THE MODEL OF UNIVERSITY TRAINING OF PROFESSIONALS FOR THE IRON AND STEEL INDUSTRY

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Abstract: The model of approach to designing educational programmes of professional engineering personnel training for research activities, creation of new products and development of iron and steel works is proposed. The model differs from the traditional approach within the education massification, it differs in certain academic mobility, freedom and a personalized approach to students.

Keywords: design of engineering educational programmes for the iron and steel industry, inter-disciplinarity, multi-professional competences, engineering personnel competences, mass, personalized education, modernization of universities' educational policies

1 Introduction

The modern iron and steel industry has some unique features. On the one hand, technologies and scientific principles known from the 18th and 19th century are still used in it, and on the other hand, in the past 30 to 50 years, this industry has become so complicated due to development of information technologies, the power industry and automation, that it requires specialists of higher level compared to those trained 10 to 15 years ago [1].

In the context of stiff global competition of world steel making companies, expenses per 1 tonne of product are one of key criteria of competition. In this respect, the issues of headcount optimisation and specialist model change through development of his or her multi-functional professional knowledge and skills are of high importance at metallurgical enterprises. In addition, there is a demand for specialists who are capable to solve quickly and understand existing process and operational problems, and improve the technology efficiency, create new products, apply new methods and approaches, developing in this way the production and the industry in general [2].

In this situation, universities get involved into the competitive struggle of metallurgical companies. In this context, universities have to compete with each other not only for the best applicants and students, but also in the area of development of new educational programmes and educational technologies providing training for 'new' specialists working on the frontier of knowledge in metallurgy and contributing to technology breakthroughs of iron and steel companies. Such educational programmes, certainly, shall be unique, exclusive, and shall differ from the principles of mass training at universities.

2 Task Setting, Problems

Before talking about design of new educational programmes for the iron and steel industry, it is required to summarize the existing models of engineering personnel training at universities. Modern universities having 5,000 to 10,000 students and more are forced to be involved into education massification under optimisation of the resources. When such model is used, an educational programme has a certain "base" and a variable part that determines the educational profile and specialization of a graduating student. The massification model is explained on Fig. 1 in more details.

One cannot deny that when such model is implemented universities are seeking to keep up with the time as much as possible, develop their own, and implement existing, frontier educational technologies, which will replace traditional education formats in the nearest future. They are global educational internet-platforms, on-line trainings, different simulators, etc. Availability of internet resources is currently one of the main modules for developing programmes of mass engineering personnel training.

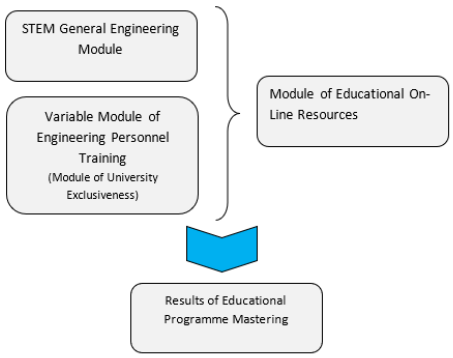

Fig. 1. The Model of Mass Implementation of Engineering Personnel Training

Due to development of information technologies, the amount of information is so large that the present knowledge could not be placed into textbooks and is becoming out-of-date. It should be mentioned that the portion of implementation of educational programmes due to the use of internet resources will only grow and will achieve 30 to 40% of the total volume of credits, and these technologies are used for implementation of the following two modules.

The next module is so-called the general engineering module named STEM: Science means science basic knowledge (philosophy and history, philology, mathematics and physics, chemistry, economics), Technology means existing technologies in engineering (application of basic knowledge in existing technologies of different industries); Engineering means basic principles of computer-aided design and simulations, basic knowledge of CAD and CAE systems; Math means applied mathematics and informatics.

The third module of an educational programme in the context of mass implementation of the educational process of engineering personnel trainings is so-called the variable module, where the profile and specialization of a future engineer is formed, and elective courses are implemented. In this module, higher education institutes and their departments and sub-departments can implement original courses based on implementation of own research, and an educational process in this module can consider the regional component of university positioning.

Therefore, the content and specific character of this module reflects original exclusive features of each university within educational courses built on the results of own scientific studies, availability of unique specialists-experts as instructors, and particularities of the regional industry. The portion of this module shall be at least 30% of the total volume of an educational programme.

