6, 7].

Two-three years after the project start-up at Robotics department for the “Production mechanical engineering” major, this experience had been propagated to other majors: “Mechatronics” (Quality Control Department) and one major of the Computer Science Department.

Since 1996 the project of integrated education had been propagated to teaching in German for the “Mechatronics” major and its elements had been used when implementing the probation program for students of Heat Engineering Department in universities of Germany.

Comparison results show that the academic performance for student of experimental groups turned to be 8–15 % higher as compared to results of students from reference groups. The results indicate a rather high level of quality of integrated learning when speaking about MMS and English.

Along with their high professional level in their engineering major, ISTU graduates of integrated education revealed the following skills and traits of their professional identity: fluent spoken and written English; advanced level of PC mastering; capability of working at several problems simultaneously both independently and as a part of an international team; capability of working with different official documents both in Russia and abroad; capability of negotiating at a high international management level; personal traits as responsibility, crea-

tivity, initiative, communicative skills, learning ability, neatness, executive abilities, stress resistance; profound analyzing skills, etc.

For the whole period of this pilot program execution the total number of graduates is above 300. The available information shows that the acquired competences help the graduates find a good application of their skills as scientists, engineers, interpreters, managers, and technical experts.

For different economic reasons the project of integrated teaching was stopped in 2010, but it was partially revitalized in 2011 and the accumulated experience of teaching different classes in English helped a lot to teaching instructors of the university when foreign students showed interest in studying technical courses in Russia. Developed guidelines, tutorial support, teaching packs, textbooks and professors already skilled to deliver lectures, to perform practical and laboratory works for teaching engineering courses to students in English within a Russian university were ready to be immediately implemented for teaching students from different countries (China, Egypt, Syria, etc.) since 2012. Moreover, the accumulated experience of teaching engineering courses in English within Izhevsk State Technical University allowed teaching instructors to deliver lectures in authoritative world-known universities, thus increasing the authority of Russian education institutions.

Engineering activity is associated with making decisions and taking responsibility for these decisions. In order to implement such an activity successfully, an expert should possess the necessary knowledge in his professional scope and in related areas. Ability of an expert to self-educate during his long-life professional career to obtain new information, to acquire advanced skills and experiences is also of great importance. Experience shows that mastering only a native language limits professional scopes and narrows down the horizons.

Studying the foreign-language education information, its mastering and comparing with native language information makes it necessary to apply bilingual and multilingual dictionaries for terms and concepts in MMS. To our opinion, special academic dictionaries-thesauruses are more preferable for classes when compared with technical dictionaries with an alphabetic order of terms appearance [8, 9].

Logics of making-up such a dictionary of thesaurus type implies revealing the descriptors specific for different theories (and chapters) of MMS study course and their grouping according to a definite law. It determines the name of the very dictionary and differentiates it from general purpose technical non-structured dictionaries.

Classes of descriptive units include: basic notions, formulae with special names, names of mechanism links, derived notions, and others. The system of classes follows the structure of study course of TMM/MMS teaching in Russian technical universities.

The Russian-English academic dictionary-thesaurus for the study course "Theory of mechanisms and machines" (TMM) [10] is composed on the basis of Russian-language academic thesauruses of the theoretical and applied mechanics, developed by Prof. Yu.N. Semin [11]. When translating terms, classic and advanced English and Russian textbooks on MMS, on-line dictionary of terms within the official web-site of the International Federation for the Promotion of Mechanism and Machine Science (IFToMM), technical dictionaries, Russian and foreign scientific papers on individual issues of the study course have been studied.

Dictionaries-thesauruses can be used both as the auxiliary education means and independently. The example of an independent usage can be the students' tuition to translating and making-up foreign-language specific terms.

Integrated Teaching in English at ISTU as the Pre-stage for Students' International Olympiads on MMS

Development of integrated optional classes on theoretical mechanics (MMS) in ISTU in 2011 was caused by the objective reason. In 2009 the Executive Council of the International Federation for the Promotion of Mechanism and Machine Science (IFToMM) initiated international subject students' Olympiads in MMS (Student International Olympiad on Machine and Mechanism Science – SIOMMS). The decision was made to hold the first international students' Olympiad on MMS in Kalashnikov Izhevsk State Technical University [12].

The procedure of carrying out the Olympiad SIOMMS–2011 implied solution of 8 competent tasks during 4 hours. The text of tasks had to be presented in English, the solution had to be written only in English. Since Russian universities were unready to provide teams of students fluent in English with respect to MMS, the organizing committee of the first international Olympiad made exclusion and accepted presenting equal texts both in Russian and English.

By the time of holding the first Olympiad the project of the integrated teaching of production mechanical engineers had already been closed, the latest graduates left the university in 2010. That was why at that time there were no students at the "Theoretical Mechanics and MMS" department good at both major and English. Within these conditions a team of three students had been formed without knowing English at all. The team won the fifth place.

According to the SIOMMS constitution, the second Olympiad had to be held two years after the first one. It was entrusted to the Shanghai Jiao Tong University (China). Of course, no Russian version of tasks could be given to participating students. That was why the question arose to train the team of students knowing English within the scope of mechanical engineering.

For this purpose, first-year students of Civil Engineering department were chosen because of their high intellectual capabilities and because of a long enough period before the Olympiad to make a thorough efficient training. There were two stages of the training process. At the first stage the students were invited to attend optional additional classes on theoretical mechanics (as the study course preceding the Machine and Mechanism Science and related to it in terms of definitions). At the second stage a group was determined to be prepared for the SIOMMS-2013 in English.

