Ecosystem of education competence center of the Industry 4.0

D A Zakoldaev, A V Shukalov, I O Zharinov and N I Dorofeev

Faculty of Information Security and Computer Technologies, Saint Petersburg National Research University of Information Technologies, Mechanics and Optics, 49, Kronverksky Av., Saint Petersburg, 197101, Russia

E-mail: mpbva@mail.ru

Abstract. The task is to organize an educative process to prepare the specialists in direction of the Industry 4.0 paradigm. The Industry 4.0 paradigm means to create industrial companies with digital informative technologies and which function automatically. To work in such companies, they must prepare the specialists of profile competences. It is clear that the educative program scientific content must contain the property of interoperability for all technologies which are used together in a digital production. To attain informative technologies, they need to create technological and branch centers of competences which are specialized preparation of highly-qualified personnel. There is a structure and components description for an Industry 4.0 competences branch center.

1. Introduction
The highly-qualified specialists preparation to work in the Industry 4.0 companies [1, 2] under the economy digitalizing is a strategical task of the National technological initiative «Tekhnet». The features how to prepare cadres to work in digital companies are [3]:

- oriented on practice approach to realize an educative program;
- competence approach for the student to acquire knowledge and skills (abilities and visions);
- cross branch approach to choose the progressive informative technologies which are the scientific content of a specialist preparation educative program.

Oriented on practice approach [4, 5] to realize an educative program is based on application of industrial company resources in a study process which are net partners for an educative company. Competence approach [6, 7] for the student to form knowledge and skills is based on institute environment creation inside the educative company oriented for student professional competences development. Cross-branch approach [8] to choose the informative technologies necessary for the Industry 4.0 digital company to form the educative program scientific content is based on technological and branch competences centers creation which function in the digital economy.

Technological and branch competences centers are the base of unified specialist preparation educative environment oriented to work in cyber and digital production divisions [9, 10]. In this case specialist professional preparation can be done in distance from the company they work or inside the company itself. This approach organizes the education (re-preparation) of professional cadres for the
existing companies of the Industry 3.0 and may give the students the educative programs oriented to work in the Industry 4.0 companies.

2. The Industry 4.0 technologies interoperability

Digital companies’ creation from cyber and physical division productions is done with integration of technological equipment and advanced informative technologies of the Industry 4.0 smart factories. The main technologies being applied in digital companies and which being studied today in educative companies are given in figure 1.

Having analyzed figure 1, each technology being used in production is of thin application and to acquire that one student must have the necessary resource provision and educative environment. Each separate technology industrializing of the educative program leads to the student formation of only the surface knowledge of all technologies at the same time or some special knowledge in one or several related technologies. To provide the student with the programs of the Industry 4.0 they must acquire multi-disciplinary competences as well as professional technologies disciplines and the disciplines which reflect advanced informative technologies interoperability.

Cyber and physical production technologies interoperability shall define the technology properties which grants the steady interaction of production components with the standard protocols of data exchange. So technology interoperability reflects its ability to interact with each other (functional compatibility) as a cyber and physical production.

In this line branch informative technologies competences and the skills how to apply several technologies at the same time must be acquired by the student which are necessary to solve the production tasks. In practice they apply together the following technologies in particular:

- cloud technologies and industrial Internet of Things technologies;
- cloud technologies and augmented reality technologies;
- cloud technologies and the technologies of BigData to process the vast amounts of production data;
• sensor technologies and technologies of machine interaction (Machine-to-Machine – M2M) and systems (Systems-to-Systems – S2S);
• additive technologies and technologies of man-machine interaction (Humane-to-Machine – H2M);
• cyber and physical system security technologies and technologies of Industrial Internet of Things and other.

The functionality of a cyber and physical system (for example, a 3D-printer) is based on the application at the same time: additive technologies, industrial internet of things and cloud technologies and also the technologies of BigData and sensor technologies. To control such a cyber and physical system they require additional technologies cyber and physical system security, augmented reality technology and H2M-technologies. So advanced informative technologies must be acquired by the student together as an educative program.