It should be understood that within the model represented above it is very difficult and sometime impossible to train a specialist capable of solving actual production tasks at the expert-analytical level, capable of conducting scientific research independently, designing a technology and creating new products for the iron and steel industry, contributing to the development of an iron and steel company in this way. Therefore, new approaches and understanding are required for design of engineering educational programmes.

3 Description of the Process of Development of the Engineering Personnel Training Model

Provided that training of 'a unique specialist' shall be based on certain training, the process of designing of an educational programme for training of master-level students for the iron and steel industry is reviewed as an example. Before we have considered the model of training of a specialist as a person working inside the profession, and now the attention will be given to the modelling of the process of training of 'a professional' as a person developing the industry.

Before starting to design an educational programme, it is required, as banal as it may sound, to set goals, to answer the question about a purpose of this educational programme: what product will be received as a result, what 'should happen' after mastering the educational programme, what effect will be received after solving the considered problems, how the condition of the existing system will be changed. For example, a metallurgical company needs specialists in the area of predictive and statistical analysis, or computer modelling of cold rolling, or automation of a process technology, or in general, a combination of these skills.

When developing a new educational programme, it is necessary to consider specific aspects and a unique nature of a university in this field, there should be a concept of new proposals on its content and forms of educational process organisation. It is logical to analyse how other universities implement similar programmes now, whether they did it before, and what results were achieved.

Students must not be viewed as young and inexperienced for such training. These educational programmes are entered by quite mature people who usually already have production experience, know the technology and equipment of metallurgical productions and who have faced certain technological problems. It also should be taken into account that in the modern world every person seeks to make himself or herself within 'his or her unique trajectory', and, respectively, an educational route [4].

So, how can a student find his or her unique route and, respectively, control his or her education? There should be a general principle or a common ground, on which many educational formats can be combined and the results of experiments in education can be captured. This general principle is a competence as an ability to follow a certain type of actions in a certain professional and social context.

The following types of competences are distinguished in training of professional engineering personnel:

- Narrow specialized competences (knowledge of technologies and equipment of cold and/or hot rolling of flat products, grasp of calculation methods, operation of automated control systems, mill speed mode control, steel cooling, etc.)
- Over-professional competences, such as an ability to come up with new possibilities and identify them (development of control system operation algorithms, programming, big data analysis)
- Competences characterizing a universal class of activities, which, as some people think, are personal characteristics, a personality of a specialist and a student, but which also can be developed during an educational process. These competences are also called existential, for example, leadership skills, teamwork, public speaking skills, etc. [5, 6].

To a large extent, a competence is not a perfect concept. Some difficulties with competence description also exist. However, a competence-based language of description of education results is convenient for an employer and clear to the labour market, as it is easy to evaluate narrow competences. Outlook studies in this field represent a specialist competence model formed through big data analysis in the system of a metallurgical enterprise.

When designing educational programmes of professionals training, the following formats are usually taken as the key ones:

- Designing of educational programmes together with business. In this case an employer is not a sponsor, but a task provider. And in this case there is a risk of being dependent on a certain employer; therefore, game formats, creation and study of models and analysis of cases are used
- An educational programme is created on the basis of practical skills, and knowledge plays a secondary role
- In the educational programme, a student gets into a professional community of experts through practice/internship in the actual production environment
- Work in teams of students where they teach each other
- In the training process, students implement projects within selection of gaols and means for solving tasks of research and applied nature [7].

In any case, an educational programme of professional engineering personnel training in its content represents research and development projects and creation of technologies.

The suggested model of design of educational training is based on the world known approach of an educational programme structure named MAJOR-MINOR with additions and corrections [8].

In contrast to the traditional approach to the MAJOR module formation as the fundamental or general engineering training, introducing a student to a special filed, it is suggested to immerse master-level students into issues of metallurgical production, studying of global scientific problems in the considered industry, receiving skills of formulation of new hypotheses, problems setting, organization and conduction of pilot studies, acquiring skills of applied mathematics and informatics using up-to-date software packages. It is also necessary to analyse the existing methods and approaches to solving tasks for the iron and steel industry in order to develop the new ones. It is clear that new results cannot be received by old methods.

The result of student education at this module should be the skill to 'ask questions rather than the ability to answer them'.

The MAJOR model can be called 'the problematics module' in the represented concept of the educational programme design.

In turn, the MINOR block is focused on development of over-professional and narrow competences of a specialist in the area of metallurgy.