The main purpose of integrated optional classes on theoretical mechanics in English was to create the environment favorable to form the foreign language communicative competence within the subject matter. Another (but not least) purposes were providing a student with the possibility to thorough understanding the subject and acquire more profound knowledge in MMS.

MADI experience

As far as Moscow Automobile and Road Construction State Technical University (MADI) is concerned, a great experience has been accumulated in the field of development and implementation of educational programs jointly with universities of European Union countries, intended to teach future engineers and also to create favorable conditions for young experts to adapt in a foreign-language environment.

For example, Department of Logistics and General Transport problems of MADI is implementing with Otto-von-Guericke University (Magdeburg, Germany) the educational program of teaching the Masters' major "Logistics in transport systems".

The structure of the syllabus of Master's degree program HDM "Roads design and control" has been developed within the program Tempus by the group of authors with MADI being part of this group. The program is intended for two academic years (4 semesters), 120 ECTS (1 ECTS corresponds to 30 academic hours) and it comprises 12 educational modules, practical training of students, working-up and presentation of Master's Thesis.

MADI takes and active part in development of programs for engineering education which are relevant in a technical university. International educational activity is organized in this direction within events of IGIP. Scientific and scientific-educational fundamentals have been created in MADI to develop the system of teaching and increasing the effectiveness of teaching instructors of technical educational organizations of Russian higher educational institutions to be integrated into IGIP system. Significant attention is paid to acquiring foreign-language competences within the professional activity.

Twenty years ago MADI initiated the creation of Russian monitoring center of International Society on engineering education that united representatives of universities of Russia from the Far East to the North-Western region of Russia.

MADI acted as the leader and active participant of developing the requirements to the structure and contents of educational programs covering the training, advanced training and increasing the effectiveness of teaching instructors of technical engineering study courses and also the qualifying requirements to a teacher of a technical university interconnected with European and world-wide educational systems.

At present time the Design and Mechanical Department of MADI is implementing the educational program of Master course "Machine Science and Machine Parts" jointly with the University of Naples Federico II.

Within training according to this educational program and as specified in the Agreement on Cooperation between MADI and the University of Naples Federico II the Master's degree student of MADI is on practical training now in Italy.

Cooperation between educational organizations of higher education of the European Union countries allows solving a number of high priority tasks:

– to develop and start implementing the joint engineering Master's programs on basis of the innovative educational media;

– to train the personnel capable of implementing the program by means of advanced techniques;

– to develop the strategy and concept of academic mobility;

– to converse to developing the practice-oriented programs based on requirements to education results;

– to develop the rules and regulations for implementing the joint programs with account of academic mobility [13, 14].

Conclusions

Effective engineering education, including MMS area, is determined, to our opinion by the following aspects:

– knowledge of professionally-oriented English to communicate within the world-wide scientific and production society;

– access for student to national and international databases on engineering themes;

– possibility of professional training at production enterprises,

– possibility of professional training at foreign university and laboratories;

– integrating the Russian educational institutions to international professional communities;

– availability of some forums for communication of young researchers and engineers [15, 16];

– possibility to exhibit the creative potential within competitions and contents (for example, participation in Olympiad on MMS).

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Получено 13.01.2016

УДК 371.38

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К ВОПРОСУ О ФОРМИРОВАНИИ СОЦИАЛЬНО-ЭКОЛОГИЧЕСКОЙ КОМПОНЕНТЫ ЭКОЛОГИЧЕСКОЙ КУЛЬТУРЫ ШКОЛЬНИКА В УСЛОВИЯХ ВВЕДЕНИЯ ФЕДЕРАЛЬНОГО ГОСУДАРСТВЕННОГО ОБРАЗОВАТЕЛЬНОГО СТАНДАРТА ОСНОВНОГО ОБЩЕГО ОБРАЗОВАНИЯ

Сегодня, не изменяя сознательного отношения к окружающей природной среде, нельзя остановить экологический кризис, начавшийся еще в XX в. Отсутствие единства между обществом и природой еще более обусловило потребность формирования бережного отношения каждым индивидом, каждой личностью к окружающей природной среде.

На решение данной проблемы было уделено внимание еще в Экологической доктрине РФ от 31 августа 2002 г. № 1225-р, указывающей на необходимость обеспечить приоритетность экологически ориентированного образования путем реализации государственной политики в области экологии в регионах средствами экологического образования и просвещения. Согласно этому документу обучение во всех предметных областях знаний общего полного образования должно основываться на цепочке взаимосвязей и взаимозависимостей в системе Человек – Общество – Природа.

Поскольку природа – это не только среда существования общества, но бесценная кладовая тех ресурсов, которые необходимы человеку в производственной деятельности и в повседневной жизни, необходимо отметить, что одна из задач современного экологического образования школьников заключается в формировании ответственного отношения учащихся к социально-природной окружающей среде на основе усвоения системы научных знаний, овладении практическими умениями и навыками.

Согласно действующим ФГОС основного общего образования установлены требования к личностным результатам освоения обучающимися основной образовательной программы основного общего образования, в том числе «п. 9. Формирование основ экологической культуры, соответствующей современному уровню экологического мышления, развитие опыта экологически ориентированной рефлексивно-оценочной и практической деятельности в жизненных ситуациях». К метапредметным результатам освое-