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The Project-Oriented Educational Model for Training of Young Engineering Professionals on the Example of the Project "CNC-Team"

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***Abstract*—In the article, the authors offer an educational model of training for teams of young professionals in engineering and technical specialities with the realisation of the project-oriented approach in their training based on the Industry 4.0 concept. The project-oriented approach allows future specialists of enterprises to adapt to changing modern technologies quicker and more successfully. The article deals with the process of transformation of the concept of engineering training, with the purpose of creating prerequisites for the formation of a fundamentally new approach to engineering education, the current challenges of the global market today and in demand for enterprises in the future. Project-oriented modules implemented within the framework of the CNC-Center project-production workshop as a possible alternative for the corresponding modules of the traditional educational program are provided, which allow completely to excluding the threshold level of competence formation. As the main educational technology is project training. The main carrier of the transformation of educational process is project activities and practical training.**

Keywords—modeling, project work, Industry 4.0, foresight technologies, look into the future

I. INTRODUCTION

Today's society is characterized by the growing influence of modern digital and Internet technologies. The development rates of such technologies surpass those of the adjacent technological and non-technological sectors of the economy for which they act as development accelerators. Rethinking concepts "production" and "production process" over 2005-2010 has led to the formation of a new industrial structure concept – Industry 4.0. The key development factor in this concept is reduction in time used to prepare and upgrade production facilities, along with the emergence of urgent consumers' demand differentiation.

In this regard, problems of training engineering and technical specialists remain relevant. Enterprises often resort to so-called "project teams" – teams of professionals in different engineering and technical spheres. Such teams can quickly adapt to new conditions, prepare a design decision, have necessary skills to work with modern technologies, and are able to project the current situation taking into account the future outlook [1,2].

Introduction of the Industry 4.0 concept is closely associated with the next development stage of the modern production. One aspect of such production (digital production, production within the new industrial structure) is the widespread application of hybrid, combined and additive technologies to the production process and the departure from traditional mono-technologies. The development of unmanned production, adaptive production systems, and autonomous transport systems and complexes was also announced [3,4].

Restricting factors here are the lack of educational models intended for training of young professionals with the use of the integrated approach within the single digital and technological flow, exchange and processing of information regarding the state of the production process; [2,5,6] along with a number of problems related to the staffing support of digital production, and the lag of the existing university structure used to train engineering personnel [3,7,8].

The proposed model involves the creation of the supportive environment favorable for training teams of young professionals who are able to independently develop professionally in the foreseeable future, to adapt to new challenges of advanced society development, to engage in engineering of prospective production systems, in creation and maintenance of intelligent digital production control systems.

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An example of this is the CNC-team. This CNC-center created within the framework of the new educational model, this student team is working on the creation and commercialization of projects in the field of advanced production systems and technologies.

II. The Fundamental Construction of the Educational Model

The purpose of this educational model creation is not the transformation of bases and processes of the educational process, but the transformation of the engineering training concept and creation of prerequisites for the emergence of an essentially new approach to engineering education relevant to the current challenges of the global market today and vital for enterprises tomorrow.

Testing the proposed model (see Fig.1) of the educational process will ensure the continuous formation of students' competences in achieving perspective production objectives which involve engineering of constructions, technologies, materials that will be in demand in 5-10 years or in the foreseeable future.

Detailed and regularly updated subjects for project work guarantee the continuous engagement of a great number of students in thematically-oriented projects and stimulate the influx of new students of junior courses to the teams of senior students [1,9].

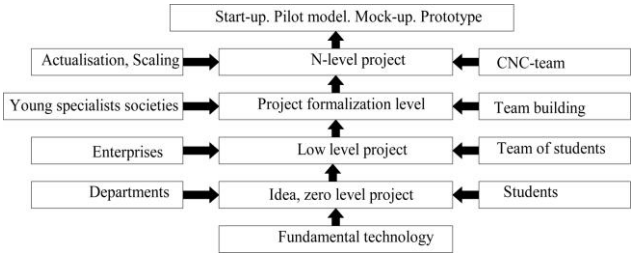

Fig. 1. Block diagram of the educational model

As part of the CNC-center, students with new idea or zero level project, implement mini-projects (for example, the calculation and design of the machine spindle), then there is a consolidation of the project, testing of its results. Then, after team building, the most successful technical solution is implemented in the project of creating a mini-CNC machine. The difference of this approach in the implementation of such a model of the educational process from the traditional is that the whole process is controlled by students. Moreover, the most active participants form the backbone of the CNC-team, which ensures the development of the project to the start-up stage.

