

Principles of organization of smart-university at personnel training for «industry 4.0»



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The article considers the necessity of changing the educational paradigm by universities as a result of the development of «industry 4.0» concept — the fourth industrial revolution. The article shows the expediency of universities' transition into the category of «smart enterprises» and transformation into smart-universities. The article describes the main principles of organization of smart-universities, such as the implementation of competence approach to educational process, the usage of methods of project teaching, digitalizing and computerizing of education, realization of individual educational trajectories. The article considers the principle of the formation of professional competences on the basis of communities of teachers, students, scientists. The method of web-portfolio is offered as one of the innovative methods of teaching, based on the formation of an individual educational trajectory.

Keywords: fourth industrial revolution, «industry 4.0», smart-university, personnel training, industrial enterprises, portfolio.

Topicality

In the recent years, a new term has appeared in special literature and experts' discussions, which defines the fourth industrial revolution. The first appearance of this term was connected with the 2011 Hannover fair — the largest industrial exhibition in the world. In 2012 the German government accepted the innovative program «industry 4.0» within the frames of the «Strategy in the fields of high technologies 2020» — a strategic project which was aimed at preserving the leadership of industry through the stimulation of innovations in all sectors by uniting state and business with the best scientists for new technological dash of German economy.

In Russia, under the instruction of V. V. Putin of the realization of the message to Federal Assembly from December 4, 2014, the work of creating the National Technological Initiative began. This initiative was introduced as a «program of creating principally new markets, as well as the conditions for global technological leadership of Russia by 2035».

National technological initiative (NTI) is among interconnected programs, some of which are the Strategy of scientific and technological development (SSTD) of

Russian Federation and the Program «Digital Economy». These programs are being realized in line with the fourth industrial revolution and similar directions which are being developed in the USA («advanced manufacturing technology»), Germany («industry 4.0») etc. [1].

The advancement of the fourth industrial revolution is closely connected with the creation of smart-enterprises, development of global industrial nets, appearance of cyberphysical systems, implementation of concepts of the industrial Internet and the Internet of things [2-5]. As a result of the development of «industry 4.0» the industrial resources (both labour and material), technological equipment and finished products will become active components of a single system that manages its industrial and logistical processes. In this case cyberphysical systems will connect the virtual Internet space with the real world. They will also be able within the smart-factories to make their own decisions, regardless of people, provided there is sufficient supply of finished products and «smart machines» with the appropriate sensors and chips.

According to the director of German research centre of artificial intelligence V. Valster «in the world of «industry 4.0» machines will be able to understand its surroundings

and communicate with each other through the Internet-protocol. It is assumed that the first enterprises of new industrial revolution will start to function in just five years» [6]. The results of Russian experts' research show that «according to various assets within the next 20 years from one third to a half of workplaces in industrially developed countries will be replaced by robots, computer programs and other automatic solutions» [7].

This fact becomes a sort of a challenge for universities, so that some leading world educational organizations with technical emphasis take over new attitudes to personnel training with appropriate skills. According to the authors, the transformation of educational establishments to smart-universities may be the response to the challenge of the fourth industrial revolution.

Goals and objectives

The main aim of the research is to formulate a number of principles which must be the foundations of the smart-university concept. Accordingly, the objectives of the research are to analyze and define main principles of the organization of smart-universities and to show the connection between these principles. From the theoretical point of view, the research is significant to the formation of the basics of conceptualization of smart-education. The practical value of the research is that the formulated conceptual principles of smart-education might be applied to the development of the full-scale concept of a smart-university.

The transition to the model of «smart enterprises» will lead to the appearance of new specializations, such as «system engineers», united in one traditional engineers-constructors, technicians, material specialists, estimators, programmers, etc. Thus, traditional specializations will be replaced by the new ones. Employees who possess the creative potential and are able to think and work in the new world will be necessary to industry. In fact, the work path of the growing generation will be surely connected with adaptation to appearing challenges and constant development throughout all life. It is vitally important to every specialist to realize that in the modern world one cannot initially get the education which will be sufficient for the work for all years to come. The realization of this objective is impossible on the basis of the old educational technologies and demands both new technical, program, information, communication means and new methodologies of open education.