This block consists of two parts:

1. MINOR Professional Project (an intersdisciplinary module of team eduction of students). At this module, a student is not taught to individual special disciplines, but is immersed into implementation of actual research tasks in the interdisciplinary field. Therefore, the student training shall result in solving industrial problems or research tasks. The theme of tasks to be solved can be determined by business, or by a university, or by a student himself. This module shall be designed in such a manner that it would be of the same volume in credits and it should start and end at the same calendar period at several engineering educational programmes for training specialists in partner areas for the iron and steel industry (power, automation and IT, and equipment). It will allow for the formation of student teams during an educational process, who will deal with scientific studies, applications and engineering. Within this module, a student, on his or her own, can also get an internship in R&D structures of iron and steel companies. A key moment in this module is not a studied subject/discipline, but a topic. The required specialist is formed at the module. This module is a 'formation' module.

2. MINOR The Module of Multi-Professional Competencies Development. In the contrast to the module described above, this

module is disciplinary and elective. In this module, a student can choose additional competences from other educational programmes, for example, to study programming in depth, improve the skills of designing and modelling in CAD and CAE-systems, electric drive and hydraulic systems.

Essentially, this module is a competence build-up of the model of professional engineering personnel training for the iron and steel industry. This module shall be based on the needs of the 'future' responding to the question 'What additional competences shall a professional in the area of metallurgy have?' Students from different engineering educational programmes are also admitted to elective courses for purposes of creation and development of professional communities. This module can be called as 'the module of development'. The model of an educational programme of professionals training for the iron and steel industry is schematically represented on Fig. 2.

Conclusion. Implementation of the considered approach on design of an educational programme of master-level professionals training for frontier development of the iron and steel industry also involves creation of absolutely new evaluation systems, for example, projects completed by a student, obtained results, an economic benefit, implementation, the level of interested experts from the industry, etc.

The distributed system of competence exchange at the interdisciplinary and multi-professional level addressed in the paper can become one of the directions of educational policy modernisation within current expert professional communities (clubs, departments, etc.) at universities.

Implementation and positioning of such programmes shall be started within the following aspects and leads:

- Interest and demands of students
- Trajectories of personal growth of 'successful people' from the considered professional community, an industrial iron and steel plant; for example, which competences are required in order to become a chief technologist of rolling production
- Formation of an educational trajectory with involvement of so-called 'mentors', 'educational navigators', the future of education is his or her individualization

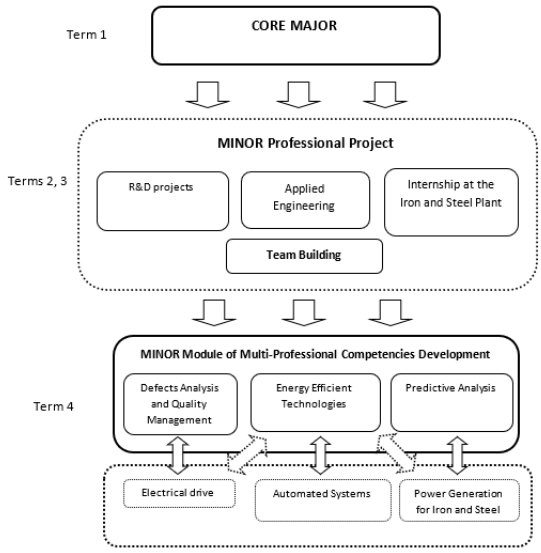

Fig. 2. The Model of Master-Level Students Training for Iron and Steel Industry Enterprises

One should be warned against possible mistakes in modernisation of the engineering personnel training system at universities. You cannot choose between education and R&D at universities. The competences of R&D should be obtained first, and then the education shall be focused on [9, 10]. It should be noted that a person not involved into research cannot teach anything. Presence of an R&D centre at the university also does not mean presence of competences for professional engineering personnel training.

It is possible to teach only in the course of actual actions, and these actions shall be focused on development. However, new knowledge cannot be born 'in captivity'. 'An academic freedom', autonomy from mass educational processes taking place at universities shall be created. Topics of projects shall be selected by a student, not given by an instructor. Efficient tools for students' immersion into independent behaviour shall be developed at the university. The proposed format of design of new educational programmes requires certain liberation of teaching and research staff from the burden of existing restraining educational formats.

It should be understood that education is a basis and a source of transformation.

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