Within the course of the project implementation, at its initial stages, the joint work of departments and student projects is ensured, and at the final stages the network of other divisions and laboratories of the university joins in. Cooperation with them enables the student project at the stage of its completion to develop the technical solution formed within the project and makes possible its refinement until it becomes a "pilot model", a "mock-up" or a "prototype" [10-12].

The main effects of the model implementation steps are expected to be an increase in the demand for graduates and higher prestige of engineering and technical specialities in the region.

Since the example of the project under consideration mini-CNC machine can also be implemented projects of larger organizations and customers.

III. Research Methodology

The model implementation is based on a set of technologies allowing to perform an analysis of trends that are relevant both in the near and far perspective and represents a series of activities in a logical sequence [12,13]. The paper presents the results of the educational model testing with the use of foresight technology, using foresight technology in relation to the activities of CNC-center [14].

At the first stage, in the process of processing the trend, students are divided into teams and form the image of the future determine the vectors of future development of production and technology that will be in demand by society in the future to form a social environment. The next step is to formulate a key idea for the team, and then they develop a project that is relevant for the future (zero-level project, figure 1). Further, taking into account the role of each participant, the CNC-team prepares the project passport, presenting in detail the necessary activities and resources of the project [15,16]. Further, using the knowledge gained by the zero-level project, the CNC-team have the opportunity to review and develop their projects until they reach the first level, the second level, etc. Result of the implementation of the educational model is the joint work of departments and student teams, as well as enterprises that can enter into work at the final stage [17]. Cooperation with them ensures that the student project will create a ready-to-use technical solution.

IV. Testing Results

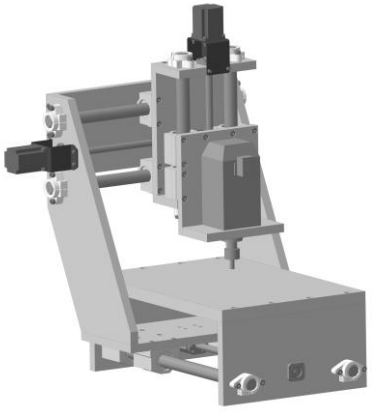

Fig. 2. CNC-machine model

In the process of testing the proposed educational model, students CNC-team, implemented a project to create an existing mini CNC-machine (Fig.2). According to the results of the implementation of mini-projects, students conducted tests. Further, the functional model of the machine in full size was prepared (Fig.3). Further on the basis of the model was created a prototype CNC-machine. According to the results of the study of the model layout (Fig.1), the students made a working CNC-machine (Fig.3) [18]. This project was implemented on the basis of the production equipment available in the CNC center.

According to the model (Fig.1) when implementing the CNC-machine project, the student team of CNC-team, three mini-projects were implemented. This is a project for the CNC-machine table development (Fig.3), the project for the CNC-machine portal drive development (Fig.4), the project for the CNC-machine spindle development (Fig.5). As a result of the implementation of three mini-projects, the assembly of the finished design of the CNC-machine was carried out (Fig.6).

Fig. 3. The CNC-machine table development project result

Fig. 4. The CNC-machine portal drive development project result

According to the results of the educational model implementation, it is possible to conclude that already in their first year the CNC-team students demonstrate sufficient competence to "enter" the first phase of the project work – to formulate an idea and implement the project.

CNC-team students enthusiastically realize their initiatives and learn to plan the work rationally and allocate responsibilities for its implementation among their team members, with the approach focused on the achievement of the result.

Fig. 5. The CNC-machine spindle development project result

Fig. 6. CNC-team testing of the CNC-machine finished design

V. CONCLUSIONS

As the results of the educational model testing have shown, the following is ensured already at the first stage of zero level projects realization.

1. An opportunity to organize project sites and interaction with the city community. The students have the chance to talk about the future of their professions and to understand their importance in the future.

2. A methodical opportunity to work directly with the intellect of each team member, both at the stage of producing ideas for the projects in demand, and at the stages of the project implementation, without the need to form certain professional competences in students in advance.

3. An opportunity to create an effective academic environment in universities. To instill in students, from the first days of training, a team approach to solving complex problems, to enable students to understand their personal

roles and the influence of each team member on the project results.

4. The experience gained in the introduction of project-oriented training indicates that the structure, content and organization of training in such practice-oriented programs makes it possible to form, at early stages of the training of young engineers, their individual educational trajectories, to form student youth teams, project groups, to carry out interdisciplinary projects, provide cross-disciplinary training of specialists in demand in enterprises in the foreseeable future.

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