An executive director of the Centre of modern manufacture and innovative design of Florida technological institute (USA) Michael Greeves says that nowadays they constantly demand USA universities to implement the programs of industry teaching, despite the lack of experience in this sphere. This is due to the need of organization of workplaces at the USA industries, as well as the implementation of innovative technologies, which alter the way of industrial processes and cut the final production expenses [8].

A professor of logistics and industrial engineering of business-school ESB at University of Roitlingen (Germany) Vera Hummel notices that while formulating a curriculum we have to come across the same difficulties

as the industry encounters while organizing technological processes [8].

The curriculums of modern universities almost do not include the subjects which are aimed at the most important thing to students – the search of problems and objectives, the analysis of society's needs and ways of their realisation. For all that the development of intelligence, as well as information and analytical systems of vocational education are expedient [9-11]. The system of information and analytical support in the field of education must meet a number of complex tasks aimed at the development of the education system, in accordance with the target orientation and current activities of educational institutions. In the foreseeable future the wide implementation of artificial intelligence systems (information, expert, analytical ones) into educational process is expected.

The contents of the concept of smart-university is understood differently in every country, but, in all cases, it brings us to obtaining a number of new effects, which satisfy the needs of interacting sides in the conditions of a new type of society, which is characterized primarily by the presence of communication technologies in collective action. Considering this, only modifying the whole system of Russian education can make it possible to get the specialists who possess the professional skills of some quality and are able to be recognized all over the world.

The following principles define a smart-university:

- implementation of competent approach;
- usage of methods of project teaching (focusing on problems);
- digitalizing and computerizing of education (flexibility of teaching in the interactive educational sphere, free access to the Internet contents all over the world);
- individual teaching.

The implementation of these principles will help to develop the necessary competence in the training of personnel for «industry 4.0», which involve the problem of transmitting the interdisciplinary nature of the new production environment. The solution to this problem requires enhanced cooperation between education and industry to demonstrate the primary focus on mastering new ways of thinking and teaching, as well as production.

In today's world the transition to project education is happening. Projecting is being defined as an activity towards creation of new objects with the characteristics given in advance. The main way of personnel training – education together with work on certain projects. To achieve that, creation of integrative scientific and educational creative spaces on the basis of universities is necessary. Such spaces must be aimed at forming the environment for interdisciplinary project work on Russian and world industry orders, which are being executed jointly by the representatives of academic institutions, industrial enterprises, students, postgraduate students and teachers. In order to make this activity well-developed, the outrunning implementation of key technologies, the improving of material and technical base, as well as the acquiring of positive work experience with world leading high-technological enterprises are necessary.

Integration of educational and scientific environment, business sphere, as well as the sphere of real economy

sector allows industrial enterprises, by influencing on the teaching process, to get the personnel that will be trained in accordance with topical current tendencies. In their turn, universities, monitoring the changing demands of industries from different branches to specialists, are interested in operative review of the contents of educational programs, methods of their teaching, which in turn increases the competitiveness of a university. Thus, the currently observed gap will be excluded – the gap between educational and practical spheres, when a graduate goes to the industry job and is offered to forget everything they taught them at university [12].

At the same time, business and industrial enterprises may not only play the role of «consumers» of graduates, but also be the «financial source» of university – a customer of scientific, research, experimental, engineering, technological works carried out by universities. To university such a form of integration is the mark of its efficiency not only as an educational center, but also as a scientific and research one.

When sectors and branches of economy become closer and borders of fundamental and applied science blur due to the necessity of solving complex scientific and technical problems it is expedient to orientate on competences of graduates as the final result of project-orientated teaching. Competences may be defined as a personality's quality, which is constantly developed in the process of education at university, which is expressed in the ability and willingness to self-sufficient resolving of research objectives, connected with orders of Russian and world industries, as the acquiring of methodology of research work, as the willingness to use existing methodological development in one's future profession [13].