3. Industry 4.0 competences centers
The Industry 4.0 technological competitive center is a collaboration of an educative company and some industrial companies which have resources provision necessary for the student to acquire a limited nomenclature of informative technologies.

Organization resource provision is:

• informative technologies practical application results data base received during the creation of new highly-technological product with high added value;
• theoretical bases knowledge base, methods and means which can be used to realize advanced informative technologies;
• science and educative cadres of so called artful groups and research groups oriented to research and implement with the student advanced informative technologies into the industrial production;
• cyber and physical system industrial and laboratory equipment which are necessary to create the flexible automatic production divisions of the Industry 4.0.

The Industry 4.0 technological competences center has a specialty of science and educative cadres limited to set of educative process instrument provision and a limited set of informative technologies, which are necessary for the student. Technological competences centers cannot be a strategical academic unit of the Industry 4.0 educative process. Such an academic unit could be a branch competitive center. The Industry 4.0 branch competitive center ecosystem is shown in figure 2. A branch competitive center unites resource provision of several technological competences centers which function in an educative organization base.

By resources of different technological competences centers integration into a resource provision an educative program they may level the problem of specific specialization of some informative technologies which student gains in an educative company. Unification of technological competences centers resources creates the conditions for inter-disciplinary content of an educative program science content, which shows multi-technical character of the item being manufactured in a digital company cyber and physical production division.

Data base, knowledge base, science and educative cadres, industrial and laboratory equipment is an internal environment ecosystem of the competitive branch centers which has its own intellectual property. An external environment ecosystem of the competitive branch center has sets of norm documents which are necessary to prepare the specialists and which prepares the organization groups specialized in development of digital economy standards.

Norm base to prepare the specialists of the Industry 4.0 is formed with the sets of following standards:
• federal educative standards to regulate the content and order for the student to acquire educative program in his own country;
national research institutes educative standards to regulate the content and order for the student to acquire educative program in educative companies which have the right to define independently the features of the educative process realization and choose the innovative educative technologies;

- federal professional standards which define the student requirements to the competences who pretend in a competition to the occupation to the industrial company structural subdivision;

- branch industrial standards to regulate rules and features how to complete in production some technological operations being studied in the technological centers of competences to acquire the professional disciplines;

- online course which permits the student in a distance and interactively to acquire the theoretical bases and features of practical application in production of some advanced informative technologies.

4. Conclusion
The most important aspect of the Industry 4.0 digital company creation is the preparation of professional cadres oriented to work in cyber and physical production.

The Industry 4.0 specialist competence is the ability to apply in practice knowledge, skills acquired in the educative company by studying the advanced production technologies, which is the main content of disciplines in the educative programs. Oriented for practice educative program provides interaction...
of educative company and its industrial partner, which in the paradigm of the Industry 4.0 should be known as the center of competences.

The centers of competences define the event system, which are necessary to provide as oriented for practice educative programs to prepare the specialists by the educative standards of digital economy. In the paradigm of the Industry 4.0 the centers of competences are a form of professional society which prepares the cadres who know the different advanced production technologies.

Practical application of technological and branch competences centers is done with interaction of big number of different property types of companies (state and private partnership) which has a resource provision sufficient for educative process and united for a single purpose of highly-qualified personnel preparation procedures completion processes.

Organization of state and private partnership in education today are to be regulated by laws and can be done in net form on the contract base for companies. Educative program net form contract defines the volumes and types of educative load which is realized by parties with their own resource provision and also the place for auditory classes and availability of specific specialists (scientists) to the educative activity.

The development of educative technologies in the Industry 4.0 paradigm must be done in practice by the branch competitive centers, which prepare the specialists for cyber and physical automatic production. At the same time with the development of the educative technologies the education laws and standards must be perfected as well oriented to be applied in the conditions of the digital economy.

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