The achievement of the best results in the process of forming the competences of specialists may be provided with the help of practical solution of complex industry objectives by teachers and different kinds of students within the frames of interdisciplinary teams on the basis of leading scientific schools through mutual accomplishment of interdisciplinary research, applying high technological equipment and innovative industrial technologies (fig. 1).

Innovative methods of education must lead to the change of teachers' role, who have become not just

knowledge carriers, but also tutors (consultants, experts), who initiates students' creative search of applying innovative technologies in the teaching process. A new interactive form of teaching must replace the traditional one, which supposes lectures and seminars only, as well as one-sided form of communication. A new form should include the joint work of students and teachers which allows participants to interact, make mutual decisions, share information and model situations.

The most important factor of the transformation of modern society and higher education in particular is its global computerization and digitalization, caused the rapid development of information computer technologies, Internet resources, communication channels and means of communication and exchange of information. Information technologies open new opportunities for educational system: allow educational establishments to cover additional categories of students, including foreign ones; open new horizons of teaching; give new means and innovative educational technologies; strengthen research opportunities.

The system of continuous education is quite topical; it may have different names [14, 15]: «lifelong» (USA), «continued» (England), «renewable» (Sweden). Continuous education considers the demands of real economy and supposes constant training of specialists throughout their life in the process of building a career ladder. Contemporary smart-society and its approach «education throughout all life» define the necessity of training according to the principle «train where it is convenient to the learner», that is the mobility of contents' consumption must become an essential principle of smart-education.

Implementation of cloud technologies allow to provide universal net access to general repository («storage» of information), which supposes the search intelligence system. Access to the Internet resources for every user, as well as availability of various educational Internet contents satisfy the students' need to get information and improve their knowledge. Cloud evaluations and sharp inflow of mobile technics have defined one of the important directions in education – mobile training as a contemporary technology of studying, personnel training and re-training.

The importance of students' personal development is becoming evident, which demands individualization of training trajectories in the format of «education throughout all life», as well as increasing self-sufficiency in studying. Great motivation in training may only be on the basis of both creative acquiring of knowledge in subjects' fields and setting important objectives in terms of practice, which are not solved up to date. The possibility of applying interactive methods to self-studying is in the organization of group students' work. Stimulating positive communication between students leads to formation of social behavior skills, managing conflict situations, ability to make decisions quickly and constructively.

One of the innovative methods of training on the basis of formation of individual educational trajectory is the method of web-portfolio. Portfolio – is a modern innovative educational technology which is based on usage of the method of authentic estimation of results

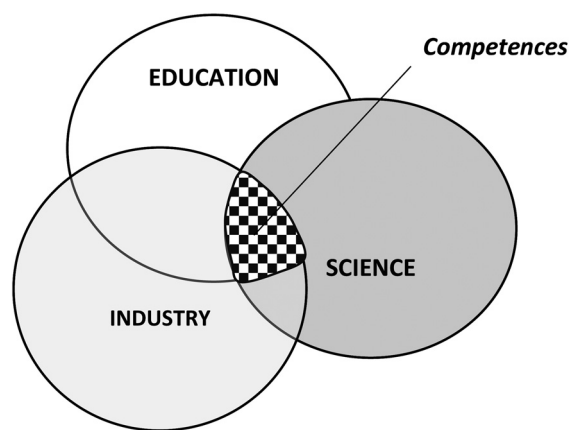


Fig. 1. The principle of the formation of professional competences

of educational, scientific and professional activities. As a rule, portfolio represents students' self-presentation of their achievements, which are fixed by themselves. Within the frames of a competence approach portfolio manifests itself as a way of demonstration, development and evaluation of students' competences, a mechanism of monitoring their achievements, presenting students' successes to the interested people. Portfolio contributes to the development of social and professional communication of students and graduates, helps establishing contacts with potential employers. Unlike the traditional resume web-portfolio allows to present and evaluate social, personal and professional competence of a person, define their inclinations, trace the direction of their development significantly better.

The totality of portfolios of students, graduates and teachers makes portfolios of departments and institutes, which in turn form the portfolio of university, within the frames of which they all actively integrate with one another and with the outer surroundings – applicants and employers (fig. 2).

Thus, web-portfolios of students and teachers are the core of rates of their achievements. The analysis of portfolios' contents allows to improve the system of criteria and marks of efficiency evaluation related to educational and scientific activity of departments and institutes, as well as to order the organization and management of university's activity.

Conclusions

The impetuous development of the fourth industrial revolution makes universities dealing with the question about of the necessity of changing the educational paradigm, which must coincide with the paradigm of industrial production. The borders between formal and informal education must be gradually eliminated, personalization of education must be strengthened, which will define the university's role as an integrator of educational, scientific, business and industrial environments. The universities which are able to realize the principles of creating a smart-university will be the most competitive.

The main principles of organization of smart-universities are the implementation of a competence approach to educational process, the usage of methods of project teaching, digitalizing and computerizing of education, the realization of individual educational trajectories.

One of the methods of education within the frames of realization of the principles of a smart-university is the method of web-portfolio, which is based on formation of individual educational trajectory. The analysis of the structure and interaction of university's portfolio allows to improve the system of criteria and marks of efficiency evaluation related to educational and scientific activity of departments and institutes, as well as to order the organization and management of university's activity.

Performing the actions on building a smart-university on the basis of the principles offered will allow to realize new forms of training, increase the motivation of participants in carrying out scientific research and the efficiency of university's management. At the same time the possibility

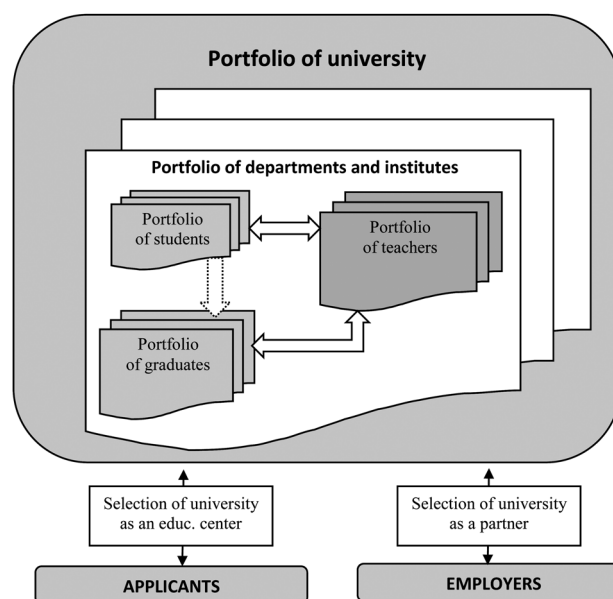


Fig. 2. The structure and interaction of university's portfolios

of formation of university's innovative environment on a new quality level will be maintained, as well as the building of university's management system in accordance with objectives to solve and considering contemporary tendencies. High qualification of graduates, their ability to adapt acquired competences to continuously changing conditions of activity, new goals and objectives must become the most important non-material asset, which will provide and maintain stability to the enterprises of the real economy sector, as well as the development of domestic and world markets.

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Принципы организации smart-университета при подготовке кадров для «индустрии 4.0»

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В статье рассмотрена необходимость смены образовательной парадигмы университетами в результате развития концепции «индустрии 4.0» — четвертой промышленной революции. Показана целесообразность перехода вузов в категорию «умных предприятий» и их трансформация в smart-университеты. Рассмотрены основные принципы организации smart-университетов, такие как внедрение компетентностного подхода в образовательный процесс, использование методов проектного обучения, цифровизация и информатизация образования, реализация индивидуальных образовательных траекторий. Рассмотрен принцип формирования профессиональных компетенций в результате интеграции образования, науки, бизнес-структур и предприятий высокотехнологичной промышленности на базе сообществ преподавателей, студентов, ученых. Предложен метод электронного портфолио (web-portfolio) как один из инновационных методов обучения на основе формирования индивидуальной образовательной траектории.

Ключевые слова: четвертая промышленная революция, «индустрия 4.0», smart-университет, подготовка кадров, промышленные предприятия, портфолио.

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